ON-FARM TREE GROWING OPPORTUNITIES AND CONSTRAINTS IN MURANG'A COUNTY, KENYA

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ABSTRACT

Careful and efficient collection of information on agroforestry practices at different agro-ecological zones has a great contribution to promote or to improve important agroforestry practices. This survey was conducted with the objective of identifying major reasons for on-farm tree planting, tree species preferred and prioritizing major constraints to tree planting in Murang'a County, Kenya. The survey was done on 141 selected farmer households in Murang'a North, South and East sub-counties. The data was collected using a pre-tested questionnaire and analyzed with SPSS software. The tree species most popular in all the studied sub-counties included *G. robusta, C. eminii, P. americana* and *C. macrostachyus*. These species are valued by farmers for their products including fuelwood, fruits, timber, fencing and ornamental. From the study, 30 tree uses were recorded. About 81% of respondents face various constraints in tree growing such as drought, pest attack, theft, high cost of seedlings, poor soils, animal browsing and trees competition with crops. Despite the constraints, 93% of respondents had plans to plant more trees in future, with preferred species being *G. robusta*, *P. americana*, *M. indica* and *Eucalyptus spp.* These species were preferred because of their high benefits as souces of income, timber, fuelwood, and fruits. Farmers also prefered tree species that didn't compete with agricultural crops and potrayed faster growth. Most of the farmers with future tree planting plans preferred boundaries planting. The study findings can guide tree planting in Muranga county and other similar areas.

Key words: Opportunities, constraints, tree species, Muranga, agroforestry

INTRODUCTION

High population densities, intensive cultivation, fragmentation of family land 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). It is encouraging that farmers in Kenya, in response to loss of forest cover, have been successful in cultivating and managing trees in and around their farms. Trees on farm or agroforestry systems and practices come in many forms including; improved fallows, Taungya or Shamba system, home gardens, among others.

It is upon the realization of the importance of trees in Kenya's socio-economic and environmental development that the constitution of Kenya mandates that the State increase tree cover to 10% of its total land area (GoK, 2010). The Farm Forestry Rules (2009) also require farmers to establish and maintain farm forestry on at least ten percent of every agricultural land holding. The promotion of farm forestry in most parts of Kenya's central highlands has, however, resulted to the farmers' adoption of a few tree species. *Grevillea robusta* has been well adopted such that it forms a near monoculture in central Kenya highlands, particularly in Kirinyaga (Tyndall, 1996) and Meru (Lengkeek and Carsan, 2004) districts where it was found to be grown on nearly every farm. Such a near monoculture agroforestry system is, however, very delicate. According to Njuguna, (2011), the species is under threat from a widespread canker and dieback disease and a host to over forty fungal species, some of which cause serious diseases to other woody species as well as agricultural species.

Diversification of tree species composition is therefore important and can lead to enhancements of stability and productivity of ecosystems (Cottingham *et al.* 2001) and agroforestry systems are potentially suitable for conservation of tree genetic resources when they grow different tree species in their farms. Careful and efficient collection of information on agroforestry practices has a great contribution either to promote or to improve important agroforestry practices. Thus the survey was conducted with the objective of describing and understanding various agroforestry practices, identifying

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and characterizing major tree species, identifying reasons for tree growing, what tree species farmers most want to plant in their farms and also identifying and prioritizing major constraints related to tree planting in Muranga county as the county is striving to attain 17 per cent tree cover by 2022 from the current 14.5 per cent (The star, 2020).

METHODOLOGY

Study site

Murang'a County is one of the five counties in central region of the republic of Kenya. It covers an area of 2,558 square kilometers and borders Nyandarua County to the west, Embu County to the east, Nyeri County to the north, Kiambu County to the south and Kirinyaga County to the north east (Figure 1). The county is divided into six agro ecological zones. The agro ecological zone one consists of the highest potential zones where forestry, tea and tourism industry form the most important economic activities. Agro-ecological zones two and three are the lowlands east of Aberdares and are generally suitable for both coffee and dairy farming (Muranga, 2014). The flatter area of Makuyu division of Maragwa constituency is characterized by arid and semi-arid conditions. This forms the agro ecological zones 4, 5, and 6. In these zones coffee and pineapple plantations thrive by irrigation (www.murang'a county.go.ke). In term of forestry, the county has five indigenous gazetted forests covering a total area of 254.4 km^2. They are: Gatare, Karua, Kimakia, Kiambicho and Wanjerere forests. These forests are divided into two zones; the tropical montane forest zone located along the Aberdare ranges and the semi-arid forest zone located in the lower parts of the county. There are also 204,557 farm forests which are privately owned plantations (Muranga, 2014).

