CONSULTANCY REPORT

FARMER PREFERENCES ON AGROFORESTRY PRACTICES AND TECHNOLOGIES IN KENYA

Swedish Society for Nature Conservation

A STUDY CONDUCTED BY:

CropCare Technologies
...Healthy growing

PRESENTED TO:

World Agroforestry Centre

Biovision Africa Trust

PELUM ASSOCIATION
Networking for a greener Africa.

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Acronyms and Abbreviations

AEZ	Agro Ecological Zone
AJOL	African Journal Online
BvAT	Biovision Africa Trust
EOA-I	Ecological Organic Agriculture Initiative
FGD	Focus Group Discussion
GDP	Gross Domestic Product
ICRAF	International Center for Research in Agroforestry
KALRO	Kenya Agricultural and Livestock Research Organization
ICIPE	International Center of Insect Physiology and Ecology
KEFRI	Kenya Forestry Research Institute
KENDAT	Kenya Network for Dissemination of Agricultural Technologies
IFAD	International Fund for Agricultural Development
IJAS	International Journal of Agroforestry and Silviculture
NGO	Non-Governmental Organization
MOALF	Ministry of Agriculture, Livestock and Fisheries
PELUM - Kenya	Participatory Ecological Land Use Management in Kenya
Vi- Agroforestry	Vi-skogen
SSNC	Swedish Society for Nature Conservation

Acknowledgement

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Executive Summary

Preference of agroforestry technologies differs among farms in various agroecological zones in Kenya (AEZ) in Kenya and needs to be documented as a basis for shaping future research and development programs. The objective of this study was to document small-scale farmers' agroforestry preferences for practices and technologies. The study consisted of a combination of informal surveys, participatory gender based ranking exercises, key informant interviews and nine (9) focus group discussions (FGDs) in Machakos (3 sites), Embu (3 sites) Vihiga (Vihiga (3 sites) representing different AEZs. Among the regions studied, the understanding of agroforestry concept was highest in Machakos (Mwala and Town), Embu (Runyenjes) and Siaya (Gem and Ugunja) with more than 90% of the farmers being able to correctly describe the agroforestry concept. More than 50% of the farmers heard about agroforestry from NGOs including World Agroforestry Centre (formerly ICRAF), ICIPE, CARE-Kenya, Vi-Agroforestry, IFAD, World-Vision and KENDAT. Governmental institutions including MOA, KARLO, and KFS impacted 21% of the farmers while media (radio and television), schools and other farmers were ranked as important avenues of disseminating agroforestry information. Constraints to adoption of agroforestry (AF) practices were listed as high AF inputs costs, water scarcity, lack of market for agroforestry products especially tree seedlings, land tenure insecurity, lack of capacity and knowledge. However, it was also quite clear that knowledge of agroforestry practices varied among the farmers interviewed. An agroforestry preference for tree fertilizers or legume species was established to be highest in all the regions with red calliandra (*Calliandra calothyrsus),* Gliricidia *(Gliricidia sepium),* Leucaena (*Leucaena* spp.), silky oak *(Grevillea* sp*),* apple-ring acacia *(Faidherbia albida),* yellow cassia *(Senna siamea)* Jack bean *(Canavalia ensiformis)* being the most common species. Vihiga and Siaya counties had, in addition to the species above, leguminous shrubs velvet bean *(Mucuna pruriens),* tree marigold *(Tithonia diversifolia),* rattle weed *(Crotalaria spp),* dolichos bean *(Lablab purpureus)* and Tephrosia *(Tephrosia vogelli)* also as a preferred AF practice. Gender perspective on the AF practices showed that, where tree species had multipurpose utilities, men chose it first because of the returns while women ranked the same species important based on uses such as fuel wood and food. A survey and a tree ranking exercise showed most common timber species included Indian siris (*Albizia lebbeck)*, umbrella tree (*Maesopsis emenii),* pepper tree (*Schinus molle),* Markhamia *(Markhamia lutea)*, Eucalyptus (*Eucalyptus* spp.*)*, Silky oak (*Grevillea robusta)*; while fruit trees included mango (*Mangifera indica)*, pawpaw (*Carica papaya)*, orange/lemon (*Citrus* spp.,) guava (*Psidium guajava)*, avocado (*Persea americana)*, passion fruit *(Passiflora edulis),*

Custard apple *(Anona senegalensis) and* Jacket Plum (*Pappea capensis).* Our results suggest that a revision of priorities should consider extending attention to AF species that match farmer preferences to include those options that have a direct potential for generating income. This study provides useful information for mainstreaming ecological based agricultural approaches into the national agricultural production systems.

1. Introduction

1.1 Background

In Kenya, Agriculture is one of the main development sectors contributing approximately 25% of the GDP annually and providing employment to more than 75% of the population. In addition to growing crops, farmers also raise livestock, including cattle, sheep, goats, donkeys, pigs, poultry and bees, as an integrated part of their land use, and most households meet their needs for tree products and services (i.e. firewood and charcoal) from trees in the local communities. However, the development of agriculture in the country has been encountering a variety of challenges including, land defragmentation, unsustainable farming practices, soil erosion, pollution and climate change, land degradation, poor market infrastructure and storage facilities resulting in low agricultural productivity. To mitigate against these challenges, more investment in development of resilient agricultural systems that are able to maintain or increase, agricultural productivity and food security in the face of the adverse ecological and climatological effects of climate change, drought, and land degradation. Sustainable agricultural land management practices are currently being implemented by farmers in the country championed by government agencies and NGOs such as Biovision Africa Trust (BvAT), World Agroforestry Centre (formerly ICRAF) and PELUM-Kenya with a special focus on the Ecological Organic Agriculture Initiative (EOI). Ecologically based approaches have been identified as potential solutions, especially in the Kenyan context where agriculture is characterized by a large percentage of small-scale farmers. For this category of farmers, the cost farm inputs such as inorganic or synthetic fertilizers, crop protection products, improved seeds, irrigation are out of reach. Therefore, ecological based approaches such as agroforestry offer practical and sustainably viable options to addressing the many challenges facing small-scale farmers in Kenya.

