Tree nursery trade in urban and peri-urban areas

A survey in Nairobi and Kiambu Districts, Kenya

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Abbreviations

Kshs Kenya Shillings (Kshs 78 = USD 1)

USD United States Dollar

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Abstract

The urban and peri-urban population in many developing countries is increasing at an alarming rate and it is projected that by 2015 the urban population will equal the rural one. Food and fodder insecurity is foreseen to accompany this increase. Agroforestry technologies can contribute to increased food and fodder production and minimized risks associated with small-scale agriculture, especially in the peri-urban setting. Tree nurseries play an important role in these areas and to understand their status, 39 nurseries were studied in urban and peri-urban Nairobi, Kenya, with the aim of understanding the technical and managerial nursery practices, germplasm pathways and the current economic situation of these nursery operations.

In the urban nurseries, 47 agroforestry tree species were encountered while the species in the peri-urban nurseries were 66. Most frequently encountered species - in declining order - in urban nurseries were *Grevillea robusta*, *Dovyalis caffra* and *Casuarina equisetifolia*, and in the peri-urban nurseries *Dovyalis caffra*, *Grevillea robusta* and *Passiflora edulis*. All nurseries visited were commercial enterprises. The majority (76%) of the urban nursery operators have no other source of income, whereas 76% of the peri-urban nurseries contributed between 5% and 90% of household income. Urban and peri-urban nurseries also differed in their approach to nursery management. Irrigation water was drawn from rivers by 36% of the peri-urban and only 11% of the urban nurseries. 30% of the urban nurseries used sewage water or road runoff for irrigation, none of the peri-urban nurseries did. Urban nursery operators generally had a higher education level than the peri-urban operators. Most prevalent constraints were access to water, germplasm availability and quality, and a lack of markets.

The total value of seedlings raised in the 39 surveyed nurseries in January and February 2000 was over USD 320,000.

1. Introduction

1.1 Background and objectives

The term "urban and peri-urban agriculture" comprises of activities within or on the fringe of a town or a city. Here, a diversity of food and non-food products are grown, raised, processed and distributed, largely to the urban area. The predominant products are high value and/or high-energy foods, such as fresh fruits and vegetables, milk, eggs and herbs. Many of these can be produced within a short-term rotation, on small plots and with insecure land tenure (Mougeot, 1999). Nearly a billion people worldwide are engaged in some form of urban and peri-urban agriculture and it is estimated that by 2015 more than one half of the world's population will be living in urban areas (Mougeot, 1999). This will increase food insecurity, threatening the urban environment and quality of life. In the context of this increase in population, agroforestry technologies can help to increase food and fodder production and minimize risks associated with small-scale agriculture (Jaenicke et al., 2000). To date agroforestry has not received much attention in literature covering urban and peri-urban agriculture (e.g. Kuchelmeister and Bratz, 1993; Mougeot, 1999), although it is getting increasingly more coverage in international journals (Kuchelmeister, 2000). The integration of trees in the peri-urban production systems is also increasing. Trees produce high-value products, such as fruits, medicines, fodder, timber and firewood, which have a ready market in both urban and peri-urban communities. Although some of these take several years to mature, there are either managerial ways to decrease time to harvest (e.g. grafting of fruit trees) or appropriate species or provenance selection (e.g. fast growing fodder tree species, such as *Calliandra* sp. or *Leucaena* sp.). Apart from environmental benefits of trees that are widely recognized in peri-urban forestry (Kuchelmeister and Braatz, 1993; Caballero Deloya, 1993), trees can also spread risks—especially in drought years—and yield even when extensively managed in cases when off-farm employment is contributing to the household income.

In order to assess the potential of agroforestry interventions in the urban and peri-urban areas, a survey of small-scale tree nurseries was carried out in January and February 2000 in the Nairobi and Kiambu Districts (urban and peri-urban, respectively), Kenya. This was a collaboration activity between the International Centre for Research in Agroforestry (ICRAF) and the Regional Land Management Unit (RELMA). The objectives of the study were to:

- Understand the pathways of germplasm for tree species raised in the nurseries
- Assess the status of technical practices within urban and peri-urban tree nurseries
- Gather baseline information for an economical analysis of urban and peri-urban nurseries
- List constraints facing tree seedling production within urban and peri-urban Nairobi
- Identify possible interventions to make the nurseries more productive.

1.2 Survey area

Nairobi is the capital city and a major metropolitan, commercial and industrial centre of Kenya with an area of 696.1 km^2. Geographically, the surveyed nurseries lie at 36° East, 1° South and more than 1,500m above sea level with a bimodal rainfall (March–April long rains and September–November short rains). Economic pressure due to the downward trend in economic growth nationally and like other cities in the developing world, has caused a major shift of people from rural areas and other towns to Nairobi to look for work and opportunity. This has contributed to high population growth – over 2 million with a growth rate of 4.8% according to the 1999 Kenya population and housing census (Republic of Kenya, 2000). This has led to increased employment shortfalls and poverty that has yielded to new psychological, social and physical problems.