Three sub-counties of the county were selected for the study. They comprised of Murang'a North representing the upper elevations or the tea zone, Murang'a East

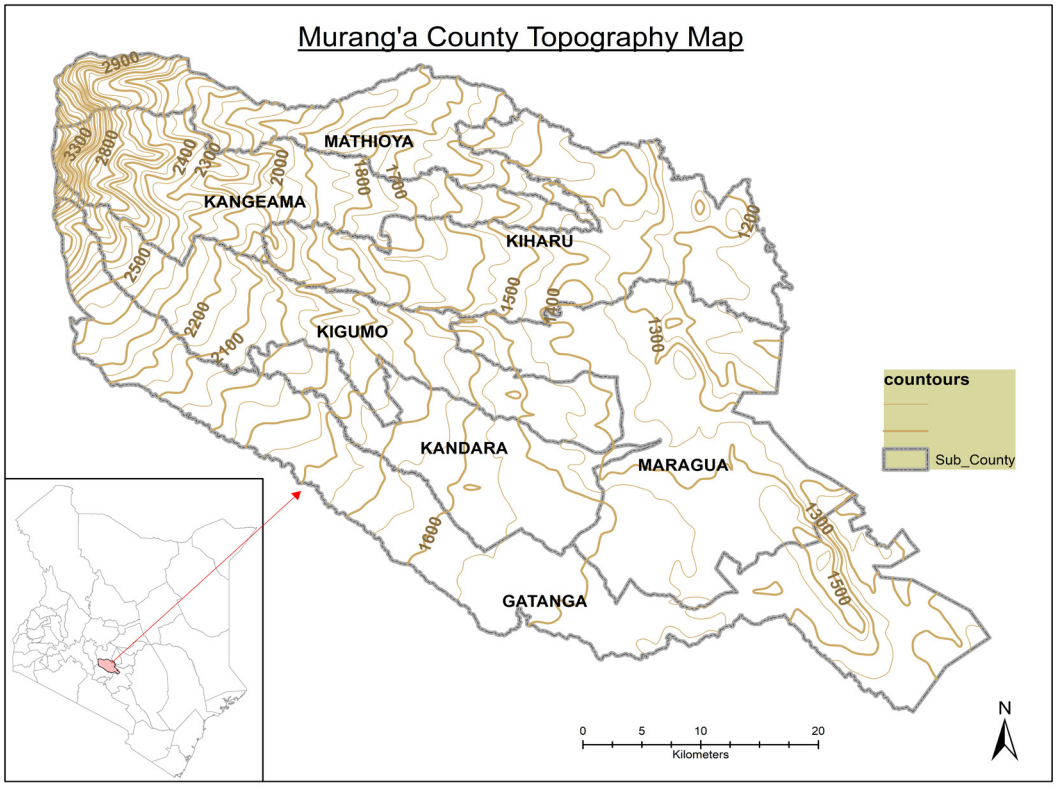

Figure 1. Muranga County

representing mid altitude elevation or coffee zone and finally Murang'a South representing the lower altitude elevation or the sisal/ pineapple zone (Table I).

included Kambiti, Makuyu, Kimoroni, Wempa, Kirimiri, Sabasaba and Kamahuha. Simple random sampling was finally at village level to select households that were

TABLE I - A SUMMARY OF HOUSEHOLDS REPRESENTATION STATUS PER ELEVATION CLASS IN MURANGA

Sub county	**Households frequency (%) per altitude range (m)**				**Total**
	2201-2900	1801-2200	1281-1800	700-1280	
Muranga North	11 (22)	33 (66)	6 (12)	0 (0)	50 (100)
Muranga South	0 (0)	0 (0)	47 (94)	3 (6)	50 (100)
Muranga East	0 (0)	1 (2)	39 (96)	1 (2)	41 (100)

Elevation categories (Jaetzold and Schidt (1983))

> 2900 m = Afro-alpine highland

2201-2900 = Upper highland

1801-2200 = Lower highland

1281-1800 = Upper midland

700-1280 = Lower midland

< 700 = Inland lowland

Most of the households surveyed in Muranga North lies in the upper highland category while majority of the studied farms in Muranga South and East are in the upper midlands.