Figure 1: Integration of trees into farmland

1.2 Agroforestry

The term 'Agroforestry' is a commonly used to refer to practice where farmers deliberately retain and integrate trees with annual crop cultivation, livestock production among other farm activities as a form of land management technique. This practice has been widely promoted as an ecological based and sustainable practice involving a mix of both agriculture and forestry. The need for agroforestry was first felt due to challenges posed by food shortage and ecological degradation, high population pressure, land defragmentation, land encroachment on forested and steeply sloping landscapes.

In spite of agroforestry being a native practice in SSA, a lot of its understanding to date is owed to dedicated efforts by World Agroforestry Centre, formerly the International Council for Research in Agroforestry (ICRAF). A wide range of studies on description and characterization of agroforestry systems, constraints and opportunities of agroforestry, intercropping and integrated farming systems have been documented, as providing mitigation against soil fertility and livestock challenges. An example includes development of agroforestry systems using tree species such as apple-ring (*Faidherbia albida*) for provision of fodder, fixation of nitrogen among other uses. As a result, farmers in Kenya have practiced integration of legume species within cropping systems using species such as Calliandra (*Calliandra calothyrsus),* rattle pod *(Sesbania sesban), Leucaena (Leuceana leucocephala) and* Markhamia *(Markhamia lutea).* The leafy biomass of agroforestry species is mainly popular among the small-scale farmers as a cheaper alternative for plant nutrients from the organic matter.

Figure 2: *Leucaena* sp.: An example of an agroforestry tree

The benefits accrued from agroforestry systems are many and varied. First, Agroforestry complements food and nutritional security in diverse ways including provision of tree foods such as fruits and leafy vegetables, use of tree species for fodder such as Calliandra for improved milk production, increasing raising farmers' incomes through the sale of tree foods and tree products, provision of fuel for cooking; ecosystem benefits such as pollination, soil and water conservation

among other benefits. In spite of the recent milestones in agroforestry, we need to acknowledge that the agroforestry practices that have so far been promoted and subsequently adopted by small-scale farmers. It has been demonstrated that often, farmers have a preference for agroforestry practices that meet their multiple needs depending on the available resources. Similarly, the preferences of agroforestry technologies vary across farms.

Several authors have demonstrated that small-scale farmers in the SSA are distributed over a wide range of AEZs. There is therefore, the need to use innovative approaches to identify potential for agroforestry practices as they apply to diverse small-scale farming systems. In so doing, participatory methods that include surveys, informal interviews, key informant interviews, technology testing and farmer ranking of importance of tree species provide the best approach that would easily identify agroforestry technologies preferred by the small-scale farmers in Kenya. This study was designed to assess the preference of small-scale farmers in agroforestry technologies and practices in Kenya as per the objectives below.

2. Objectives

The main purpose of this study was to document the farmer preferences on agroforestry practices and technologies in Kenya.

The specific objectives were;

a) To conduct desk study on farmer preferences for agro-forestry technologies applicable in at least 3 different AEZs distributed in selected parts of Kenya including as Western (Siaya, Vihiga) Upper Eastern (Embu) and Lower Eastern (Machakos).

b) To undertake focus group discussion (FGDs) and/or key informant interviews to assess farmer preferences for selected practices/ technologies in order to satisfy different use functions such as timber, fodder, fruit, medicinal, soil and water conservation, shading, windbreaks etc.

c) To prepare a detailed findings report.

3. Methodology/Approaches

The activities of this study followed a three-step approach namely:

3.1 Activity I – Inception phase

The purpose of this phase was to achieve concurrence among the stakeholders during the period of the assignment. The inception meeting served to meet the following purpose:

a) Introduction of the team nominated by CropCare Technologies to carry out the assignment.
b) To have an understanding of the deliverables/expectations of BvAT at the end of the assignment.
c) To have a consensus between the stakeholders on the methodologies and tools to be employed during the study.
d) To introduce the task team to the BvAT, PELUM-Kenya and ICRAF field staff for logistical facilitation of field activities.

i) *Site Characterization:* Three AEZs were selected for comparison in this study. As presented in Table 1 below. The sites selected for the field visits are as highlighted in Figure 3.

Table 1. Site characterization based on the AEZ

	AEZ	County	Altitude (M)
1	Lower Midland (LM) and Lower Highland (LH)	Machakos	4304-4791 asl
2	Lower Midland (LM) and Upper Midland (UM)	Vihiga/Siaya	4313 -4765 asl
3	Upper Highland (UH), Upper Midland (UM) and Lower Midland (LM)	Embu	4180 – 4390 asl