Kiambu is a high agricultural potential district in Central Province. It borders Nairobi City to the south, Kajiado and Nakuru Districts to the west, Nyandarua District to the northwest, Thika District to the north and Machakos District to the east. Surveyed nurseries lie between 36°E and 0° to 1°S. Rainfall is bimodal ranging from 500 mm to above 1,800 mm per year. Its agricultural activities include dairy and sheep production, horticultural and food products (fruits, vegetables and flowers) and cash crops (mainly coffee and tea) (Kenyaweb, 2000) and Nairobi as the main market. It has four topographic regions: Upper Highland Zone, Lower Highland Zone, Upper Midland Zone and Lower Midland Zone. The Upper Highland Zone soils are of high fertility, well drained, very deep, dark reddish-brown to dark brown, strongly calcareous, in many places saline and/or sodic with inclusions of lava fields. Hills, plateaus and high-level structural plains characterize the Lower Highland Zone. The soils are developed on undifferentiated tertiary volcanic and basic igneous rocks. They are well-drained, shallow and reddish brown though in some places they are poorly drained, very deep, dark grey to black, with calcareous, slightly saline deeper subsoil. The Upper Midland Zone lies below 1,500m above sea level. It comprises volcanic footbridges and middle level uplands. The soils vary from well-drained, deep dark reddish-brown to dark brown with acidic humic topsoil to well drained, moderately deep, dark reddish-brown soils with nitro-chromic cambisols and chromic acrisols. Fertility varies between variable and moderate. The Lower Midland Zone soils are on dissected erosional plains. The area is very dry with low and unreliable rainfall. Soils are developed on undifferentiated basement system rocks, ashes, pumice from recent volcanoes, and sediments mainly from crystalline basement system rocks. Soils vary from well drained, shallow, dark red to yellowish red, stony loamy sand to imperfectly drained very deep, dark brown, firm, strongly calcareous, moderately saline and strongly sodic clay, with a top soil of a clay loam. Drought resistant crops such as millet are grown. Soil fertility ranges from high to low.

2 Methods

Mapping and identification of the nurseries were carried out in collaboration with the Forestry Department's (FD) extension services of Nairobi and Kiambu Districts. In Nairobi, 17 nurseries were selected from a list provided by FD. Selection criteria were geographic location at the edge of Nairobi City, FD extension staff availability, and nursery operator/manager presence. In Kiambu, divisional forestry extension officers availed all known nurseries in their locations (divisions) for the survey. Two nurseries were excluded from the survey since they had closed down due to drought. The focus of the survey was on small-scale nursery operators. Although most of the nurseries also raised ornamental plants, only agroforestry tree species were considered in the survey. Four divisions were surveyed in Nairobi–Kibera, Pumwani, Embakasi and Westlands, and five in Kiambu–Githunguri, Kiambaa, Limuru, Lari and Kikuyu (see Table 1 and Figure 1).

Table 1 *Number of nurseries per division interviewed in Nairobi and Kiambu, January 2000*

District	Division	Number of nurseries
Nairobi (urban)	Kibera	8
	Embakasi	5
	Westlands	3
	Pumwani	1
Kiambu (peri-urban)	Githunguri	4
	Kikuyu	7
	Kiambaa	8
	Limuru	2
	Lari	1

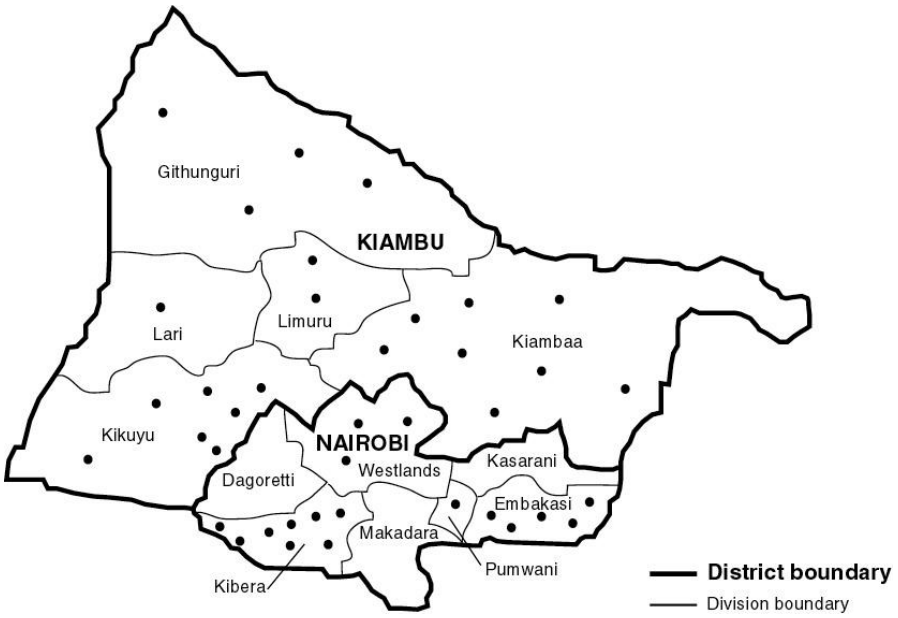

Figure 1 *The distribution of surveyed nurseries in Nairobi and Kiambu Districts (not drawn to scale).*

The interviews were conducted semi-formally using a loosely structured questionnaire (see Annex 1). The interviews were conducted in Kiswahili and only to limited extent in English. Global Positioning System (GPS) readings on the location of the nurseries were taken.

The questionnaire records were entered in MS Excel spreadsheets and analysed quantitatively using pivot tables. Data is archived in ICRAF's 'Logbook' data archiving tool (Muraya and Kaaria, 2000).

3. Results

3.1 Nursery classification and characteristics of respondents

A total of 39 nurseries were surveyed, 17 in Nairobi and 22 in Kiambu (Table 1). They were all commercial enterprises, except for the central and to some extent the group nurseries, which reported to give out seedlings at a fairly low price, and sometimes free, to group members for their own planting.

Of the 39 nurseries, the majority (79%) were individual enterprises[1], followed by group nurseries[2] (13%) and central nurseries[3] (8%)(Table 2). Most of the individual nurseries were owned and managed by men (84%). Only 16% were female owned and managed. However, women owned or managed 60% of the group nurseries. Men managed the three central nurseries. Group and central nurseries consisted of 80% and 67% respectively of nurseries found in the peri-urban region. Household heads operated and depended on most of the urban nurseries as their sole source of income, apart from a few cases where there were supplemental resources. In the peri-urban area, they were also heads of households, but other farming activities contributed significantly (between 10 and 95%) to household income.