Sampling design

The survey was done on selected farmer households per sub-county. Selection was purposively framed so as to represent various heterogeneity features especially land use systems and altitudinal elevation, of each sub-county, constituency and ward levels. The upper altitudinal or tea zone was represented by Murang'a North sub-county. Two constituencies, Mathioya and Kangema, represented this zone while the selected locations include Gakuyu, Githiga, Ichichi, Kaero, Kanyenyaini, Kiriti, Kiru, Kiruri, Mioro, Njumbi, Nyakianga and Rwathia. The coffee or mid-altitude zone was represented by Kiharu constituency in Murang'a East sub-county. Several locations that were a true representation of coffee zone were chosen as Njoguini, Gikandu, Gakandu, Wangu, Gaturi, Kiria, Mugoiri, Mushungusha, Mbiri, Nyakihae, Gakuyu, Kigetuine, Wethaga and Kahuhia. Murang'a South (lower zone) is composed of Makuyu and Maragwa divisions. Maragwa's chosen locations included Nginda and Ichagaki while in Makuyu division the locations selected subjected to data collection. Working with a confidence level of 95% and a confidence interval of 5 (margin error of 0.05), conditions widely accepted for a social science survey, and a household population of 135,244, a total of 141 households were included in the study (www.surveysystem.com/sscal.htm).

The data was collected using a questionnaire which was pre-tested in Muguga, Kiambu county. Several tools were used in the survey during data collection. They include a GPS for mapping the sampled farms, a running tape measure for measuring plots and tree crown diameter, a dbh tape measure for measuring tree diameter, a counter for counting or enumerating the trees, camera, questionnaires for recording the information, note book, pencil, eraser, sharpener and a folder.

Data analysis and presentation

A statistical package for social sciences (SPSS) template was created for the collected data to be coded and entered. It was then cleaned and subjected to various analyses. The information was presented as frequency tables and bar graphs.

RESULTS AND DISCUSSIONS

Tree growing history - general status of trees growing upon acquisition of land

In the sampled farmers, majority of their farms had trees already by the time of acquisition, with Muranga North and East leading. Most of the trees found in the farms were indigenous in all the sub-counties, with Muranga South leading with 83% (Table II).

TABLE II -STATUS OF TREES GROWING UPON ACQUISITION OF LAND

Sub county	Presence of trees on farm upon land acquisition by households (%)		Type of trees initially present on farm by households (%)	
	Trees present	Trees absent	Exotic	Indigenous
Muranga North	66	34	41	59
Muranga South	60	40	17	83
Muranga East	66	34	26	74
Total	64	36	29	71

According to Lepetu *et al* (2015), trees in high potential agricultural areas of Kenya occupy a significant land area. Land use inventories have suggested that planted and managed trees usually cover between 5 and 10 percent of agricultural land. On average, over 20 percent of the total high potential, smallholder agricultural land area has been used for growing trees, or has otherwise been left under natural woody cover. Even when other forms of land use could generate substantially higher levels of household income, the planting and management of trees has remained an important form of land use

Changes in initial tree species composition and reasons

All the respondents in both Muranga North and South have changed their initial tree species composition. In Muranga East, about 98% have changed their species composition while only 2% have not changed. The most significant change is an increase in exotic trees (58%) of all the respondents and a decrease in indigenous trees (27%) (Table III).

Reasons for the tree composition changes

The main reasons for the tree composition changes include growing tree species with capacity to provide timber/ poles (28%) and fuel (26%) and also to give way for agriculture or house construction (14%), among other reasons (Table IV). According to Lepetu *et al* (2015), farmers leave trees on farms. This is an old prac-tice, which is some form of agroforestry, hence farmers are likely to adopt an improved version of this system since they are already familiar with the importance and benefits of trees.

TABLE III - KIND OF CHANGE OF TREE COMPOSITION ON FARMS

Sub county	Kind of change of tree composition by respondents (%)					
	Increased indigenous trees	Decreased indigenous trees	Increased exotic trees	Decreased exotic trees	Increased both	Decreased both
Muranga North	4	26	54	6	6	4
Muranga South	14	26	58	2	0	0
Muranga East	2	32	66	0	0	0
Total (Average)	7	27	58	3	2	1