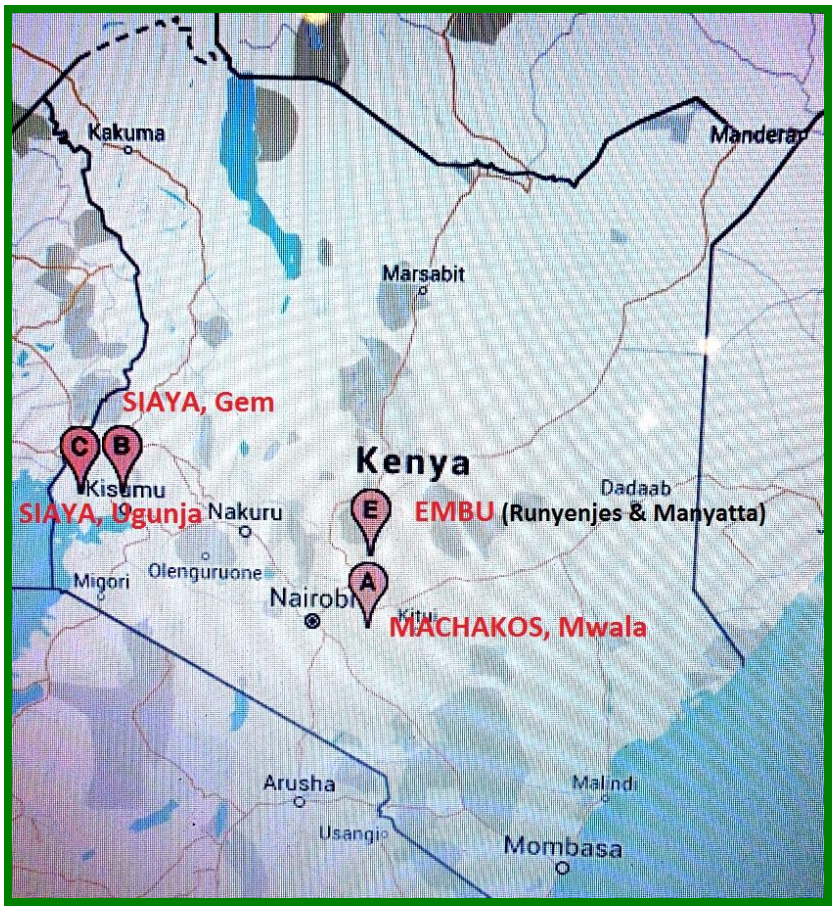

Figure 3. Map of the sites selected for the Study. Siaya-Gem, Siaya-Ugunja, Vihiga- Emuhaya, Embu-Runyenjes, Embu-Manyatta and Machakos -Mwala. Map generated using BacthGeo.com

3.2 Activity II – Desk Study on Farmer Preferences for Agroforestry Practices

During the inception meeting and after subsequent introduction(s) of the review team to the lead organization (BvAT) of the consortium, the reviewers were provided with information including previous reports relevant to the study, annual reports to-date, and additional research reports submitted to the organization by previous consultants. In addition, the review team consulted the consortium partners' websites BvAT, PELUM-Kenya and ICRAF. To properly assess studies on agroforestry technologies systems, practices and adoption in Kenya, open access electronic journals such as AJOL, and International Journal of Agroforestry and Silviculture (IJAS) and Forest Research were consulted and some publications obtained from the ICRAF online library network. To ensure the literature obtained on the wide-ranging agroforestry technologies and practices was sufficiently reviewed, each of these sources of information was independently assessed by the two members of the review team. The full list of reviewed material is listed in Appendix 1.

3.3 Activity III – Focus group discussions (FGDs) and key informant interviews

The team also conducted nine (9) focus group discussions with interest groups. Focus group discussion is a qualitative research method, in which a small group of participants discusses a specific topic under the guidance of a trained moderator. The aim of the FGDs was to solicit information that would generate qualitative data on agroforestry practices and to further understand farmers' preferences to satisfy different use function such as timber, fodder fruits, medicinal, soil and water conservation, shading, wind breaks etc. The FGDs participants were limited to not more than twenty per persons, whose selection was also based on gender and type of agroforestry practice. A checklist was used to facilitate the focus group discussions (Appendix 2).

Figure 4: FGD in Machakos County; Bidii SHG.

In addition, key-informant interviews were also conducted with experts on agroforestry within the selected zones to gain in-depth understanding of the current practices and their adoption. Participants of the key-informant interviews were drawn from national and county levels, local leaders, local NGOs and private sector organizations. These included Climate Change Unit of the Ministry of Agriculture, Livestock and Fisheries (MOALF), Vi-Agroforestry, World Agroforestry Center (formerly ICRAF), and Stockholm Environment Institute (SEI) International (Appendix 3).

3.4 Activity IV – Data collection and analysis

The data were gathered separately for FGDs and key-informant interviews using an open-ended interactive questionnaire. Data collected included objectives of the farmers groups, period of agroforestry practice, uses of agroforestry practices and technologies, farmers' preferences for specific species and their management, list of agroforestry species in farms. Since the local language (Kamba, Embu, Luhya and Luo) was sometimes used during the FGDs, tree names that were given

in local names were cross-checked and translated into their common as well as scientific names with the help of an agroforestry expert from the local ICRAF office. The data obtained was then uploaded onto *Mfarms Survey*, a mobile based platform specializing in analysis of survey data.

4. Findings

4.1 Ecological characterization of study sites within Machakos, Embu, Siaya and Vihiga Counties

These study sites, namely Machakos, Embu, Siaya and Vihiga counties were selected in consultations with BvAT and ICRAF staff. All the sites had a history of active engagement in agroforestry practices and therefore served as important sources of information for the reviewers since these were projects sites where ICRAF and other partners had or were implementing agroforestry projects.

4.1.1 Machakos County

Machakos County neighbors seven counties, including Muranga, Kiambu, Nairobi, Kajiado, Makueni, Kitui and Embu, and covers a total area of 6,208 km^2. The county comprises eight sub-counties, namely Yatta, Kangundo, Masinga, Mwala, Mavoko, Kathiani, Matungulu and Machakos Town. The county has an altitude of 1000-1600 meters above sea level. Temperatures range from a minimum of 9.1°C to a maximum of 26.7°C and rainfall ranges from 500 mm to 900 mm per annum. Local natural resources include wildlife, hills, building sand, water (rivers), pasture and land. The main economic activities/industries include farming, beekeeping, trade, dairy farming, limited coffee, eco-tourism, businesses and manufacturing. The primary agricultural products include mangoes, pawpaws (papaya), watermelons, maize, cow peas, beans, pigeon peas and lentils, and livestock.

The Akamba people are the dominant habitants of Machakos County. Small-scale farmers in Machakos have greatly benefitted from the EverGreen Agriculture programme which has been implemented by ICRAF through the Rural Research Center. Three groups were interviewed in Mwala and Machakos Town sub-counties of Machakos County which included Two-Ten Youth Group, Bidii SHG and Muti Nzuki Women Group (Table 2).