Table 2 *Nursery classification, ownership and management of (peri-) urban nurseries*

Nursery class	Total number	Male owned/managed	Female owned/managed
Individual	31	26	R
Group	5	2	P
Central	3	3	M

In Kiambu, 45% of the operators did not have education higher than primary school, compared with 29% in Nairobi. Many did not finish primary school. In Nairobi, 53% started secondary school compared to 45% in Kiambu.

Table 3 *Level of education among nursery operators in Nairobi and Kiambu, January 2000*

Level of schooling	Nairobi (% of 17)	Kiambu (% of 22)
Primary	29	45
Secondary	53	45
College	6	5
No answer	12	5

Numbers of nursery operators considered: Nairobi 17, Kiambu 22.

Knowledge on operating a nursery was acquired through various sources, such as earlier employment in the forestry, national parks or flower production sectors, friends and relatives. However, training in nursery management was amongst the important constraints mentioned. Operators were interested in

[1] Private enterprises run by a family or individual for their own needs or for sale.
[2] Owned by a group and usually managed by a chairperson with the help of other group members.
[3] Belong to a private or public body, such as a company, school, college, church, NGO or a research organization.

short or long-term training on nursery management and also there was a great interest to be provided with nursery periodicals. Some operators train others, for example, one operator who previously worked in the Forest Department used his nursery as an educational centre for primary and secondary school students who attend the surrounding schools.

3.2 Nursery location and land ownership

There was a large variation and diversity in nursery production between Nairobi and Kiambu. Land ownership and utilization, contribution to the household income, city (municipal) council attitude and regulation, agro-economics, availability of resources, poverty, employment on or off farm, and use of tree species were the main factors attributed to this variation. Most urban nurseries were situated along roadsides to attract clients. These operators do not own the land on which they have set up their nurseries. Some of the nurseries are situated on city council plots and others on undeveloped private land under agreement with the landowners. Peri-urban nurseries were mostly located on farms with secure tenure. This distinction contributes to the difference in management approaches by the urban and peri-urban nurseries.

3.3 Choice of species

In total, 78 different tree species were raised—47 in Nairobi and 66 in Kiambu—totalling more than 700,000 seedlings in all surveyed nurseries (see Annex 2). This averaged to approximately 19,000 seedlings per nursery. Numbers of species per nursery ranged from 5–23 in Nairobi and 1–27 in Kiambu. The average number of species was 10 in both districts. The most important species in Nairobi were *Grevillea robusta* (16 nurseries), *Dovyalis caffra* (10), *Casuarina equisetifolia* (11), and in Kiambu *Dovyalis caffra* (19 nurseries), *Grevillea robusta* (14) and *Passiflora edulis* (11). Annex 2 shows the tree species that were encountered, average number of seedlings in those nurseries with those species and total number of seedlings.

The choice of which species produced depends on demand, seed availability and cost and location of the nursery. Nursery production inside Nairobi varied greatly with urban residents preferring ornamentals although some tree species such as *Grevillea robusta* (timber, firewood and boundary demarcation) and *Dovyalis caffra* (fence, fruit) have a high demand. This is probably due to expansion of city boundaries to the neighbouring areas such as Mwiki, Kiserian, Rongai, Ruai, Ruiru, among others, where many new plots for residence are being created and boundary demarcation is important. Whereas in Nairobi's urban nurseries timber species predominate in the nurseries, the peri-urban nurseries had larger variation in species.

Table 4 *The 12 most frequent species in urban and peri-urban Nairobi*

Nairobi		Kiambu	
Species	**No. of nurseries**	**Species**	**No. of nurseries**
Grevillea robusta	16	*Dovyalis caffra*	19
Casuarina equisetifolia	11	*Grevillea robusta*	14
Dovyalis caffra	10	*Passiflora edulis*	11
Jacaranda mimosifolia	9	*Cupressus lusitanica*	9
Eucalyptus sp.	8	*Jacaranda mimosifolia*	9
Terminalia sp.	8	*Eucalyptus sp.*	8
Cupressus lusitanica	7	*Persea americana*	8
Acacia sp.	6	*Prunus africana*	8
Callistemon citrinus	6	*Podocarpus sp.*	7
Citrus sinensis	6	*Casuarina equisetifolia*	6
Persea americana	6	*Mangifera indica*	6
Podocarpus sp.	6	*Markhamia lutea*	6

In peri-urban areas, tree species such as *Grevillea robusta* are planted on farm since it is believed that it has a minor competition with, and does not damage, crops. It provides timber and fuel wood. As a hedge-plant and boundary-marker, *Dovyalis caffra*, is a 'conflict prevention' plant. It prevents livestock from damaging crops, security and ensuring good relationship between neighbours. Medicinal species such as *Prunus africana* and *Warburgia ugandensis* are also given special attention since both nursery operators and farmers are aware that some ailments can be treated using products extracted from these species.

The choice of which species to raise was clearly influenced by the potential for sale, except in cases where nursery work is a hobby or when nurseries were set up to promote certain tree species (for example, for wood carving species at a nursery run by a handicraft society). Tree species with high value and market demand were preferred most although in many cases seeds for such species were scarce.

3.4 Propagation

Most of the tree species were propagated from seed while some fruit trees were vegetatively propagated (grafting or cuttings). About 30% of the nurseries produced grafted fruit species (mangoes, oranges, lemons, macadamia nuts). All nurseries used seed as one of their means of propagation. The proportion of tree species raised from seed is 90% and 80% in urban and peri-urban nurseries respectively. Wildings were only important in the peri-urban nurseries, where 10% of species were raised from wildings. Vegetative propagation methods (grafting, cutting and air layering) were known and used by 50% of urban and 55% of peri-urban nurseries (Table 5).

Table 5 *Propagation methods in the urban (Nairobi) and peri-urban (Kiambu) nurseries*

	Nairobi		Kiambu	
	Nurseries (% of 17)	Cases (% of 164)	Nurseries (% of 22)	Cases (% of 209)
Seed	100	91	100	80
Cutting	6	1	18	2
Grafting	41	6	36	7
Air-layering	6	1	0	0
Wilding	0	0	36	12

Number of nurseries: Nairobi 17, Kiambu 22.
Number of cases (species in nurseries): Nairobi 164, Kiambu 209.
Some species were propagated by several methods.