TABLE IV - REASONS FOR TREE COMPOSITION CHANGES

Sub county	Reasons for tree composition changes by respondents (%)								
	Fuel	Income	Fast growth	Shade	Wind break	Environmental conservation	Timber/ poles	Fruits	Agriculture/ homestead
Muranga North	34	4	2	2	2	6	22	4	22
Muranga South	12	8	2	4	2	8	42	4	14
Muranga East	32	22	2	2	5	2	19	5	5
Total	26	11	2	3	3	5	28	4	14

Elsewhere, 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. Farmers in Kipkaren catchment had varied preferences for different tree species as discussed by Imo *et al*., (2001). The most preferred indigenous trees were *Prunus africana* (70 – 91% of the farmers)*, Zizygium quineense* (60 to 80%), *Erythrina tomentosa* (50 to 70%) and *Croton macrostychus* (60 to 75%), and had been retained in farmlands for timber, construction poles and firewood.

Major tree species present in Muranga County

The major 10 tree species in the three studied sub-counties of Muranga are summarized in the Table V. *Grevillea robusta* was ranked highest in both Muranga East and South, being present in all the farms visited, while Eucalyptus was the most grown tree species in Muranga North.

TABLE V- MAJOR TREE SPECIES IN MURANGA COUNTY

	Muranga East		**Muranga North**		**Muranga South**	
Rank	**Tree species**	**H/holds (%)**	**Tree species**	**H/holds (%)**	**Tree species**	**H/holds (%)**
1	*Grevillea robusta*	100	Eucalyptus spp	92	*Grevillea robusta*	100
2	*Mangifera indica*	95	*Persea americana*	92	*Mangifera indica*	100
3	*Bridelia micrantha*	90	*Grevillea robusta*	80	*Persea americana*	80
4	*Persea americana*	90	*Eriobotrya japonica*	76	*Croton macrostachyus*	70
5	*Croton macrostachyus*	87	*Acacia mearnsii*	74	*Bridelia micrantha*	68
6	*Commiphora eminii*	83	*Cyphomandra betacea*	74	*Carica papaya*	66
7	*Croton megalocarpus*	78	*Cupressus lusitanica*	62	*Psidium guajava*	66
8	*Psidium guajava*	75	*Croton macrostachyus*	60	*Commiphora eminii*	54
9	*Carica papaya*	68	*Croton megalocarpus*	48	*Cassia spectabilis*	50
10	*Markhamia lutea*	68	*Commiphora eminii*	46	*Markhamia lutea*	48

Among tree species present and ranked among the 10 most popular in all sub-counties include *G. robusta, C. eminii, P. americana* and *C. macrostachyus*. These are the species that are valued by most farmers and can grow well in high, mid and relatively lower altitudes. Another similarity observed in both Murang'a East and South, was occurrence of *Mangifera indica* as the second most popular tree species and not appearing amongst top ten tree species in Murang'a North. Other species present in both Muranga North and Muranga East but absent in Muranga North include *B. micrantha, P. guajava, C. papaya* and *M. lutea.* Some species were popular in specific locations such as *Eucalyptus spp, E. japonica, C. betacea, C. lusitanica* and *A. mearnsii* for Muranga North and *C. spectabilis* for Muranga South. Muranga East had the highest number of tree species (94) while both Muranga North and South had 84 tree species (Appendix I). In total, 134 tree species were identified in the three Muranga sub-counties. Most of the species appeared in more than one sub-county. There were, however, some species that were exclusively found in a particular sub-county, probably dictated by their ecological growth requirements among other factors. *Juniperus procera, Macaranga kilimandschariensis, Araucaria caninghamii, Araucaria heterophylla, Cussonia spicata* and *Maesa lanceolata* were exclusively recorded in Muranga North. Those species that were only found in Muranga East include; *Artocarpus heterophyllus, Celtis africana, Clausena anisata, Ficus lutea, Malus domestica, Margaritaria dioscoidea, Schrebera alata, Tipuana tipu, Trichilia emetica, Trimeria grandifolia* and *Milletia dura*. The species specific to Muranga South include; *Toddalia asiatica, Trema orientalis, Grewia bicola, Fraxinus pennsylvanica* and *Ficus benjamina*. Elsewhere, *Grevillia robusta* is considered by farmers in the highlands of East Africa to be an outstanding agroforestry tree. It is thought to be deep rooted and to possess few lateral roots, which suggests good potential for below-ground complementarity (Lott *et al*., 1996; Howard *et al*., 1997).

Tree size distribution

The diameter of trees on the studied farms indicated that trees of smaller diameter were generally more than those of bigger diameter classes, as shown in the Figure 2.