Table 2: Small-scale agroforestry groups in Machakos County

AEZ	Sub County	GPS coordinates	Group Name	Members	Activities
Lower Midland (LM) and Lower Highland (LH)	Mwala	S01^{0}24.960' E037^{0}23.944'	Two-Ten SHG	15 (9Female, 6 Male)	Table banking Horticulture farming Water Harvesting Conservation Agriculture
	Mwala	S01^{0}25.205' E037^{0}28.753'	Bidii SHG	10 (9 Female, 1 Male)	Horticulture farming Table banking Conservation Agriculture
	Machakos Town	S01^{0}30.210' E039^{0}24.544'	Muti Nzuki SHG	14 (13 Female, 1 Male)	Farming Merry Go round Apiaculture Poultry Farming Conservation Agriculture

4.1.2 Siaya and Vihiga Counties

Siaya County is one of the six counties in the Nyanza region and is bordered by Busia County to the North West, Vihiga and Kakamega counties to the North East, Kisumu County to the South East and Homa Bay County across the Winam Gulf to the South. Ecologically, the County spreads across agro-ecological zones LM1 to LM 5. The County experiences a bi-modal rainfall, with long rains falling between March and June and short rains between September and December. The rainfall ranges between 800mm – 2,000mm and temperature ranges from mean minimum temperature of 16.3° C and mean maximum temperature of 29.1° C. The main food crops include; maize, sorghum, millet, beans, cowpeas, cassava, sweet potatoes, groundnuts and finger millets while the main cash crop include cotton, rice, sugar cane and groundnuts. Vegetables produced in the County include: tomatoes, onions and kales while fruits grown in the region are; mangoes, pawpaw, bananas, oranges and watermelon. The groups interviewed included Echado SHG in Emuhaya sub-county and representative farmer's representatives from selected SHGs in Gem sub-county (Table 3).

Table 3: Small-scale Agroforestry groups in Siaya/Vihiga Counties

AEZ	Sub County	GPS coordinates	Group Name	Members	Activities
Lower Midland (LH) and Upper Midland (UM)	Emuhaya	N00^{0}05.100' E034^{0}34.051'	Echado SHG	19 (6 Female; 13 Male)	Table banking Horticulture Water Harvesting
	Gem	N00^{0}06.693' E034^{0}31.348'	Representatives of 9 SHGs*	16 (7 Female; 9 Male)	Horticulture Table banking Soil conservation Weaving
	Ugunja	N00^{0}09.595' E034^{0}25.342'	Individual Farmers**	5 (5 Male)	Farming Soil conservation

*These groups included: *Sinane Women Group, Wich Edhano, Sauri Youth Group, Tiek Gitiendi SHG, Geuza Mawazo SHG, Wacho Gitimo SHG, Sauri Women for Change, Aniko Sauri Community SHG (ANASURI)* and *Soso Women Group*.
**The FGD venue and time coincided with a Farmer's Field Day. The participants of the FGD were randomly drawn from the Field day.

4.1.3 Embu County

Embu County is located in the upper eastern region of Kenya and borders Kirinyaga County to the West, Kitui County on the East, Machakos County to the South and Tharaka-Nithi County to the North. The county is divided into four sub-counties namely; Runyenjes, Manyatta, Mbeere South and Mbeere North. Embu County shows the typical agroecological profile of the windward side of Mt. Kenya, from cold and wet upper zones to hot and dry lower zones in the Tana River Basin. The average annual rainfall reflects this contrast: from more than 2200 mm at 2500 m to less than 600 mm near the Tana River at 700 mm. The rainfall pattern is bimodal with two distinct rain seasons. Long rains occur between March and June while the short rains fall between October and December. Rainfall quantity received varies with altitude averaging to about 1,000 mm annually and ranging from 640 mm in some areas to as high as 1,495 mm per annum. Temperatures range from a minimum of 12°C in July to a maximum of 30°C in March with a mean of 21^{0}C. In Embu, the reviewers had sessions with the Kambo Kariguini SHG and Gicegere Youth Group in Manyatta sub-county and a farming community in Runyenjes sub-county.

Table 4: Small-scale Agroforestry groups in Embu County

AEZ	Sub County	GPS coordinates	Group Name	Members	Common Group Activities
Lower Midland (LH) and Upper Midland (UM)	Manyatta	S00^{0}32.495' E037^{0}30.656'	Kambo Kariguri SHG	12 (9 Female; 3 Male)	Table banking Horticulture Water Harvesting
	Manyatta	S01^{0}31.564' E037^{0}30.179'	Gicegere Youth Group	4 (2 Female; 2 Male)	Horticulture Table banking Soil conservation Quarrying
	Runyenjes	S01^{0}26.409' E037^{0}38.783'	Farming Community	17 (11 Female; 6 Male)	No common activities

4.2 Small-scale Farmers' Understanding and Perception of the Agroforestry Concept

Although we found that most small-scale farmers knew about agroforestry (Table 5), we also found out that among the small-scale farmers, the true meaning of agroforestry was far removed from the common definition. Of all the farmers, 90% were able to correctly describe the agroforestry concept. However, it was also quite clear that agroforestry meaning and definition varied significantly, among the farmers interviewed. The most common definition was '*the planting of trees*', '*planting of trees in the farm for addition of manure and nutrients'*. Among the regions interviewed, understanding of the agroforestry concept was highest in Machakos and Siaya Counties while perception and meaning of agroforestry was different and lowest among small-scale farmers of Embu County, particularly Manyatta sub-county. It is our conclusion that the differences in perception and understanding of the agroforestry concept are among the factors that contribute to differences in preferences of agroforestry practices among the farmers especially in regard to the source of dissemination of AF information as demonstrated in 4.3.

