What Informs the Choice of Free Seeds and Seedlings taken by Farmers while Adopting Agroforestry in Makueni County?

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Abstract

Purpose: The main objective of this study was to evaluate what informs the choice of free seeds and seedlings taken by farmers while adopting agroforestry in Makueni County.

Methodology: This study adopted a descriptive survey design. The study randomly selected 150 beneficiaries appearing in the list of 30,643 beneficiaries provided by Makueni County Long Rains Food Security Assessment Report (2013). This study used primary data which was collected through use of a questionnaire. After data had been collected through questionnaires, it was prepared in readiness for analysis by editing, handling blank responses, coding, categorizing and keying into Statistical Package for Social Sciences (SPSS) computer software for analysis.

Findings: The study findings indicated that agroforestry is beneficial to farmers in several ways. They can access tree products such as fuel wood, herbs, fodder and vegetables among others within their farms rather than traveling to forests, making it cheaper and less time consuming. The time saved can be invested in productive activities and subsequently improve incomes and livelihoods. It is therefore important to underscore that agroforestry practices and scaling

Conclusion: It can be concluded that the farmers were happy about the government initiative of distributing seeds. Free seed encourages planting of trees and woodlots by individual land users, institutions and community groups. Agroforestry can help in maintaining a viable system of green and open spaces for a functioning eco-system and work towards the achievement and maintenance of a tree cover of at least 10% of the land area of Kenya

Recommendations: The study recommends for rigorous mobilization and sensitization of the community on need for active involvement in agroforestry. Agroforestry scaling can take advantage of the landscape restoration programs in Makueni County.

Keywords: *Agroforestry, farmers, seed distribution.*

1.0 INTRODUCTION

Climate change is a major threat to a huge proportion of the farming populations in developing countries including Kenya, given they mainly derive their livelihoods from agriculture (Verchot *et al.,* 2004). Yields from rain-fed agriculture had dropped by half in 2020 and net revenue from crops is expected to fall by 90% by 2100 as a result of climate change (UNFCC, 2022). Agroforestry is however capable of buffering farmers against climate extremes (Thorlakson & Neufeldt, 2012), while performing wider services that directly support local production (Leakey, 2010). These include soil, spring, stream and watershed protection; animal and plant biodiversity conservation; and carbon sequestration and storage, all of which ultimately affect food and nutritional security (Garrity, 2004). Agroforestry is considered a low-cost approach to replenishing soil fertility that is technically feasible and socially acceptable to smallholder farmers especially those with limited resource endowment (Mango & Hebinck, 2016). Reduction of soil erosion, combating land degradation and soil fertility improvement were among the key goals of promotion of agroforestry in Kenya in the early years of research (Tengnas, 1994). In most rural households, incomes are seasonal in relation to the farming cycle (David, 1997), and therefore farmers are vulnerable and exposed when they wholly rely on their small farms for their livelihoods and sustenance.

Agroforestry can raise the income levels of rural households by providing profitable market products or enabling the household to obtain products that they would otherwise buy (Jamnandas *et al.,* 2013; Dawson *et al.,* 2013). Agroforestry systems provide opportunities for participation in various enterprises like tree nurseries, timber production and sale, fruit, fodder, fuelwood sale and any other product that can be commercialized. The trees serve as a 'savings account' and 'safety-net' and in some ways act as rural insurance system for the poor smallholder farming families who are highly vulnerable and subject to unexpected expenditures (Kallio, 2013). Income may also increase because of increased production in other agricultural enterprises supported by agroforestry, which enables households to sell the surplus.

Short-term leguminous trees such as *Calliandra calothyrsus*, *Leucaena trichandra and Leucaena pallida* were introduced into farms in early 1991 as livestock fodder in Embu jointly by ICRAF, Kenya Agricultural Research Institute (KARI) and Kenya Forestry Research Institute (KEFRI), under the National Agroforestry Research Project (NAFRP), sustainably raised the income level of small-scale dairy farmers (Franzel & Wambugu, 2007; Place *et al.,* 2009; NAFRP, 1993). Farmers who participated in on-farm trials with *Calliandra* fodder in Embu earned an additional US$98-US$ 124 per year from their dairy enterprises after the second year compared to farmers who did not (Franzel *et al.,* 2003a). The increase in income was attributed to adoption of *Calliandra* fodder as a substitute/supplement to commercial feeds (Franzel & Wambugu, 2007; Franzel *et al.,* 2003a), and innovations within the dairy value chains that increased farmers' income. Similar observations were reported in an agroforestry project in Kaptumo, Nandi County (Wambugu *et al.,* 2014). Wider adoption of fodder shrubs has also evolution of networks of small-scale seed dealers to support fodder shrub seed creating an additional revenue stream for adopting farmers, seed dealers and nursery operators (Dawson *et al.,* 2013; Wambugu *et al.,* 2011).