This is a desired pattern for any tree growing initiative since it shows that there is a prospective continuous provision of tree products in future. This is due to the presence of many young trees as compared to the older ones. Size distributions are considered an important indicator of population dynamics. A reversed J-shaped size distribution has been regarded as a proxy of population growth or dynamic equilibrium while a unimodal distribution, with comparatively fewer juveniles relative to adults, has been taken as evidence of population decline (Deb and Sundriyal, 2008).

Tree density and configuration in Muranga County

The total land size of the studied households was about 329.5 acres. The total number of trees counted was 58,344. Therefore, the tree density (number of trees per acre) for the study area was 177.1411 trees per acre. There were several locations where farmers preferred to plant or nature their trees in their farms as outlined in the Table VI. The most preferred niche of trees on farms was when scattered irregularly and growing together with agricultural crops.

TABLE VI- TREES CONFIGURATION IN THE FARMS

Trees on farm location	Frequency (%)
Scattered on-farm	38.1
On boundaries	26.5
Home compound	17.6
Woodlot	8.4
Contours/ terraces/ conservation structures	3.7
Hedgerows	3.4
Raparian	2.3

Scattered trees on croplands may involve planting of new trees or it may depend on careful management of selected seedlings established on site through natural regeneration (Rocheleau *et al*., 1988). Apparently, a significant number of farmers disliked trees in croplands due to their shading effects on the crops. But potential benefits of trees on farms have also been proven in Southern Africa like Zambia, Malawi and Zimbabwe where the intervention has been adopted (Sileshi *et al*., 2009). Thus, proper species selection for croplands, their arrangement and management would help make the practice more appealing hence encourage tree domestication.

Some farmers had planted trees in woodlots (i.e. a section of the farm is set aside exclusively for tree growing

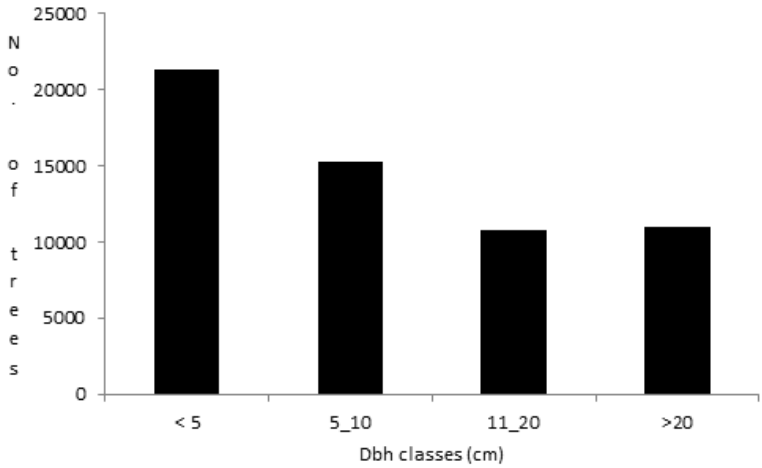

Figure 2. Tree size distribution

(Tejwani, 1987) mainly of exotic species such as *G. robusta, C. lusitanica* and *E. saligna*. 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) was also practiced by many farmers in the study area. It was also a common practice by farmers in Kakamega and South Nandi (Gachie *et al.,* 2020).

Major tree uses

Farmers will plant trees due to perceived benefits out of the planted trees. The major 10 uses of the trees in the studied sub-counties include fuelwood, fruits, timber among others as summarized in the Table VII.

TABLE VII -MAJOR TREE USES OF MURANGA COUNTY

Tree use	Frequency (%)	Tree use	Frequency (%)
Fuelwood	32	Shade	3
Fruits	29	Fodder	3
Timber	10	Conservation	3
Fencing	5	Medicine	2
Ornamental	4	Income	2

Tree planting by farmers in Muranga County has been enhanced with the involvement of tea processing industries in establishing tree nurseries and supplying tree seedlings to farmers for planting. These industries buy mature trees from farmers who earn incomes while the industries get a source of wood fuel for their production (Muranga County, 2014). Farmers have also been planting fruit trees like avocado, mangoes, pawpaw, macadamia and oranges for commercial and for nutrition purposes. There are mango and avocado processing factories in the county (Muranga County, 2014).