3.5 Nursery management

Substrate and containers

Peri-urban nurseries used on-farm soil for nursery production whereas most urban operators brought in soil from forests or construction areas to their nurseries. This is because city legislation does not allow for soil excavation within the nursery locality. Peri-urban nursery operators had a larger variety of substrate, and also used compost, sand or sawdust to improve substrate quality, whereas city operators used largely forest soil which in most cases was improved with manure–both soil and manure had to be bought.

Seedbeds range from bare ground, Swaziland beds to containers such as small to large polythene bags and tins or other alternative containers. Due to water shortage in the dry season and as a means of conserving water, some operators sowed seed and rooted cuttings in polythene bags that were tied closed to preserve moisture. This method prevents water loss since condensed water vapour finally returns back into the soil. These conditions are also good for rooting of cuttings.

Pricking out is a common practice for most of the species. For species that are sold in high quantity due to their use such as *Dovyalis caffra,* seeds are normally sown in multiples per container or in bare-rooted seedbeds. This reduces costs and makes their transportation from the nursery easier.

Shading

Shading encourages high germination rates especially when used on large seeds. This can be attributed to conservation of favourable conditions and prolonged warmth in the substrate. Cut grass is the most common shading material of the nurseries mainly used to cover seeds in containers and seedbeds until seedling germination (77% of nurseries). Other preferred sources of shade were trees (35%) and polythene (16%). A combination of various shade materials was common. There was no difference in the use of shade material between the urban and peri-urban district.

Water source

Irrigation water for the nurseries came from diverse sources, such as tap water (36%), boreholes (28%), rivers (26%), and sewage (13%) (Table 6). A major difference observed between urban and peri-urban areas was the use of untreated sewage water and road run-off for irrigation by 29% of urban nurseries, but none of the peri-urban nurseries. Sewage use in Nairobi can be attributed to inaccessibility of tap

water, which is the only major alternative source along with other runoff such as from damaged water lines. Sewage use poses a health problem to users. Almost half of the urban nurseries (47%) had access to tap water, compared to only 27% of the peri-urban nurseries which used mostly water from rivers and boreholes (36% each).

Table 6 *Source of water at the 39 peri-urban nurseries, January 2000*

	Nairobi (% of 17)	Kiambu (% of 22)	Total (% of 39)
River	12	36	26
Bore hole	18	36	28
Tap	47	27*	36
Sewage	29	0	13

*Includes two who bought water from water sellers.

Number of nurseries: Nairobi 17, Kiambu 22.

Water was one of the major constraints affecting nursery production. During the survey 2 nurseries were identified where all seedlings had died and the nursery closed down due to lack of water. The water problem was attributed to:

- Inaccessibility to tap water.
- Rivers at a far distance.
- Water sold by private water dealers is expensive.
- Reluctance by the local authority (city council) in providing a new line of tap water.

In some parts of Nairobi, the cost of one litre of water is as much as Kshs 2. For example, a nursery raising 5,000 seedlings over a period of 3 months needs approximately 6,000 litres of water, which amounts to Kshs 12,000 (100 litres per 1,000 seedlings per week–Landis et al., 1994).

Pesticide use

Most operators (over 60%) in both locations used some form of plant protection, but urban nurseries used a lager variety of chemical for pest control. Eight nurseries used more than one pesticide, 16 used one, while 15 did not use any. None used chemical weed control.

One farmer was effectively using *Azadirachta indica* as a biological control measure. He reported that he crushed the leaves and made a solution that he sprayed on seedlings infected by insect pests. He was advising his colleagues to do the same in order to cut down costs and conserve the ecosystem by using biologically friendly control measures.

3.6 Introduction of new tree species

Market variation does occur among species; some of the species have a higher demand than others. Unfortunately some of the species, which have a high demand due to their uses, are not readily available – either in form of seeds or seedlings. In order to meet the demand and the subsequent increase of their income and expansion, operators were eagerly looking for these seeds to introduce them in their nurseries. Tree species that nursery operators would like to increase their production of include *Acacia* sp., *Azadirachta indica, Calliandra calothyrsus, Callistemon citrinus, Citrus sinensis, Cupressus lusitanica*, *Dovyalis caffra, Ficus* sp., *Grevillea robusta, Jacaranda mimosifolia, Leucaena leucocephala, Markhamia lutea, Melia azedarach, Ocotea usambarensis, Olea africana, Pinus* sp., *Podocarpus* sp., *Prunus africana, Schinus molle, Spathodea campanulata, Terminalia* sp., *Vitex keniensis, Warburgia ugandensis* and fruit trees. The

presence of these species did vary from one nursery to another. However those that mentioned them as preference only had few, if any, of these seedlings.

3.7 Planting material

As all nurseries propagate from seed, they were asked about the source of germplasm, whether collected or bought, who collected the material and from how many mother trees, and which criteria were used to choose the mother trees or seed dealers.

Seed was collected from various locations, most often from the roadside (15%) or from the farm of the nursery owner (Table 7). In the peri-urban setting most seed was collected from the own or neighbours' farms (50%). A large number of operators, particularly in Nairobi, bought seed from institutions like the Kenya Forestry Seed Centre (KFSC) or from private dealers. Although more expensive than private dealers, KFSC was believed to have seed with a better germination rate than those from private seed vendors. Those who collected seed for themselves had satisfying germination results. Seed collection and seed dealers were the most important sources for seed in the peri-urban setting, whereas buying from KFSC or seed dealers were the most important source in the urban setting. When seed was collected, the nursery operator or family members collected in 75% of cases in Nairobi and in 80 % of cases in Kiambu (Table 8).