In terms of biodiversity, agroforestry has the potential to conserve tree genetic resources (Kehlenbeck *et al.,* 2010). Agroforestry presents landowners (whether of private, communal or public land) with the possibility to introduce new tree species in an area and exploit untapped

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niches for specific tree production. This is because trees can grow in different locations including boundaries, terraces or intercropped in food crops, pasturelands, riverine and hills among, many other niches. Land productivity improvement by agroforestry technologies involves some trade-offs that may impact negatively on the farmers, if not properly factored in design, however. These include cases where exotic tree species grown excessively replace indigenous species leading to low tree species diversity on landscapes. Studies such as Kehlenbeck *et al.* (2010) have reported low tree diversity and dominance of exotic tree species especially in the humid highlands. For example, Eucalyptus and *Grevillea robusta* have replaced many indigenous species as the most common tree species in farms in western Kenya (Henry *et al.,* 2009; Wanjira, 2019) and central Kenya (Njuguna *et al.,* 2014). This calls for a more pragmatic and holistic approach to realize the objective of improving biodiversity by increased diversity of tree species and other components that is paramount in building multifunctional landscapes through agroforestry.

Food and nutritional security is a major motivating factor for agroforestry adoption by farmers (Mbow *et al.,* 2013; De Souza *et al.,* 2012). Agroforestry contributes to food and nutritional security through 1) the direct provision of tree foods such as fruits and leafy vegetables and by supporting staple crop production; (2) by providing rich and nutritious fodder for livestock; (3) by providing energy for proper processing and cooking of food such as charcoal and firewood; and (4) by supporting various ecosystem services such as pollination that are essential for the production of some food plants (Jamnandas *et al.,* 2013; Dawson *et al.,* 2013).

With different species of exotic and indigenous fruit and nut trees promoted under agroforestry, farmers have access to fresh fruit throughout the year (ICRAF, 2008) which are a major source of vitamins and minerals. Example of fruits and nuts common to Kenya humid and ASALs include *Mangifera indica* (mango), *Citrus sinensis* (orange tree), *Persea americana* (avocado), *Tamarindus indica*, *Adansonia digitata* (baobab), *Syzygium cuminii,* Macadamia nuts, Cashew nuts among many other fruit and nut tree species that can grow under agroforestry. To better incorporate fruits into local food systems while addressing the challenge of seasonal availability, ICRAF has developed a methodology based on "fruit tree portfolios" that selects socio-ecologically suitable and nutritionally important fruit tree species for farm production, to meet local consumption needs (McMullin et al, 2019).

Studies have shown that fodder trees when fed to dairy cattle, can significantly increase milk yields (Franzel & Wambugu, 2007) enabling households to have more milk, an important source of proteins especially for children, for consumption and surplus for sales. According to Place et al., (2009), 1kg of dry matter equivalent of *Calliandra calothyrsus* twigs increased milk production by 0.6 kg-0.8 kg per day per cow and the butterfat content was also slightly higher when cattle were fed with fodder. Sale of tree products also provide smallholders with additional income which then allows them to be able to purchase food types not produced in the farm thereby improving household food diversity. Better access to cooking fuel also gives households more flexibility in term of what they can cook and eat, including foods with better nutritional profiles that require more energy to cook (Dawson *et al.,* 2013).

2.0 RESEARCH METHODOLOGY

This study adopted a descriptive survey design. The study randomly selected 150 beneficiaries appearing in the list of 30,643 beneficiaries provided by Makueni County Long Rains Food Security Assessment Report (2013). This study used primary data which was collected through

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use of a questionnaire. In order to test and enhance the validity of the questionnaire, the researcher selected a sample of five randomly selected agricultural extension officers within the county and discussed the contents of the questionnaire. Twenty questionnaires were piloted by issuing them to respondents who were not included in the final study sample. The twenty questionnaires were then coded and responses input into SPSS which were used to generate the reliability coefficient. After data had been collected through questionnaires, it was prepared in readiness for analysis by editing, handling blank responses, coding, categorizing and keying into Statistical Package for Social Sciences (SPSS) computer software for analysis. SPSS was used to produce frequencies, descriptive and inferential statistics which were used to derived conclusions and generalizations regarding the population. A multiple linear regression model was used to test the significance of the influence of the independent variables on the dependent variable.