Other reported uses in order of their importance include charcoal, stakes, boundary marking, soil improvement, tools handles, ripening bananas, local brew, hanging beehives, tooth brushes, edible leaves, windbreaks, gum resins and oils, carving, basket making, insects and snakes repelling, pestle and mortar, making wheels and cultural / religious values. In total, 34 uses were reported. The reported uses are in agreement with Wickens (1980) who also illustrated that in the self-contained, low-economy peasant communities such as most part of Muranga county, the main role of multipurpose trees apart from their values as fodder is for the provision of food, medicine, fuel, timber, fiber, pollen, nectar, dyes, gums, waxes, resins and also play a very important role as wind-breaks, in providing shade and protection against heat and cold and in reducing erosion. Trees also control the water table, sequester carbon and mitigate floods (Sileshi *et al*., 2007), and hence climate change. A study by Santos-Martin *et al*, (2011), showed that access to markets has a positive influence on tree-planting activities, suggesting that improvements to rural infrastructure, including constructing or upgrading roads, encourages more intensive production of agricultural and tree crops.

The land ownership

Almost all the respondents in the study areas have their own land. Majority of land owners have title deeds and ownership is majorly on individual basis (Table VII). Very few respondents were not sure whether the land they occupy have a title deed or not. Acquisition of land is a prerequisite in any tree planting activity since it is the resource upon which they grow on. This is an impetus to tree planting since individual farmers have freedom of choice and can make quick decisions on the type of trees to be planted in their own farms. They could also manage their trees as they wish for their desired products.

TABLE VIII - LAND OWNERSHIP AND TENURE STATUS OF FARMERS IN MURANGA COUNTY

Land ownership status		Land tenure status		Possession of title deed	
Status	Frequency (%)	Status	Frequency (%)	Status	Frequency (%)
Own land	99	Individual	80	Have title	74
Don't own	1	Family	20	Don't have	24

The study's findings are in agreement with. Muranga County, (2014) which reported the incidences of landlessness to be 0.2% while the farmers with title deeds were 65% and those without as 35%. The land ownership could have significant influence in tree growing. In Phillipines, for example, Santos-Martin *et al.*, (2011), found that the total area and number of parcels managed - and tenure security stand out as the main factors that affect farmers' decisions to plant native timber trees. It should also be noted that as tree planting is regarded as a mark of ownership right, customary tenure does not allow non-owners to plant trees, which is an important constraint for introduction of agroforestry systems (Neef, 2001).

Land size distribution

Most of the farmers in Muranga North (66%), Muranga South (82%) and Muranga East (58%) have land sizes less or equal to 2 acres (Table IX). This implies that majority of farmers in Muranga county are small scale farmers.

According to Muranga County (2014), the average farm size for most of the county's households is 1.4 acres. Small scale farmers are, in most cases, known to have more trees per acre than their counterparts with large pieces of land. However, a study done in the coffee belts around Mt. Kenya concluded that tree abundance was generally low among smallholder farmers and suggested the need for increased tree abundance in order to support higher nutrient requirements (ICRAF, 2010).

Land gradient and soil conservation status for Muranga County

Most land in both Muranga North (68%) and East (66%) is slightly sloping while vast (70%) of land in Muranga South is generally flat (Table X). The GPS co-ordinates also classified most of Muranga North farms being upper and lower highland (Table I). Although most farms in both Muranga East and South were in upper midlands, some farms in Muranga East were in lower highland while Muranga South had more farmers being located in the lower midlands altitudes. The land gradient and altitude dictates the type of crops grown per region and also the need and type of soil conservation measures.

Most of respondents who did not have any soil conservation measure (83%) either had their land being flat or in case of those in sloppy areas had tea as the crop covering their farms. Tea is a good cover crop and mostly with a lot of mulch from periodic prunings. The rest of the respondents either had plans to undertake the conservation measures or had an opinion that they had small pieces of land and therefore did not see the reason to conserve it.

Type of soil conservation practices present

The most common type of soil conservation practiced in all the areas is the use of terraces (Table XI). The nappier grass was also planted alongside the terraces. Together with controlling soil erosion, the nappier grass also provide fodder for livestock.