Table 7 *Source of seed for up to 3 important species*

	Nairobi (% of 38)	Kiambu (% of 45)
Own farm	13	22
Neighbour's farm	8	31
Other farm	5	9
Communal land	0	4
Road side	16	13
Other village	0	11
Forest	0	2
KFSC	26	7
Seed dealer	40	22

Number of cases considered: Nairobi 38, Kiambu 45. Multiple sources possible.

Table 8 *Responsibilities for seed collection*

	Nairobi	Kiambu
Self	75	64
Family member	0	17
Staff or hired labour	25	19

Number of cases considered: Nairobi 24, Kiambu 42 (others purchased).

Questions were asked on the number of mother trees used in order to understand the risk for genetic erosion (Lengkeek et al., in press). Answers varied from 1–30 mother trees, with an average of 6.4 mother trees.

The price of seed varied greatly and was generally high. Seed prices could only be compared between the urban and peri-urban districts for *Grevillea robusta* and *Dovyalis caffra*. Prices for *Dovyalis caffra* seed ranged from 150 to 2,000 Kshs/kg (Table 9). *Grevillea robusta* seeds were more expensive with prices ranging from 600 to 10,000 Kshs/kg (the latter extremely price calculated from a spoon measure, 10 g for 100 Kshs). Kiambu nursery operators had to pay higher prices than their urban colleagues, however, more seed being collected by the peri-urban nursery operators may balance this. A survey of seed dealers in Nairobi and environs has been carried out in connection with this survey (Mwonjoria, 1999).

Table 9 *Prices for seed (Kshs/kg) for important agroforestry species*

	Nairobi			Kiambu		
	n	**range**	**average**	**n**	**range**	**average**
Grevillea robusta	9	500–8,000	2,011	3	1,080–10,000	4,360
Dovyalis caffra	6	150–800	392	5	200–2,000	870

n = numbers of nurseries from which price information available (see also Annex 3).

3.8 Economic significance of urban and peri-urban nurseries

According to the operators, more than 5,000 clients visited the surveyed nurseries and purchased more than 190,000 seedlings in the short rainy season between August and October 1999. There were several factors that determined the prices of seedlings. These were:

- Time the seedling has taken in the nursery–a longer stay of seedlings in the nursery increases management/operation costs.
- Location of the nursery–nurseries located in affluent residential/commercial areas or roads leading to or from these areas, sell a similar species at a relatively higher price than nurseries in low-income areas.
- Demand and type of the species.
- Personality–some operators sell at higher price to rich clients (as viewed from his/her possession at that time) than they could ask from the low-income people. But for cases where the client is a regular customer, irrespective of his/her status, the pricing is standard.

The maximum and minimum prices of some of the common seedlings are presented in Table 10.

Table 10 *The price of seedlings of ten most frequent species (in Kshs)*

Species	Minimum price	Maximum price
Dovyalis caffra	0.5	5
Macadamia tetraphylla	20	150
Grevillea robusta	2.5	50
Casuarina equisetifolia	3	70
Passiflora edulis	10	50
Camellia sinensis	10	10
Eucalyptus sp.	2.5	50
Croton megalocarpus	10	150
Jacaranda mimosifolia	5	80
Callistemon citrinus	3	250

When asking nursery operators about their view on their clients, it was reported that in order to get good value for their money, clients normally selected seedlings based on quality traits. These were health, size and cost. A combination of quality features was also observed, but there were no clients who did not select seedlings by one or the other of those parameters. Clients were reported to have been very interested in good performance of the seedlings at the planting site. That is probably why most of the clients (95%) used seedling health as their primary selection criteria (see Table 11). Apparently, most tree seedling clients went for quality products irrespective of their prices. However, it is important to note that the operators provided these answers and need to be verified by a client survey.

Table 11 *Client's selection criteria on seedlings as reported by nursery operators*

	Per cent of nurseries who reported the criterion	
Criterion	**Nairobi**	**Kiambu**
Health of seedling	88	100
Size of seedling	58	68
Price of seedling	18	0

Multiple answers possible. Numbers of nurseries considered: Nairobi 17, Kiambu 22.

Nursery operators reported that their clients took seedlings to as far as western Kenya (600 km) and over the border to Tanzania (>300 km).

Seedlings within the nurseries were worth millions of shillings and could contribute greatly to the economy of the country. This is especially true if there was a steady demand for the seedlings. Tree seedlings available in the surveyed nurseries were worth Kshs 24.5 million (USD 327,000) (see Annex 2). Since not all seedlings were sold in one season the nursery operators were asked what had happened to the previous season's seedlings. Seedlings not sold were usually considered as advertisement tools as larger seedlings could be placed near the roadside to attract customers. Few nursery operators thought that overgrown seedlings were of low quality. Other seedlings that were not sold were given away, planted out or thrown away. On average, 5% of the total seedlings had died (Table 12).

Table 12 *Fate of seedlings from the 1999 short rainy season*

Fate of seedlings	Numbers of nurseries
Died	5
Left and waiting for clients	26
Given away	4
Thrown away	2
Planted on own compound or communal land	2

Number of nurseries considered: 39.

It was found that 37 out of 39 operators were willing to pay more for improved varieties or improved seed quality for a number of species. Some of the desired species for improvement were: *Grevillea robusta*, *Dovyalis caffra*, *Warburgia ugandensis*, *Markhamia lutea*, *Leucaena* sp., *Prunus africana*, *Persea americana*, *Calliandra calothyrsus*, *Passiflora edulis*, *Olea africana*, *Podocarpus* sp. and *Teclea nobilis*. These species were selected because of high market demand and a wide range of uses.

4. Discussion

Tree nursery operations in the urban and the peri-urban areas around Nairobi differ in a number of ways (see Table 13). Although the main difference is the stronger focus on cash income by urban nursery operators, differences go further into species diversity, species preferences, and use of resources.