Table 5: Distribution of respondents based on the understanding of the agro-forestry concept

County	Group	Correct understanding	Percentage
Machakos	Two ten	13 (n=15)	87
	Bidii SHG	7 (n= 9)	77
	Muti Nzuki SHG	8 (n=14)	58
Embu	Gicegere Youth Group	6 (n=12)	50
	Kambo Kariguri SHG	2 (n=4)	50
	Individual farmers	10 (n=17)	70
Vihiga	Echado SHG	15 (n=19)	78
Siaya - Gem	Many Groups	16 (n=16)	100
Siaya - Ugunja	Individual Farmers	5 (n=5)	100

4.3 Avenues for Dissemination of Agroforestry Information

The study found NGOs were the primary avenues of information dissemination regarding agroforestry. At least 50% of the respondents had first heard about agroforestry from NGOs (Figure 5). The highest levels of dissemination were observed to be in Machakos and Vihiga/Siaya sites and least in Embu, particularly in Manyatta Sub-County. It is worth noting that farmers in Embu County, Runyenjes Sub-County had comparatively more benefit from the dissemination. Most of the common NGOs listed by the respondents included World Agroforestry Center (ICRAF), International Center of Insect Physiology and Ecology (ICIPE), CARE-Kenya, Vi-Agroforestry, IFAD, World Vision, KENDAT and One Acre Fund. Public Governmental institutions (MOA, KARLO and KFS) accounted for the second most important source of information on agroforestry impacting 21% of the farmers. Media (radio and television), primary and secondary schools and other farmers were also sources of information in decreasing order. This finding is clearly evidenced by the significant role of ICRAF who in collaboration with other private stakeholders and Governmental organizations have been at the forefront in promoting awareness of agroforestry technologies and practices in Kenya since 1970s.

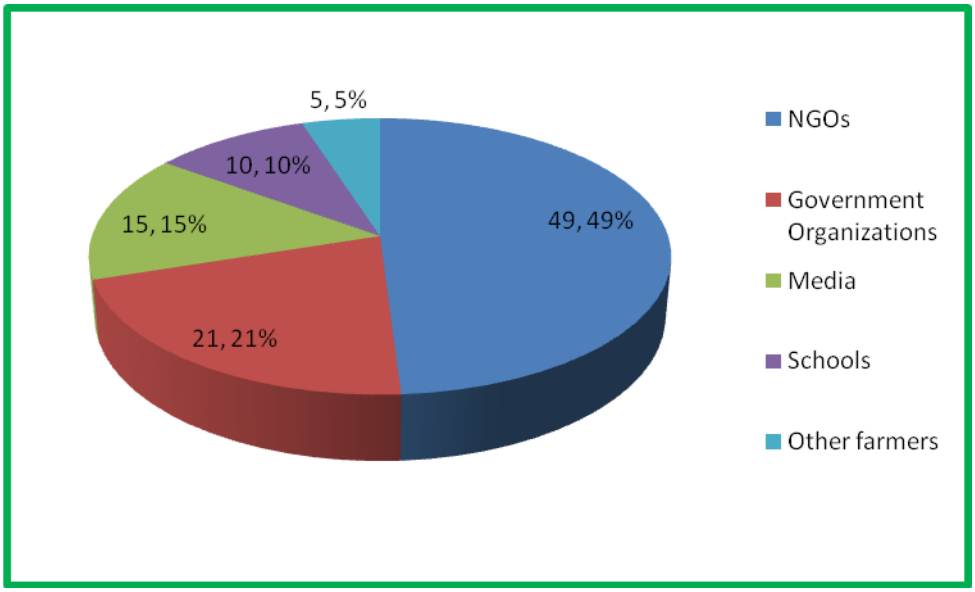

Figure 5: Primary Sources of Information on Agroforestry

4.4 Constraints of Agroforestry Practices and Technologies

The study revealed that small-scale farmers were facing diverse constraints which were aggregated into major categories associated with agroforestry. Our observation was that agroforestry in a wide variety of forms was extensively practiced in all the study areas. However, the respondents did not fully maximize the benefits of such agroforestry practices due to socio-economic and biophysical environment constraints as shown in Figure 6.

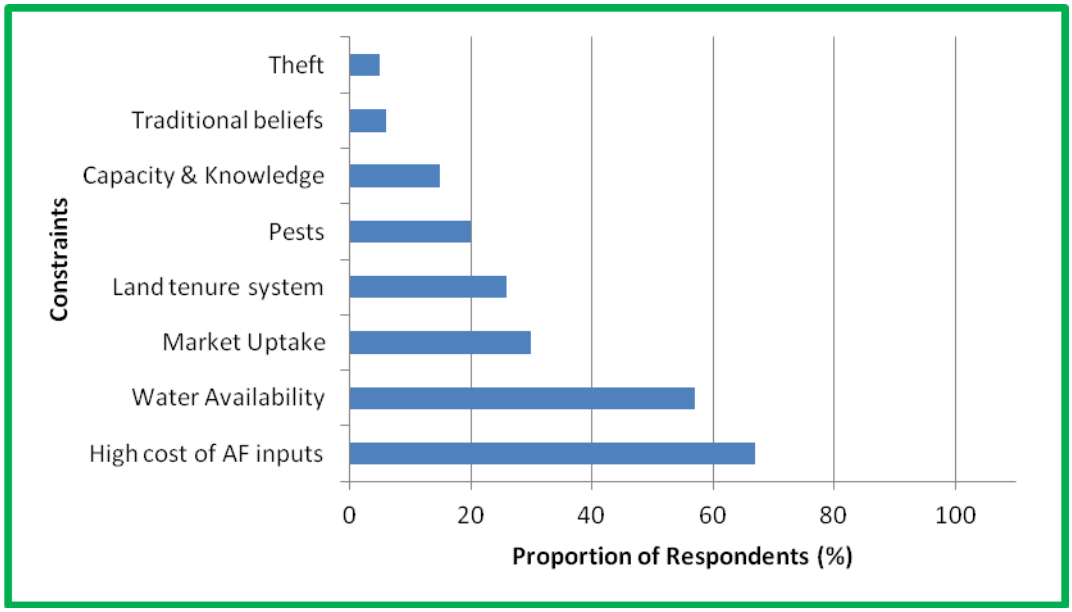

Figure 6: Constraints associated with application of agroforestry in the study sites

