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The Potential of Farm-Level Forestry Enterprises by Small Scale Farmers in Selected Arid and Semi-Arid Areas (ASALs) in Kenya

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Authors' contributions

This work was carried out in collaboration between all authors. Authors COG and DOA designed the study, performed the statistical analysis. Authors COG, DOA and HJOO performed the experiment and wrote the first draft of the manuscript. Author HJOO managed the literature searches addressed subsequent reviewer comments and suggestions for improvement. All authors read and approved the final manuscript

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ABSTRACT

Aims: The objective of the study was to establish socio-economic status of selected farm forestry groups and networks currently undertaking farm forestry (FF) and the prospects of farm-level forestry enterprises in improving and sustaining the rural livelihoods in Mbeere and Tharaka, Sub-counties and Kitui County in Kenya.
Methodology: Using interviews with 466 randomly selected farmers, farm forestry groups

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(FFG) and farm forestry networks (FFN), assessment of the current farm-level FF-related assets and activities, FF enterprises [FFE], products and the constraints to adoption and sustainability of FFE by farmers was done.
Results: Majority of farmers had an average farm size between 2-20 acres headed by females who had influence on farm activities, making them important target group for FF development and sustainability. Low level of education in Tharaka and Mbeere implied that any interventional strategies involving high level of information analysis would be difficult to sell in these areas. Several viable FFE were identifiedin the study areas: tree nurseries, mango orchards, woodlot, and the main products honey, mango, seedlings, and timber and charcoal. Market value chain analysis identified disorganized market linkages, high transport cost, access to credit and low technical knowhow as the main constraints to the success of FF.
Conclusion: Future FF interventions need to incorporate local priorities to spur investments in FF for improved livelihoods and sustainable environmental conservation.

Keywords: Farm forestry enterprise; household livelihoods; forestry products; value chain analysis; small-scale farmers.

1. INTRODUCTION

In Kenya, the arid and semi-arid lands (ASALs) occupy about 467,200 square kilometers or over 80% of the country's total landmass and hosting about 10 million people [1]. They are characterized by generally hot and dry climate, with low and erratic rainfall that varies widely [2]. Due to overexploitation of these marginal lands, there is serious land and resource degradation in these areas leading to changes in the vegetation composition, structure and densities, decreasing the ability of the ecosystem to support livelihoods and economic development. ASALs have the lowest development indicators and the highest incidence of poverty with over 60% of ASAL inhabitants living below the poverty line (subsisting on US$1 per day) [1]. Livelihoods of the people in ASALs are mainly agro-based, dependent on crop and livestock production [3]. However, due to poor climatic conditions, characterized by infrequent and prolonged droughts, crop and livestock production has been very low which has aggravated poverty in these areas. These aforementioned challenges call for paradigm shift in the planning and management system in the ASALs to play a critical role in economic development by contributing to the production of the goods and services needed by expanding human populations, without destroying the land to mitigate poverty effects. Local communities in the ASALs therefore need innovative approaches and adaptive capacity to match food production to needs while maintaining ecological integrity of the ecosystem in the face of increased demands and uncertainties caused by climate change.

Forests are important for economic development, environmental services, social and cultural values and can play a vital role in improving the livelihoods and alleviating poverty in the developing world. Forest resources can directly contribute to supporting the livelihoods of approximately 90% of the world's poorest people–either in the form of subsistence, conversion of forests to agricultural uses, or income derived from a diverse range of timber products, non-timber products, or ecosystem services [4-6]. However, Kenya is among the countries with lowest forest cover of less than 6.99% of the total land area [1,7]. The forestland ownership include either public ownership or gazetted forests and forest owned by county councils who manage them in trust from the local and the privately owned forests comprising of 90% and 10% of forest cover, respectively. Currently, gazetted forests in Kenya comprise of only 1.4 million hectares about ninety percent of which are reserved for

soil, water and biodiversity conservation besides the provision of other environmental services. The remaining 125,000 hectares are managed for the provision of industrial timber, poles and wood fuel. These state forests cannot meet the demand for forestry products at the current per capita consumption [8], and are under constant threat of deforestation and degradation due to growing population. Clearing of woodlands in dry areas for agriculture and charcoal production is also a major cause of environmental degradation [7]. Furthermore, forest management in Kenya has previously emphasized utilization with little regard to sustainability.