Both urban and peri-urban tree nurseries contribute to the environment and economy of an area. They supply tree seedlings for agroforestry activities that generate income. Most of the households practicing nursery production depend on the income derived from the nursery, although urban nursery operators rely more heavily on this income. These nurseries also contribute a lot to the ecology of a city such as Nairobi as they are located along the roads with diverse tree species and thus contribute to the green 'look' of the city.

Seed and seedlings are distributed over large distances with ecological and economic ramifications to the rural areas. An interesting link exists with regard to vegetative propagation of fruit species. Some nursery operators take material for grafting to experts in the neighbouring districts such as Thika and Murang'a (50 km away) rather than doing it themselves. This is advantageous in that selected and recommended scion material is used, however, a disadvantage may be that the grafted material is not adapted to the future climate conditions of the planting site. There is also a wholesale market for seedlings as some operators buy grafted fruits and other tree seedlings from nurseries elsewhere and sell them at a higher price in their city nursery.

Table 13 *Main differences between urban (Nairobi) and peri-urban (Kiambu) tree nurseries*

	Nairobi	**Kiambu**
Number of species (diversity)	47	66
Species functional use preference	Timber, ornamental	Timber, fruit
Main method of propagation	Seed	Seed
Substrate ingredients	Soil, manure (bought)	Soil, manure, compost, sawdust, sand (collected/bought)
Main shade material	Grass	Grass
Main water source	Tap, sewage	Rivers, borehole
Pesticide use	Yes	Yes
Germplasm collected or bought	Bought	Collected
Primary seed source	Seed dealer	Own and neighbouring farms
Average seed prices (Kshs/kg)		
Grevillea robusta	2,011	4,360
Dovyalis caffra	392	870
Prevalent level of education	Secondary	Primary
Nursery only source of income	For 76%	For 24%

A bottleneck observed during the surveys is the availability of quality germplasm and the technical know-how of advanced nursery practices, for example water saving irrigation practices.

Seed collection was done only in the peri-urban areas, and from only an average of six mother trees. However, in order to avoid a decrease in the genetic base it is recommended that seed collection for domestication of agroforestry trees be undertaken from thirty or more trees, following a standardized collection procedure (Dawson and Were, 1997). Although the collection must be undertaken pragmatically, failure by seed dealers and collectors in peri-urban and urban areas to adhere to these procedures may erode the genetic base of the concerned tree species (Holding and Omondi, 1998; Lengkeek et al., in press). By narrowing the genetic base of a tree population, its adaptive capacity for changing user requirements and a changing environment decrease. The small number of mother trees used by the peri-urban nurseries can affect the viability of tree populations in the future. In contrast, the peculiarity of the Nairobi case, in which most seed is bought from seed dealers coming from various locations (Mwonjoria, 2000), seems to guarantee a sufficient mix of genes, although a possible outbreeding depression can not be excluded.

The impact urban nurseries can have in the economy is clearly evidenced by the sales value of seedlings present in the few surveyed nurseries (over USD 300,000). However the value of these seedlings is hypothetical as not many of them are being sold within a season. Although many nursery operators expect to sell older seedlings in the next season (at a higher price), sale is not guaranteed. Sale of tree seedlings is a seasonal business, very dependent of the weather and the economic situation of the buyers. An integrated strategy, improving market information and market access could contribute to a sustainable development of a healthy seedling market.

In summary, we note that in Nairobi and Kiambu Districts, optimal nursery operation was restricted by various problems. Insufficient technical know-how in raising seedlings, lack of access to water, inadequate numbers of mother trees for seed collection, seed scarcity, essential but unaffordable nursery inputs and marketing problems of their products (seedlings) were the core problems facing nursery operators. Harassment of nursery operators in the urban areas by the city council who in some cases apparently did not recognize their business permits was another factor mentioned in the surveys. In addition, many group nurseries depended heavily on agency funding, which was declining, thus threatening the survival of these nurseries.

In order to make small-scale nurseries more productive and profitable, the following activities can be recommended:

- Training in the technical aspects of nursery production such as pre-treatment of seed, substrate quality and selection of mother trees for seed collection. Publishing and distributing nursery materials based on their need for that knowledge is essential.
- Operators should be advised on water use efficiency and storage in order to help in the proper utilization of this limited resource.
- Training nursery operators and seed dealers in seed collection procedures as well as encouragement in establishing alternative sources for seed, such as seed orchards. This will help to ensure a healthy tree population for the present and the future and create self-reliance.
- Market research is of high importance for the urban nursery products. Operators should be encouraged to form associations for the sake of marketing and training.
- Associations can also be helpful in gaining recognition by city council and security for compensation in cases where a nursery is damaged, for example by road construction work.
- Training in record keeping is advisable for proper management of income from sales to cater for the operational costs of the nursery such as buying of poly-bags, soil, seed, etc.

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Annex 1: Questionnaire

Objectives of this survey in collaboration between Forest Department, RELMA (Regional Land Management unit of Swedish International Development Cooperation agency) and ICRAF (International Centre of Research in Agroforestry): to assess the status of information within the tree nursery business in and around Nairobi and to understand the pathways of germplasm for tree species. All information will be summarized in a report, which will be distributed to all participants in the survey. All information will be handled confidentially.

date_____ GPS: _____long_____lat_____alt

Location_____

Name of owner (optional)_____ ❑ m ❑ f

Name of interviewee/manager (if not owner)_____ ❑ m ❑ f

1 Cultivation

1.1 Which tree species (not ornamental) are you raising?

	How many seedlings currently in nursery?	Price per seedling (Kshs)	Means of production (pot, direct sowing, etc.)	Propagation techniques (seed, cutting, grafted)	Potting mix (ratio of forest soil, manure, etc.)
1 *Grevillea robusta*					
2 *Dovyalis caffra*					
3 *Persea americana*					
4					
5					

1.2 Would you like to raise more seedlings of any of the species listed? (Mark with *)

1.3 Which other species would you like to raise?

1.4 What kind of shading do you use?

☐ Grass ☐ Tree ☐ Shade net ☐ Other:_____

1.5 Where / what is your source of water?

☐ River ☐ Bore hole ☐ Tap ☐ Other:_____

1.6 Do you use any pesticides?

☐ No ☐ Yes: name/kind of product, in which species and why you are using it.