4.4.1 High cost of AF inputs

High cost of inputs for agroforestry, including seeds, seedlings, black polyethene sleeves, and labour for digging of holes for planting tree seedlings and maintaining tree nurseries was ranked as the greatest challenge among the agroforestry farmers. This was supported by arguments from the respondents that these costs are borne out of their household incomes which were prevalently low amongst the small scale farmers. The explanation for such an outcome should be found in the farmers' socio-economic environment, particularly income, farm size and gender of household head. This is however contrary to the hypothesis that agroforestry practices are for the benefit resource-poor situations and are not easily adapted to more intensive agricultural practices. But this finding may also be true especially given that the competition between trees and food crops, and the priority that they must give to meeting their basic food needs, will eventually lead to lower household incomes as stated by the farmers.

4.4.2 Lack of water

With an average annual rainfall of 1000 mm, the study sites cannot be considered to be sufficiently watered. This is most probably why water stress was emphasized to be a problem by 60% of the respondents. While this water availability was a challenge cited in all the regions, it was most severe in Machakos where we encountered two out the three sites had abandoned previously abandoned

tree nurseries resulting in 100% loss due to water scarcity. In order for small-scale farmers practicing agroforestry to realize the full benefits of tree survival and successful nursery management, the availability of basic production factors is essential. Water supply was a limiting factor in all the farmers groups and their respective nurseries, regardless of the size of the nursery or the agro-ecological zone in which it was located. Although water harvesting techniques were available, few farmers could afford the cost of adoption and when available, the preference to irrigate horticultural crops was noted (Figure 7).

Figure 7: Water harvesting techniques in Two-Ten SHG and Bidii SHG, Machakos County. Both are initiatives of local NGOs including World-Vision.

4.4.3 Capacity and Knowledge

According to the respondents' perceptions, capacity building on agroforestry had laid a lot of emphasis on the exotic tree species and there was concern that information on the production of indigenous tree species was lacking. An example was given by farmers in Echado SHG in Vihiga sub-county who sought to know the recommended spacing of their indigenous mango tree (*Mangifera indica)* and the relevant production practices. The farmers' knowledge about how to raise indigenous tree seedlings was generally limited and the existing stakeholder organizations and

Figure 8: Boundary trees: A common practice around the homesteads of small-scale farmers

extension workers to promoted exotic species. Farmers in Embu and Western Kenyan pointed to the need to be supplied with seedlings and cultivation information of their local indigenous mango varieties. While it was evident that in Western Kenya, fodder and forage trees were valued by the community, it was also surprising that most of the farmers believed that *Eucalyptus* was not an agroforestry tree species. Ironically, in the same region, farmers who did not have *Eucalyptus* in their homesteads were considered not to have trees. This was because Eucalyptus was predominantly perceived as a man's tree by the women who did not see any benefits from it. The men in western region mostly planted it for income generation from the sale of timber. Most often, *Eucalyptus* were found as boundary crops that were not shared, and often as woodlots in land use systems that required reclamation. In regard to capacity and knowledge, the farmers in all the study sites expressed the need for more awareness of existing forest legislation, tree seedling management, pest and disease management in AF systems and enhanced access to AF seedlings.

4.4.4 Land Tenure System

Land tenure is an important factor in agricultural development. This issue was clearly illustrated by the farmers especially the youth and women among the groups who felt marginalized due to lack of ownership of land. The Kenyan system of land ownership is mainly patriarchal favouring men while women and youth mainly work on the land. In addition, in these communities, land ownership is often by inheritance which is biased against women. This absence of clearly defined land tenure weakens incentives for long-term agroforestry investments in land to increase its productivity. In addition, inheritance of land is also to blame for the increased land defragmentation resulting in farmers owning smaller parcels of land that limit the scale of production. The limitation in land sizes has been attributed to the poor adoption of agroforestry practices by small-scale farmers. In addition, agroforestry practices and technologies that require large tracts of land such as tree-crop fallowing are impossible when land size is constraint.

4.4.5 Other factors

Other challenges that hindered the practice of agroforestry included traditional beliefs, which seemed to play a greater role in Western Kenya, where the tree nursery business was not preferred by the youth who would rather engage in fishing. Misconceptions about tree shades negatively affect crops and fruit trees attracting wild animals were common among the farmers. It was also in western Kenya, that respondents indicated that tree planting activities were dominated by men and taboos resulted in fewer women participating in agroforestry practices. Theft was often reported where trees were grown away from the homesteads. The household level of returns compared to other alternative options will determine the rate of adoption of the agroforestry practices. Farmers were found to have a preference for horticultural activities that had a relatively quick income generation time compared to agroforestry which is either as short, medium or long term in returns and/or benefits.

Jack plum: commonly known as *Mfenesi* was belived to attract hyenas in Western Kenya

Table 6. Strategies to overcome the challenges to practicing agroforestry

	Constraint	Proposed Strategy
1	Lack of water	-Households to dig own wells -Sink communal boreholes -Implement rainwater-harvesting techniques
2	High cost of AF inputs	-Establish household nurseries -Procure seeds from stakeholder institutions (e.g. KFS, KEFRI and ICRAF) -Involve microfinance institutions -Practice conservation agriculture -Adopt agroforestry practices appropriate to small fields, e.g. scattered trees on cropland, hedges around fields -Practice EOA pest and disease control methods
3	Insecure land tenure system	-Lobby for more secure tenure system through local members of parliament - Pursue the provision to apply for title deeds or leases -Change the traditional perception that land belongs to men and not women
4	Capacity and Knowledge	-Consult extension workers - Learn from lead-farmers -Train farmers extension workers and AF on practices