3.0 Findings, Results and Discussion

3.1 Sample Characteristics

3.1.1 Gender of Respondents

The respondents were asked to indicate their gender. Figure 1 shows that majority (62%) of the respondents were male and 38% were female. The findings imply that the agricultural sector is a male dominated field.
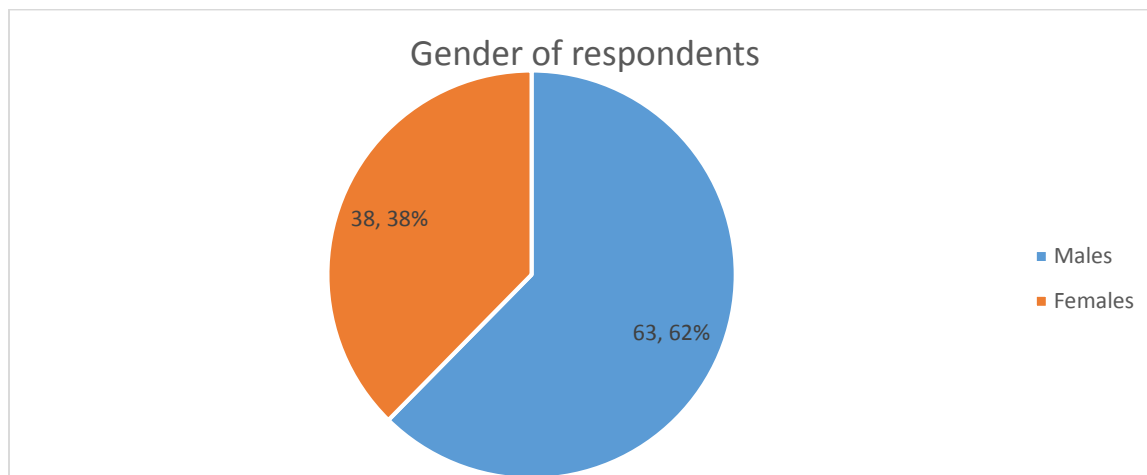

Figure 1: Gender of respondents

3.1.2 Age of the Respondents

The respondents were asked to indicate their age brackets. Results in figure 2 revealed that 1% of the respondent was between 18 and 25 years and 22% of the respondents were aged between 26 to 35 years. The findings also showed that 44% were aged between 36 to 45 years, and another 22% were between 46-55 years. The findings imply that most of the respondents were at their energetic age hence they had the energies to engage in farming as their career.
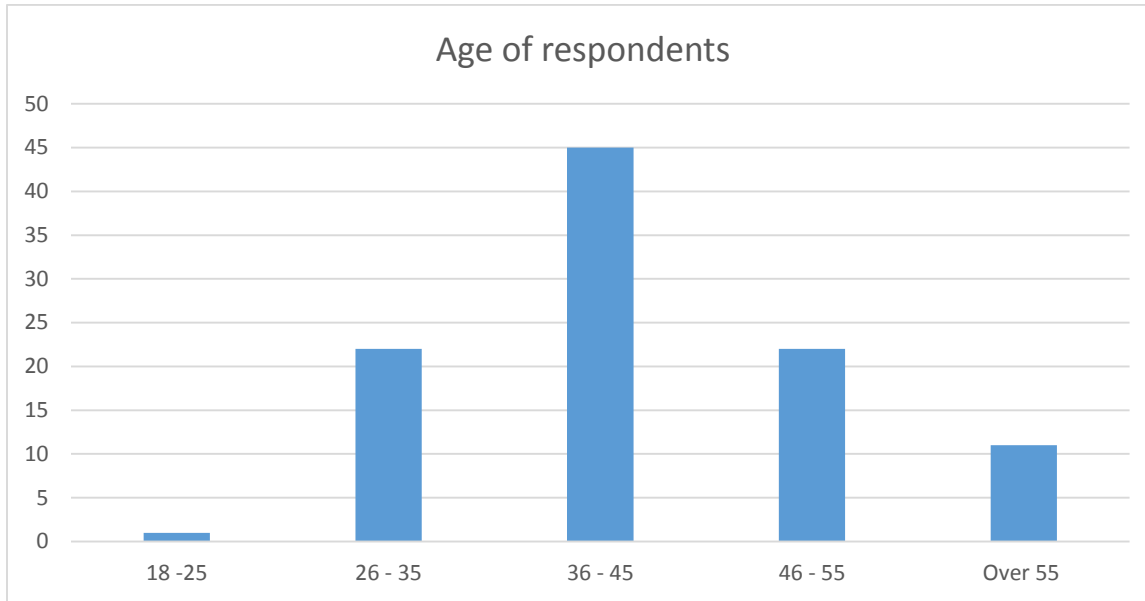
Figure 2: Age of respondents