Pesticide	Species	Reason

=

2. Plant material

2.1 For the 2 main seed propagated species: From where did you get your plant material for the current planting stock?

Species a)……

☐ Own farm ☐ Neighbour's farm ☐ Communal land ☐ Roadside

☐ Other village ☐ Other nursery ☐ Forest

☐ KEFRI/FD ☐ NGK/other agencies ☐ Private dealer

Other:_____

Species b)…….

☐ Own farm ☐ Neighbour's farm ☐ Communal land ☐ Roadside

☐ Other village ☐ Other nursery ☐ Forest

☐ KEFRI/FD ☐ NGO/other agencies ☐ Private dealer

☐Other:_____

If not collected,

2.2 What is the price for seed (Kshs per unit (note what the unit is))?

Species a) _____. Species b) _____.

Then proceed to 2.5.

If collected or as additional species if both main species are bought,

2.3 Who collects the seed?

Species a):

☐ Nursery manager ☐ Staff ☐ Family member ☐ Other:_____

Species b):

☐ Nursery manager ☐ Staff ☐ Family member ☐ Other:_____

2.4 Question about the number of mother trees from which collected: Relate to species.

e.g. *Grevillea*: From how many different trees did you collect seeds? e.g. *Pawpaw* or *non-grafted mango*: From how many different trees or otherwise fruits did you collect seeds?

Species a)_____ Species b)_____

And why did you collect from this number –X- of trees (and not X +1 or X -1 trees)?

Species a):_____

Species b):_____

2.5 Why did you choose that /those particular mother tree/s (seed-dealer in the case of bought seed) for propagation?

Species a)		Species b)
☐	Do not know / No specific	☐
☐	reason	☐
☐	Only tree (/fruit) available	☐
☐	Previous experience	☐
☐	Known variety	☐
☐	Selection / Appears good	☐
☐	Other_____	☐

2.6 (If answer is "Known variety" or "Selection/ Appears good"): What are the criteria?

Species a)		Species b)
☐	Fruit quality	☐
☐	Fast growing	☐
☐	Straight stem	☐
☐	Crown	☐
☐	Resistance to pest	☐
☐	Mature tree	☐
☐	Other_____	☐
☐		☐

3. Economy/Market

3.1 How many buyers did you have last season? _____

3.2 How far away do they come from?_____

3.3 How many buyers did you have for the previous 2 main species?

Species a)_____

Species b)_____

Species c) *(if a) and b) were bought and c) collected)*_____

3.4 When choosing between seedlings of one species, what do the buyers look for?

☐ Cheap price ☐ Large size ☐ Health ☐ They don't select ☐

Other:_____

3.5 Last season, how many of the seedlings you produced were sold? _____

What happened to the seedlings you could not sell?

3.6 Would you yourself be willing to pay more for higher productive (improved) varieties?

☐ No ☐ Yes: what kind of species_____

3.7 *If you are interviewing the owner:*

Which other income generating activities are you involved in?

Activity	Portion of income
_____	_____
_____	_____
_____	_____
_____	_____

How much (percent) of your income comes from these? 

If you are not interviewing the owner:

Is this nursery profitable? ☐ No ☐ Yes

4. General

4.1 Where or through which channels have you learnt about managing a nursery?

4.2 How old is the nursery? _____ years ☐ seasonal nursery

4.3 What area does your nursery cover?_____

4.4 What is your future plans for the nursery?

4.5 What is your level of education?

Primary school (Standard_____)

Secondary school (Form_____)

Diploma

Other:_____

4.6 Thank you for answering our questions. What else would you like to say about your nursery?

Annex 2: Number, price and total value for each species found in the nurseries

Species	No. of nurseries	Seedlings		Price (Kshs)			Total value (Kshs)
		Total number	Average No. per nursery*	Min	Max	Average	
Acacia polyacantha	5	4,750	950	20	37	28.5	135,375
Acacia sp.	7	945	135	32	30	31.0	29,295
Acacia xanthophloea	2	245	123	58	260	159.0	38,955
Acokanthera oppositifolia	1	120	120	20		20.0	2,400
Adansonia digitata	1	3	3	10	50	30.0	90
Albizia coriaria	2	124	62	25	70	47.5	5,890
Annona sp.	1	50	50	100		100.0	5,000
Azadirachta indica	4	87	22	21	70	45.5	3,959
Brachychiton acerifolium	1	55	55	30		30.0	1,650
Calodendron capense	2	35	18	15	70	42.5	1,488
Calliandra calothyrsus	3	250	83	7		7.0	1,750
Callistemon citrinus	6	4,837	806	26	155	90.5	437,749
Camellia sinensis	1	10,000	10,000	10		10.0	100,000
Carica papaya	6	431	72	25	50	37.5	16,163
Casimiroa edulis	1	40	40			0.0	0
Cassia siamea	1	15	15	20		20.0	300
Cassia spectabilis	1	40	40	3		3.0	120
Cassia sp.	2	130	65	30		30.0	3,900
Casuarina equisetifolia	17	12,757	750	19	50	34.5	440,117
Cedar**	4	1,210	303	26	70	48.0	58,080
Citrus limon	5	684	137	63	50	56.5	38,646
Citrus reticulata	1	400	400	50		50.0	20,000
Citrus sinensis	10	1,320	132	86	100	93.0	122,760
Coffea arabica	2	2,000	1,000	20		20.0	40,000
Combretum molle	1	10	10	20		20.0	200
Cordia africana	3	17	6	30	70	50.0	850
Croton megalocarpus	7	5,982	855	47		47.0	281,154
Cupressus sp.	16	3,830	239	35	535	285.0	1,091,550
Cyphomandra betacea	7	950	136	38		38.0	36,100
Delonix regia	1	5	5	100		100.0	500
Dombeya sp.	1	100	100	20		20.0	2,000
Dovyalis caffra	29	339,250	11,698	2	3	2.5	848,125
Eriobotrya japonica	7	390	56	29		29.0	11,310
Erythrina abyssinica	1	60	60	30		30.0	1,800
Eucalyptus sp.	16	8,237	515	15	30	22.5	185,333
Ficus benjamina	4	280	70	227		227.0	63,560
Ficus sp.	1	2	2	10	50	30.0	60
Ficus thonningii	4	65	16	83	50	66.5	4,323