TABLE IX- LAND SIZE CLASSES IN MURANGA COUNTY

	Land size classes (in acres) frequencies (%)					
Sub-county	0-2	2.1-4	4.1-6	6.1-8	8.1-10	> 10.0
Muranga North	66	16	14	4	0	0
Muranga South	82	10	2	0	4	2
Muranga East	58	29	7	2	2	0
Total	68	17	7	2	2	1

TABLE X- LAND GRADIENT AND SOIL CONSERVATION STATUS FOR MURANGA COUNTY

Subcounty	**Land gradient of farms (%)**			**Soil conservation presence (%)**	
	Flat	**Slightly sloppy**	**Very sloppy**	**Present**	**Absent**
Muranga North	2	68	30	68	32
Muranga South	70	30	0	86	14
Muranga East	7	66	27	98	2
Total	26	55	19	83	17

The potential for flood events in sloppy areas is increased by agricultural management practices and climate change. Construction of soil conservation structures in Muranga County is evident. Planting trees and hedgerows can significantly increase water infiltration rate into soil and storage. This reduces the potential for surface runoff and overland flow, which is key factor in reducing flood peaks (https://businesswales.gov.wales/farmingconnect/sites/farming/files/).

TABLE XI - TYPE OF SOIL CONSERVATION IN MURANGA COUNTY

Sub county	**Type of soil conservation (%)**				
	Terraces	**Nappier grass**	**Trees**	**Contour plowing**	**Riparian reserve**
Muranga North	80	14	3	0	3
Muranga South	81	19	0	0	0
Muranga East	80	17	0	3	0
Total	80	17	1	1	1

Tree planting in farms has helped in preventing soil erosion. Trees also hold the soils firmly on the ground and act as wind breakers and increase soil fertility through litter fall from leaves which later form humus. The soil conservation structures namely; retention ditches, grass strips, trash lines and *fanya juu* are also practiced across the county (Muranga County, 2014, Young; 1997)

The source of tree planting material

About 58% of responded cases revealed that the trees were planted while 42% were not planted but rather retained and natured. Of the planted lot, the majority (48%) were from the private tree nurseries, 21% from wildings, 14% from own tree nurseries and 12% were from cuttings (Table XII). Other sources include government tree nurseries, group tree nurseries, friends/ neighbours tree nurseries and school tree nurseries.

Elsewhere, in tobacco growing areas in Kenya (Eastern Western and Nyanza regions), the major sources of tree seedlings include the British American Tobacco sponsored tree nurseries, privately owned tree nurseries, own and neighbor/ friend's tree nurseries in that order of importance (KEFRI, 2017). This indicates the importance of private and own tree nurseries in provision of seedlings and the need to improve on other sources.

TABLE XII- SOURCES OF TREES PLANTING MATERIAL

Source of trees planting material	**Frequency (%)**
Private tree nursery	48
Wildings	21
Own nursery	15
Cuttings	12
Government nursery	2
Group nursery	1
Friend/ neighbour	0.3
School	0.1

Tree planting constraints

About 81% of respondents disclosed that they face various challenges when growing trees while 19% do not face any challenge. The various challenges faced by the farmers and their respective frequencies are given in the Table XIII.

TABLE XIII - MURANGA COUNTY TREE PLANTING CONSTRAINTS

Constrains	Frequency (%)
Drought	39
Pest attacks	25
Theft and destruction of trees	9
Seedlings expensive	8
Soil infertility	5
Animals browsing	4
Lack of labour	3
Competition with crops	2
Lack of adequate land/ insecure land tenure	2
Dropping leaves on tea	1.
Loss of tree value	1
Flooding	1
Lack of nursery materials	1
Bad policies, need for permission to harvest trees	1
Tree nurseries are far away	1
Poor planting method	1
Trees damaging structures eg buildings	1

The most prominent constraints include drought (39%), pest and disease attack (25%), theft and destruction of trees and the cost of buying seedlings being high. The problem associated with seed procurement is especially common with certain species, such as *Grevillea robusta, Hakea saligna, Olea africana* and *Terminalia mentalis*. Thus, promotion of seed vending would help in sourcing for seeds that are in low supply. This would, however require quality control measures to ensure only high quality seeds are sourced. The adoption of the proven soil improving agroforestry tree species has remained low due to unavailability of cheap planting materials. Farmers usually prioritize paying for food, fertilizer and school fees over tree planting thereby concluding that poverty and lack of food security can constrain adoption of agroforestry technologies

Adapting agroforestry to farming systems is a major challenge to food production considering the complex tree-crop interactions. For better use of trees in agroforestry systems, it is important to understand the biophysical adaptability of the commonly grown multipurpose woody trees and/or shrubs (Bationo *et al.*, 2008). One of the most cited challenges is light competition between the crops and trees, a constraint that was also reported in Kakamega and Kobujoi (Gachie *et al.*, 2020). Kater *et al*., (1992) stated that differences in yields under crowns of varying sizes and shapes indicate an effect of light competition between crops and trees. If competition is to be minimized, tree planting must be combined with appropriate management practices such as crown and root-pruning. The possibility of increasing crop yields by increasing their exposure to sunlight is a strong argument for pruning. Experiments on *Cordyla pinnata* in Senegal (Samba, 1997) and *Azadirachta indica* in Burkina Faso (Zoungrana *et al*., 1993) indicate that crop yields under pruned trees are generally higher than under unpruned trees.