4.5 Farmer Preferences of Agroforestry Practices and Technologies

An inventory exercise carried out among farmers in the study sites showed that farmers from different regions differed in their preferences for agroforestry (Table 7). More timber trees silky oak Eucalytus and Markamia were planted by farmers in Western Kenya and Embu regions compared to the lower Eastern region of Machakos. While in Western Kenya, fodder and forage trees were very important to the community, all the regions demonstrated preference for leguminous tree species such as Calliandra*, Gliricidia,* Leuacaena*,* silky oak*,* apple-ring, and jack bean were the most common species. However, the Western part of Kenya of Vihiga and Siaya counties had, in addition to the species above, leguminous shrubs velvet bean *(Mucuna pruriens),* tree marigold *(Tithonia diversifolia),* rattle weed *(Crotalaria spp),* dolichos bean *(Lablab purpureus)* and Tephrosia *(Tephrosia vogelli)* species

planted among the farmers. In the legume species category, Calliandra (*Calliandra calothyrsus)* was rated highly for its ability to provide poles, palatability, coppicing and compatibility with other crops. In addition, Calliandra was common among the farmers for its potential to improve soil fertility. In Machakos, fruit trees were most preferred to the fodder and forage trees. *Croton* sp was the least important tree species in Western Kenya though it had a lot of medicinal importance. In the fruit trees category, all the regions had mango (*Mangifera indica)*, pawpaw (*Carica papaya)*, Lemon/orange (*Citrus* spp.), guava (*Psidium guajava)* and avocado (*Persea americana)*, passionfruit (*Passiflora edulis and* wild custard apple (*Anona senegalensis)* most often planted near the homestead or in orchards. However, *Citrus* spp were not grown in Western Kenya and Embu regions but proved to be well adapted to the lower eastern region of Machakos.

Table 7. Inventory of current trees grown on farms among the study sites

Agroforestry Practice	Preferred Agroforestry Species		
	Machakos	Embu	Siaya/Vihiga
1. Fertilizer trees/annuals/shrubs	Pegion pea, Calliandra, Gliricidia, Leucaena, apple-ring acacia, jack bean, yellow cassia, Senna and Sesbania	Calliandra, Gliricidia, Leucaena, apple-ring acacia, jack bean, and Sesbania	Rattlle pod, Tephrosia, velvet bean, Calliandra, Gliricidia, Leucaena apple-ring, lack bean, velvet bean, Tithonia Sesbania Dolichos bean, and Tephrosia
2. Fuel wood	Jatropha, yellow cassia, silky oak, apple-ring acacia, casuarinas, senna	Jatropha, yellow cassia, silky oak, apple-ring acacia	Jatropha, yellow cassia, silky oak, apple-ring acacia
3. Timber	Albizia, umbrella tree, pepper tree, cedar and Markhamia	Albizia, umbrella tree, pepper tree, cedar, and Markhamia	Eucalyptus, Markhamia and Casuarina
4. Food& Fruits	Mango, pawpaw, guava, orange/lemon, passion fruit avocado and custard apple	Mango, pawpaw, guava, passion fruit avocado and custard apple, macadamia, tree tomato.	Yellow cassia, Mango, pawpaw, guava, passion fruit avocado and custard apple
5. Fodder	Acacia, Albizia, Gliricidia Calliandra, Sesbania and Leuceana, Senna	Acacia, Albizia, Gliricidia Calliandra, Sesbania and Leuceana, Senna	Acacia, Albizia, Gliricidia Calliandra, Sesbania and Leuceana
6. Hedges/Boundary Marking	Acacia, African myrrh, Croton, Senna, Eucalyptus, silky oak, Gliricidia	Silky oak, Eurphobia, Albizia, Senna, Mimosa, Fig tree, Jacaranda	Thevetia, Euphorbia, Eucalyptus, guava, Tithonia, Tephrosia, Senna Mimosa and fig tree
7. Windbreaks	Casuarina, silky oak, Senna, pepper tree and Cedar	Cassuarina, Albizia, silkyoak Cedar, pepper tree	Eucalyptus sp., Cedar
8. Medicinal	Croton, apple-ring acacia, neem tree, Moringa	Aloe vera, neem tree Moringa	apple-ring acacia, moringa
9. Shade	Croton, Markhamia, Senna, apple-ring acacia Cedar	Croton, Markhamia, Senna, apple-ring acacia Cedar	Croton, Bishop tree, Markhamia, Jacaranda, Stinkwood (*Prunus africana*) Terminalia and apple-ring acacia
10. Woodlots	Eucalyptus, silky oak, Markamia	Eucalyptus, silky oak, cedar and Markhamia	Eucalyptus and silky *oak*

4.5.4 Gender perspective on the preference of agroforestry practices in the study sites

In agriculture, there is a general consensus that gender inequalities in areas such as ownership and access to resources, land tenure, and education have contributed to lower productivity. Given the importance in all spheres of production, we sought to evaluate the role of gender in the preference of agroforestry practices and technologies. In each of the FGD, women and men were grouped separately and asked to rank the importance of the trees from the most to the least important

(Figure 10). The focus on women and preference of agroforestry practices is critical because women play a central role in agroforestry mainly by managing trees as they do most of the work in the initial stages of establishment such as planting weeding and watering. For both men and women across all the study sites, *Grevillea* was ranked highest, however for different reasons between the two genders (Table 8). According to the women, *Grevillea* was most important for fuel wood while men valued it for timber and the returns generated. Whereas in Machakos fruit trees were ranked highly by both genders, women appreciated the source of food while men valued them for the income they bring. In general, it was established that women's preference for trees that provide fuel wood and fruit tree is in line with the traditional responsibility of women to obtain food and fuel wood for the household. In Western region, fodder and forage trees were preferred by women with *Sesbania* perceived as woman's tree. In general, women were allowed to collect and use fruits, but are restricted from harvesting fuel wood of high value timber trees such as *Markhamia lutea*, *Eucalyptus* and *Grevillea*.