3.1.3 Years Engaged in Farming Activities

The respondents were asked to indicate the number of years they have been engaged with farming activities. Figure 3 reveals that 46% of the respondents had been in the farming activities for a period of more than 7 years, while 25% indicated between 6 to 7 years and 25% of the respondents had been in farming for a period of between 3-5 years. The findings imply that all the respondents had been in the field for a long period hence accurate response regarding the study.
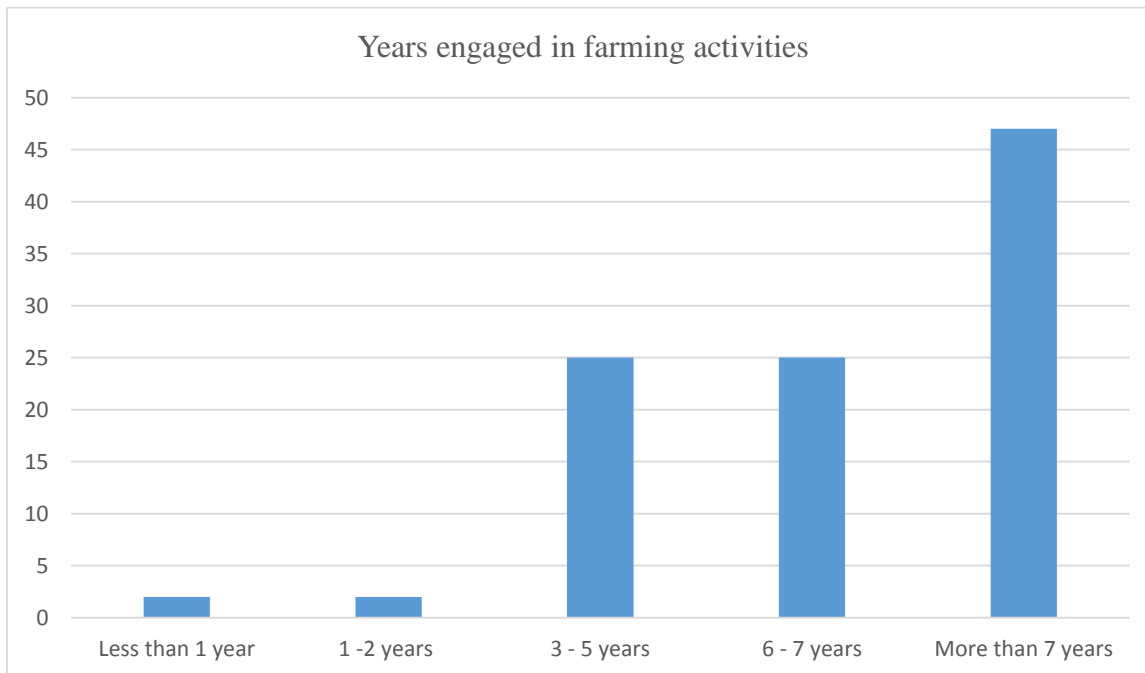
Figure 3: Years engaged in farming activities