However, soils under mature parkland tree canopies are generally more fertile than those in the open due to limited availability of leaf litter (Boffa, 2000). Cannell *et al*. (1996) argued that agroforestry may increase productivity provided the trees capture resources which are under-utilized by crops. Competition for below ground resources between trees and food crops can mask or suppress many of the advantages that trees may provide for long term sustainability of agroforestry systems (Van Noordwisk and Purnomoshidi, 1995). Therefore, there is need to select trees with desirable root and shoot architecture that will be compatible with food crops under different agroforestry systems (Bationo *et al*., 2008). Harborne (1977) also proved that some higher plants (tree crops) release some phytotoxins into the soil, which adversely affect the germination and yield of crops.

Future plans to tree planting

Out of the total respondents, 93% had plans to plant more trees in future, 6% had no plan and 1% were not sure. In all the cases reported not to have future plans of planting trees, they cited small land as their reason. For those who would like to plant more trees, the more preferred tree species include *Grevillea robusta* (35%), *Persea americana* (14%), *Mangifera indica* (11%) and *Eucalyptus spp* (10%) (Table XIV).

TABLE XIV- THE TEN FUTURE PREFERRED TREE SPECIES OF MURANGA COUNTY

Future preferred tree species	Frequency (%)
Grevillea robusta	35
Persea Americana	14
Mangifera indica	11
Eucalyptus spp	10
Macadamia spp	4
Cupressus lusitanica	3
Indigenous trees (unspecified)	3
Citrus spp	3
Prunus africana	2
Cordia africana	2

Reason for future tree species preference

The future preferred tree species were based upon various issues(Table XV). The species that provided income in one way or the other rated the highest. Next was the need for provision of timber, fuelwood, and fruits. Some tree species attributes such as low competition with agricultural crops and fast growth also featured prominently.

TABLE XV - MAJOR REASONS FOR TREE SPECIES PREFERENCE

Reason for tree species preference	Frequency (%)
Income	24
Timber	21
Fuelwood	15
Fruits	15
No competition with other crops	9
Grows fast	5
Soil conservation	4
Fence/ security	1
Aesthetic beauty/ shade	1
Fodder	1
Able to respond after management	1
Medicinal	1
Windbreak	1

Elsewhere, Faye, *et al* (2010) prioritized tree functions in west Africa as medicine, human food, fuel, wood, animal food, soil fertility improvement, revenue regeneration, shade and soil and water conservation in that order of importance. Farmers have high preference for 'premium' native trees, i.e. those with high quality by-products and multiplicity of uses, both economic and ecological. High ratings were also recorded for three common exotic tree species, namely *Gmelina arborea, Swietenia macrophylla* and *Leucaena leucocephala*.

Future preferred tree planting niche

Most of the farmers with future plans to plant more trees preferred planting them at the boundaries (Table XVI).

TABLE XVII- FUTURE PREFERRED TREE PLANTING NICHES

Future preferred tree planting niche	Frequency	Percent
Fence/ Boundaries	90	36
Scattered on farm	82	33
Homestead/ compound	29	12
Woodlots/ fruit orchard	29	12
Contour terraces	17	7
Riverine	4	2
Quarry	1	0.4

The next closely popular site for future tree planting is when scattered on farms intermixed with other agricultural crops (32%). Woodlots and trees planting on homesteads tied as the third most preferred sites for future tree planting.

CONCLUSIONS AND RECOMMENDATIONS

Most farms had trees during time of acquisition and there have been changes in their species composition to cater for the farmers preferences. The types of tree species grown also conform to the degrees of land elevations. *Grevillea robusta* was most popular tree species in the region. Most trees are grown scattered on farm together with crops.These results showed that it is important to ensure that promotion of agroforestry will translate to tangible economic benefits for farmers. More research should be conducted to focus on fast growing, system compatible and marketable tree /shrub species for future ease of adoption by farmers. The results need to be shared with various stakeholders having an interest in the county.

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