Species	No. of nurseries	Seedlings		Price (Kshs)			Total value (Kshs)
		Total number	Average No. per nursery*	Min	Max	Average	
Filicium decipiens	1	50	50	20	70	45.0	2,250
Grevillea robusta	30	79,628	2,654	13	33	23.0	1,831,444
Hakea saligna	1	2,000	2,000	5	6	5.5	11,000
Jacaranda mimosifolia	18	5,070	282	27	30	28.5	144,495
Leucaena sp.	4	390	98	9		9.0	3,510
Macadamia tetraphylla	3	200,150	66,717	57	110	83.5	16,712,525
Malus sylvestris	4	670	168	68	80	74.0	49,580
Mangifera indica	7	305	44	87	150	118.5	36,143
Markhamia lutea	11	2,600	236	18	58	38.0	98,800
Morus alba	1	50	50	20		20.0	1,000
Olea africana	3	590	197	21	15	18.0	10,620
Olea hochstetteri	1	1	1	20	70	45.0	45
palms	11	3,244	295	61	205	133.0	431,452
Passiflora edulis	14	12,535	895	25		25.0	313,375
Persea americana	14	3,029	216	48	60	54.0	163,566
Pinus sp.	2	1,400	700	28	35	31.5	44,100
Podocarpus sp.	13	790	61	53	150	101.5	80,185
Polyscias kikuyuensis	4	185	46	35	20	27.5	5,088
Prunus africana	9	405	45	21		21.0	8,505
Prunus cerasifera	1	30	30	50		50.0	1,500
Prunus persica	1	60	60	25		25.0	1,500
Prunus serrulata	1	60	60	20		20.0	1,200
Psidium guajava	3	151	50	13	38	25.5	3,851
Rapanea rhodondendroides	1	100	100	20	70	45.0	4,500
Rhus natalensis	1	20	20	20	70	45.0	900
Rosmarinus officinale	1	100	100	30		30.0	3,000
Schinus molle	6	685	114	26	55	40.5	27,743
Sesbania sesban	2	45	23	8	15	11.5	518
Spathodea campanulata	7	360	51	30	70	50.0	18,000
Syzygium cuminii	1	2	2	10	50	30.0	60
Syzygium sp.	2	20	10	10		10.0	200
Tamarindus indica	1	1	1	10	50	30.0	30
Tarchonanthus camphoratus	1	300	300	20	70	45.0	13,500
Teclea nobilis	5	710	142	28	70	49.0	34,790
Terminalia sp.	11	4,565	415	62	104	83.0	378,895
Tipuana tipu	1	3,500	3,500	3		3.0	10,500
Trichilia emetica	1	1,000	1,000	30		30.0	30,000
Vitex keniensis	2	110	55	15	33	24.0	2,640
Warburgia ugandensis	4	2,420	605	21		21.0	50,820
Grand Total		727,037					24,562,656

* Calculated for nurseries who have the species

** Mainly *Juniperus procera*, but other species included in this term and not always possible to verify.

Note USD1 = Kshs75

Annex 3: Seed source and cost of seed for the main species

Species	Collected seed							Bought seed	
	Own farm	Neigh-bour's farm	Other farm	Comm. land	Road-side	Other village	Forest	KFSC/ others	Private dealer
Acacia polyacantha								**N** (2000)	
Calliandra calothyrsus	**K** (1)								
Callistemon citrinus	**N** (1)	**N** (1)						**N** (500)	
Casimiroa edulis		**N** (1)							
Casuarina equisetifolia	**N** (1), **K** (1)	**K** (1)			**N** (2)			**N** (N/A)	**N** (140)
Croton megalocarpus	**N** (1)								
Cupressus lusitanica	**K** (1)							**N** (600)	
Cyphomandra betacea	**K** (1)	**K** (2)							
Dovyalis caffra		**K** (4)	**N**, (1) **K** (4)	**K** (2)	**N** (3), **K** (3)	**K** (2)		**K** (1050)	**N** (500, 400, 250, 250, 800, 150), **K** (500, 200, 600, 2000)
Grevillea robusta	**N** (1), **K** (2)	**N** (1), **K** (4)			**N** (1), **K** (1)	**K** (2)	**K** (1)	**N** (free, 2000, 1500, N/A, N/A), **K** (1080)	**N** (1000, 1000, 1500, 500, 8000, 1600, 600), **K** (10000, 2000)
Jacaranda mimosifolia	**N** (1), **K** (1)							**N** (free)	
Leucaena sp.	**K** (2)								
Macadamia tetraphylla									**K** (32)
Markhamia lutea	**K** (1)								
Passiflora edulis		**K** (1)							**K** (1500, N/A)
Persea americana									**K** (50)
Podocarpus spp					**K** (1)				
Polyscias kikuyuensis					**K** (1)				
Prunus africana		**K** (1)							
Terminalia sp.			**N** (1)						
Warburgia ugandensis		**K** (1)				**K** (1)		**K** (2000)	

N = Nairobi.

K = Kiambu.

Numbers in brackets for collected seed = Number of nurseries that collect from that source.

Number in brackets for bought seed, price per kg (in Kshs).

N/A = No answer provided.