To overcome shortcomings of the traditional centralized state-led forest management system, the Government of Kenya instituted a Kenya Forestry Master Plan 1995-2020 [9] and a new Forests Act 2005 that established Kenya Forest Service (KFS) that is mandated to come up with innovative means of forest management, including a strong emphasis on partnerships, the engagement of local communities, and promotion of private investment [1]. Community participation is achieved primarily through Community Forest Associations, and integrated management of forests is the central principle motivating the new policy [10]. The new forest policy emphasizes the development of farm forestry as a way of increasing the low forest cover, diversifying subsistence products and incomes while contributing to soil and water conservation.

Farm forestry (FF), the planting of trees along agricultural crops, has long been recognized as a feasible solution to more sustainable land use and forest conservation in the developing countries [6,7,11]. A study by Kabubo - Mariara [12] found that in Kenya, forests play an important role as an economic 'safety net' that can cushion rural households during periods of economic hardship and can provide opportunities for rural poor to harness the various forest resources and as a means of livelihood diversification particularly those communities living in more vulnerable marginal ASALs. The cultivated ASALs are sometimes referred to as tension zone because conflicts are occasioned by expansion of farming activities and use for dry season farming [1]. Kenya Forest Services (KFS) is currently employing the Farm Forestry Field School (FFFS) methodology as one of the ways of increasing Kenya's forest cover to the prerequisite 10%. For example, the Intensified Social Forestry Project (ISFP) and Support to Community Based Farm Forestry Enterprises (SCBFFE) project in ASALs of Kenya are community-based dry land farm forestry development partnership arrangement. The focus of the project is on improving the livelihood security of households using the farm forestry enterprises in the arid and semi-arid areas (ASALs) of Tharaka, Mbeere and Kitui forest zones.

Studies have shown that many factors influence smallholder farmers `decisions to participate in FFE. These specific socio-economic and institutional variables affecting the decisions differ across countries, regions, villages, and farms [7,13-15]. Farm forestry improvement measures on biological (e.g. succession, biodiversity and traditional industrial timber production) and technical concerns (e.g. material input delivery such as providing free tree seedlings for field planting), coupled with household-specific, plot-specific and institutional factors, local values and interests, and the constraints facing farmers are important influences [16-21]. However, the direction of influence of a given variable is not often consistent across studies.

The objective of the study was to identify socio-economic background and the prospects of farm-level forestry enterprises in improving and sustaining the household's livelihood rural communities in the arid and semi-arid areas (ASALs) of Tharaka and Mbeere Sub-counties and Kitui County. The study also involved determination and assessment of the potential market of the FFE products, opportunities for the establishment and/or deepening of business linkages between the private sector and the FFGs engaged in production of FF products; and challenges and opportunities that exist in the identified farm forestry enterprises to unlock the business linkages potential in FF value chain.

2. MATERIALS AND METHODS

2.1 Study Area

2.1.1 Tharaka

Tharaka Sub-county falls in the Eastern part of Kenya located between latitude 0º18′S 38º0′ E and longitude 0.30º S 38.000ºE. It covers an area of 1569.5km^2 with 365,330people and 88,803 households as per the 2009 population census of Kenya [1]. The Population density is 138 people per km^2 and 65% of the population live below the poverty line. The district has semi-arid climate conditions with lower midland 4 (LM 4), lower midland 5 (LM5), intermediate lowland zone 5 (IL5), intermediate lowland zone 6 (IL6) as the main agro-ecological zones (AEZ). The district is sub-divided into three broad livelihood zones; agro-pastoral, mixed farming and rain-fed cropping. The AEZ IL5 and IL6 cover the north-eastern and southern tip of the district and are the driest agro-ecological zones with agro-pastoralism as the main livelihood. LM4 covers the western part of the district and is characterized by mixed farming and rain-fed cropping in the north-west. The dominant annual crops are finger millet (*Eleusine coracana*), sorghum (*Sorghum bicolor*), green grams (*Phaseolus aureus*) and maize (*Zea mays*), while perennial crops are banana (*Musa* sp.) and fruit trees.