3.2.1 Motivation of Farmers to Adopt Agroforestry Practices in Makueni County

This section analyzed the views of the farmers regarding the motivation of farmers to adopt agroforestry practices. About 77% of farmers indicated that they adopt agroforestry as a means of boundary planting or live fence. The farmers prefer trees such as *Euphorbia tirucalli, Cassia siamea, Melia volkensii, leucaena spp, Croton megalocarpus, Cupressus lusitanica, and Grevillea robusta*. The trees planted as live fence or boundary planting serve the purpose of farm boundary demarcation, soil erosion control, protection from intrusion into farms, and homes, wind breaks, fuel wood, construction poles and timber, aesthetic values etc. Another 45% of the respondent indicated that they adopt agroforestry in form of fruit orchards. The common trees of choice for these farmers are exotic fruit trees such as *Mangifera indica, Carica papaya.* Indigenous fruit trees adopted by farmers targeting fruit orchards are *Tamarindus indica, S. cuminii, Lannea stuhlmanni, Sclerocarya birrea, Adansonia digitata.* The main aim of adopting orchard trees are household nutrition and income generation. About 26% of the respondents indicated that they adopt agroforestry as a form of farm forestry, specifically woodlots. The major types of trees used as farm forest are *Melia volkensii, Eucalyptus camaldulensis, Azadirachta indica, Senna siamea,* and other acacia species. The main purposes of adopting these tree are timber, construction poles and posts, fuel wood, medicinal value, gum and resins.

About 29% of the respondent indicated that they adopt agroforestry as a form of homestead planting. The main varieties of trees adopted for this purpose are *Cassia siamea, Melia Volkensii, Melia Azedarach, Acacia spp, Balanites aegyptiaca, Mangifera indica* etc. The main purpose of planting trees at home are provision of shade, windbreak, and fruits for household nutrition. In addition, 12% of the respondents stated that they adopt agroforestry in a form of scattered trees in croplands. He preferred trees for adoption as scattered trees in cropland are *Grevillea robusta and Terminalia brownie.* The major reasons for having these trees are preventing soil erosions, providing shade to crops, animals, and herders during hot seasons. Furthermore, 7% of the respondent said that they adopt agroforestry as an alley cropping or hedgerow cropping. The main trees adopted as hedgerows are *Leucaena spp, Acacia saligna, Calliandra calothyrsus, Sesbania sesban, Passiflora edulis etc.* The goal of adopting hedgerows is either soil improvement, soil structure protection and stabilization, livestock fodder, fuel wood, or fruit. Finally, 12% of the respondents indicated that they adopt agroforestry as a form of fodder banks with major plants being *Sesbania sesban, Croton megalocarpus and Dombeya cosanii* planted in napier grass farm to provide fodder during dry seasons, and improve land productivity.

3.2.2 The Context of Agroforestry in Makueni County

This section aimed to establish the context of agroforestry in Makueni County. The study found out that agroforestry practices in the Makueni County have been practiced in the context of livelihood and resilience strategies, land degradation and loss of pasture associated with livestock husbandry with overstocking, and large scale farming with mechanization. In the context of livelihood and Resilience strategies, Makueni County is basically harsh for any meaningful rain-fed agriculture implying intensified competition for agricultural water. For efficiency, tree planting targets high value tree species such as timber and fruit trees whose products can be sold for family income generation may. The trees may not establish well under low moisture level but are watered since their establishment improves the resilience of farmers against climatic challenges.

In the context of land degradation and loss of pasture associated with livestock husbandry with overstocking, livestock offers the most promising enterprise but pasture degeneration leads to conflicts among communities and human-wildlife conflicts in areas with wildlife protection. Sustainable rangeland management approaches such as sustainable grazing management have shown potential to foster regeneration land restoration as supported by Cheche et al. (2015). Agroforestry scaling should be encompassed within sustainable rangeland management and grassroots institutional innovations for purposes of peace building and conflict reduction. In the context of large scale farming with mechanization, the land size in semi-arid areas is still very extensive and affords large scale farming such as of green gram farmers. In such farming system, agroforestry is seen to be in conflict with mechanization and thus presenting an uptake barrier. Agroforestry initiatives should target right tree species selection and proper design of tree-crop configuration to fit the context.

3.2.3 Beneficiary Participation

The third objective of the study was to determine the influence of beneficiary participation on the implementation of hunger eradication projects in Makueni County. Table 4 shows that 72.3% of the respondents agreed that the government should involve all the stakeholders in the implementation of projects, 70.3% agreed that Agricultural extension officers are key in educating farmers on how to improve their farm productivity and 42.6% agreed that they attend all seminars organized by the agricultural officers. In addition, 78.2% agreed that the government should look for ways of communication modern methods of farming using locally understood languages and 77.2% agreed that the government promotes agricultural show in the county for farmers to learn more. The mean score for the responses for this section was 3.70 which indicate that many respondents agreed that beneficiary participation was a key driver of hunger eradication project implementation.