Figure 10: Women (left) and Men (right) in small groups rank the importance of trees species

Table 8: Gender Perspective on Preferred Agroforestry species

Gender	Machakos		Siaya/Vihiga		Embu	
	Men	Women	Men	Women	Men	Women
Most Important	Mango Pawpaw Citrus Grevillea	Grevillea Mango Pawpaw Citrus	Grevillea Gliricidia Markhamia Eucalyptus	Grevillea Callliandra	Grevillea Avocado Mango	Grevillea Mango
Least Important	Croton	Eucalyptus Thivetia	Sesbania Croton	Eucalyptus Croton	Croton	Calliandra Croton

5. Conclusion and Recommendations

Employment of participatory approaches, key informant interviews, by-stander observations and FGDs are tools that enabled us to understand smallholder agroforestry preferences in diverse agro ecological zones to address their needs. The combination of surveys of existing practices together with following farmers' preferences for planting tree species as well as the farmers' own evaluations allowed us to identify practices adopted by agroforestry farmers. We found that farmers from different agro-ecological zones had preferences for different tree species. The understanding of the agroforestry concept by farmers among small holder farmers can be improved further by scaling up capacity and knowledge by all stakeholders in agriculture. NGOs have played a key role but these efforts need to be supplemented. The constraints identified herein do need to be mitigated. Land tenure security needs to be enhanced for improved investment into agricultural lands. Market outlets for agroforestry products need to be provided; value addition where possible may be explored and strategies to mitigate water shortage to be taught the farmers. Similarly, financial education on access to credit facilities and microfinance institutions need to be introduced to the small scale farmers to help them offset the high cost of inputs. In our study, from gender perspectives, preference for agroforestry practices is based on food security as the first order of priority in the household among the women. Income generation is the first order priority men seek in agroforestry practices. If farmers cannot satisfy these priorities the path to agroforestry adoption will be blocked. Fortunately, the priority needs of both genders are often met by same tree species albeit with multiple benefits. While soil conservation and soil fertility have previously been key drivers for adoption of agroforestry practices among the farmers, perhaps other entry points need to be sought for agroforestry-based approaches to these problems such as provision of staking material for tomatoes and climbing beans could be an entry point for introduction of multi-purpose legume trees into the farming system, which could provide multiple benefits. Our results have important implications for setting priorities for future investment in agroforestry research. For instance, from the study, we have seen the impact of fruit trees having received less attention on account of previous emphasis on timber and legume species to deal with soil erosion and soil fertility problems especially in Western Kenya. Our results suggest that a revision of research priorities should consider extending attention to agroforestry species that match farmer preferences and include those options that have a direct potential for generating income.

6. Appendices

Appendix 1: Selected References

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Appendix 2: FGD Checklist

Questionnaire – Focus Group Discussions

1. Name of Group_____
2. County_____ Sub-county_____ Village_____
3. GPS Coordinates_____
4. When was the group formed? _____Year of registration_____
5. What was the purpose for forming the group?
   i) _____
   ii) _____
   iii) _____
   iv) _____

6. What is the membership disaggregated by gender?
   Male_____ Female_____

7. What common activities do you presently undertake as a group?
   i) _____
   ii) _____
   iii) _____
   iv) _____

8. In your own opinion, what is agroforestry?
   _____

   _____

9. How did you first hear about agroforestry?
   - ☐ 1-Ministry of Agriculture
   - ☐ 2-Other farmers
   - ☐ 3-Media
   - ☐ 4-Organisations (Specify)
     i) _____
     ii) _____
     iii) _____
   - ☐ 4-Others (Specify)
     i) _____
     ii) _____
     iii) _____

10. How has agroforestry benefitted you?

    i) _____
    ii) _____
    iii) _____
    iv) _____
    v) _____

11. For how long have you practiced agroforestry?

    ☐ Less than 3 yrs ☐ More than 5 years ☐ More than 10 yrs

12. Where do you source your seedlings?

    ☐ a- local tree nursery ☐ b-produce own seedlings

    ☐ c-Organizations (Specify_____) ☐ d-neighbours/farmers

    ☐ e- Others (specify) _____

13. What challenges do you face in practicing agroforestry

    i) _____
    ii) _____
    iii) _____
    iv) _____
    v) _____

14. In your opinion, what recommendations can you make for the as solutions to the challenges above?

    i) _____
    ii) _____
    iii) _____
    iv) _____

15. What trees have you planted in your home and their respective uses?

    i) _____ (vii)_____
    ii) _____ (viii)_____
    iii) _____ (ix)_____
    iv) _____ (x)_____
    v) _____ (xi)_____
    vi) _____ (xii)_____

16. Why did you plant them (Rank from the most important to the least)

    i) _____
    ii) _____

iii) _____
iv) _____
v) _____

17. Have you encountered any disadvantages of planting trees?
    If yes, which ones?
    i) _____
    ii) _____
    iii) _____

18. Do you practice any soil and water conservation measures? If yes, name them
    i) _____
    ii) _____
    iii) _____-
    iv) _____

19. What trees don't you have that you would like to plant on your farm?
    i) _____
    ii) _____
    iii) _____
    iv) _____
20. Why would you like to have these trees?
    i) _____
    ii) _____
    iii) _____

21. Any other comment concerning agroforestry?

    i) _____
    ii) _____
    iii) _____

Appendix 3: Key Informant Interviews Participants

Name	Tel . Contact	Organization
Dr. Othniel Yila	0731 748151	SEI
Beatrice Tuei	0723 301277	MOA - Nairobi
Janet Oyuke	0726 657238	MOALF - Nairobi
Thomas Mboya Ochinga	0722 627527	ICRAF - Kisumu
Silas Muthuri	0723 903400	ICRAF – RRC Machakos
Oscar Masika	-	ICRAF – Nairobi/Embu
Elizabeth Kiura	0723 741717	MOA -Embu
Jared Odhiambo	0727 895611	Vi-Kisumu
Wilson Nyariwo	-	Vi-Kisumu
Florence Karuri	0723 903626	Lead Farmer, Embu, Runyenjes