The standard deviation on the other hand describes the distribution of the response in relation to the mean. It provides an indication of how far the individual responses to each factor vary from the mean. A standard deviation of more than 1 indicates that the responses are moderately distributed, while less than 1 indicates that there is no consensus on the responses obtained. Therefore an average standard deviation of 1.195 shows a significant variation from the mean

Table 1: Beneficiary participation

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std. Dev
The government should involve all the stakeholders in the implementation of projects	2 (2.0%)	15 (14.9%)	11 (10.9%)	34 (33.7%)	39 (38.6%)	3.92	1.129
Agricultural extension officers are key in educating farmers on how to improve their farm productivity	3 (3.0%)	18 (17.8%)	9 (8.9%)	39 (38.6%)	32 (31.7%)	3.78	1.163
I attend all seminars organized by the agricultural officers	25 (24.8%)	13 (12.9%)	20 (19.8%)	22 (21.8%)	21 (20.8%)	3.01	1.48

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The government should look for ways of communication modern methods of farming using locally understood languages	0 (0.0%)	14 (13.9%)	8 (7.9%)	43 (42.6%)	36 (35.6%)	4.00	1
The government promotes agricultural show in the county for farmers to learn more	9 (8.9%)	9 (8.9%)	5 (5.0%)	50 (49.5%)	28 (27.7%)	3.78	1.205
Average	**8 (7.7%)**	**14 (13.7%)**	**11 (10.5%)**	**37 (37.2%)**	**31 (30.9%)**	**3.70**	**1.195**

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions

Food and nutritional security is a major motivating factor for agroforestry adoption by farmers. Agroforestry contributes to food and nutritional security through 1) the direct provision of tree foods such as fruits and leafy vegetables and by supporting staple crop production; (2) by providing rich and nutritious fodder for livestock; (3) by providing energy for proper processing and cooking of food such as charcoal and firewood; and (4) by supporting various ecosystem services such as pollination that are essential for the production of some food plants. With different species of exotic and indigenous fruit and nut trees promoted under agroforestry, farmers have access to fresh fruit throughout the year which are a major source of vitamins and minerals. Example of fruits and nuts common to Kenya humid and ASALs include *Mangifera indica* (mango), *Citrus sinensis* (orange tree), *Persea americana* (avocado), *Tamarindus indica*, *Adansonia digitata* (baobab), *Syzygium cuminii,* Macadamia nuts, Cashew nuts among many other fruit and nut tree species that can grow under agroforestry. To better incorporate fruits into local food systems while addressing the challenge of seasonal availability.

In most rural households, incomes are seasonal in relation to the farming cycle, and therefore farmers are vulnerable and exposed when they wholly rely on their small farms for their livelihoods and sustenance. Agroforestry can raise the income levels of rural households by providing profitable market products or enabling the household to obtain products that they would otherwise buy. Agroforestry systems provide opportunities for participation in various enterprises like tree nurseries, timber production and sale, fruit, fodder, fuel wood sale and any other product that can be commercialized. The trees serve as a 'savings account' and 'safety-net' and in some ways act as rural insurance system for the poor smallholder farming families who are highly vulnerable and subject to unexpected expenditures. Income may also increase because of increased production in other agricultural enterprises supported by agroforestry, which enables households to sell the surplus.

4.2 Recommendations

This study recommend institutional coordination for scaling up agroforestry technologies. Though adequate institutional mechanisms to promote agroforestry exist, there is low coordination among the various actors and stakeholders that promote agroforestry in Kenya. This has seen agroforestry activities being carried in isolation by actors and institutions sometimes in the same geographical area. The findings from agroforestry research end up not benefiting the community after the project

comes to an end especially where there is inadequate involvement of community groups that may be very active at grassroots level. Also, the study recommend address of marketing constraints. Marketing agroforestry products such as timber, fruits, fodder and others are different from marketing agricultural commodities because of their diverse nature. Most often agricultural products are subject to government rules and regulations and even drastic measures to salvage farmers from unexpected low market environment that lead to losses. For instance, bail outs and/or price stabilization interventions for products usually done by the government on milk, tea, coffee, rice to name a few, which has influenced market conduct, performance and even structure. On the contrary, agroforestry products such as fruits, timber, poles and charcoal that sometimes suffer imperfect and inefficient marketing systems have attracted little or hardly government supports to say the least.

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Conflict of Interest

The authors declares no conflict of interest.

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