2.1.2 Kitui

Kitui County is located in the central south of Kenya, between latitude 0º 3.7' and 3º0' south and longitude 37º45' and 39º0' east. The total surface area is 30,124 km^2, of which more than 20% is part of the largely uninhabited Tsavo National Park. The county has approximately 1,012,709 inhabitants and 205,491 households according to the 2009 population consensus with 63% of population living below poverty line[1]. The average population density is 18.3 persons/km^2, ranging from 6 persons/km^2 in the division including the Tsavo National Park, to 153 persons/km^2 in the Central Division (including Kitui Town and the research area. Climate of the county include temperatures range between 14-34ºC and rainfall ranges from 500-1050mm per annum in different parts of the county [2]. The county has four agro-ecological zones: semi-arid farming zone with good potential for agricultural development is currently either cultivated or under woodlands; semi-arid ranching areas; arid-agro-pastoral area and arid-pastoral zone. The semi-arid ranching areas are less fertile and are currently used for drought resistance crops and livestock keeping while the arid-agro-pastoral and arid-pastoral zones used for livestock production.

2.1.3 Mbeere

Mbeere Sub-county is one of the 12 districts constituting Eastern Province of Kenya and lies between latitudes 0º20' and 0º50' south and longitude 37º16' and 37º56' east. The district

has a total area of about 2,093 km^2 and is sparsely populated with a population density of 82 persons per km^2 [1]. The altitude ranges from around 500m above sea level on the Tana River basin to 1,200m above sea level. Mbeere can be divided into two general agro-ecological zones, where mixed farming is marginal and where mixed farming (livestock and crops) is possible. The bulk of Mbeere district consists of AEZ LM5 (Lower Midland, Semi-arid). The main crops are millet (*Pennisetum glaucum*), beans (*Phaseolus vulgaris*), sunflower (*Helianthus annuus*) and maize (*Zea mays*). Crop yields are low (3 bags/acre [680kg/ha] for maize) and inputs are correspondingly low. Some local farmers also grow tobacco (*Nicotiana tabacum*), pawpaw (*Asimina triloba*) and miraa/Khat (*Catha edulis*), the latter being illegal but highly profitable. There is a commercial mango (*Mangifera olifera*) plantation at the lower end of Kiang'ombe hill with several improved grafted varieties but under poor management and widespread insect damage.

2.2 Data Collection and Analysis

In the three study areas, pertinent data and information was collected through focused group discussions (FGDs) with FFGs and FFNs. Face to face interviews with individual FF farmers, input suppliers, product traders, product transporters and consumers as well as processors. FGDs with sampled FFGs was done to understand views of the larger community living within the project area and authenticate the data from the sampled individual farmers from FFGs.

Interviews were conducted among farmers, farm forestry groups, farm forestry networks, input suppliers, traders, transporters and consumers in the predetermined forest zones of Kitui, Tharaka and Mbeere. In each of the three zones the population was stratified according to the category of people participating in Farm forestry and agro forestry activities.

In this study purposeful sampling was used where a sub-sets of study individuals who have the information were sought for further investigation. A mixed purposeful sampling [22] involving the following was used:

I. Stratified purposive sampling was initially used to group major study areas (Forest zones) into smaller units i.e. Administrative divisions and locations. This would later enable comparisons between zones.
II. Criterion sampling was then used where only groups that had graduated in FFS were favored for interviewing to ensure quality as all groups considered had graduated from FFS and were thus assumed to be actively involved in farm forestry activities. In addition, other individuals and persons involved in farm forestry activities were included e.g. service providers, traders, transporters and input suppliers.
III. Random purposive sampling was finally used so as to choose a small sample from the large number of qualifiers (all the FFS graduated groups in a zone or Division). The number of respondents who were later interviewed was therefore determined using this method to avoid obvious bias in choosing groups to interview.

The sampling frame consisted of the units of all the farmers, enterprise operators and other practitioners scattered all over the project areas that are involved in the activities of the Support to Community Based Farm Forestry Enterprises (SCBFFE) project. These included a pool of: individual forestry farmers, forestry farmer groups (FFGs), farm forestry networks (FFNs), project implementing staff, key informants (village leaders and community owner resource persons). Chiefs, Village elders and other service providers like collaborating Faith

Based Organizations (FBOs) and Community Based Organization (CBOs) participating in forestry service delivery constituted a frame list from where respondents were drawn.

From the sample frame, the total number of respondents interviewed that represented approximately 1% of the different FFE operators in the study areas is illustrated in the Table 1.

Table 1. Total number of respondents interviewed

Respondent interviewed	Zones			Total
	Tharaka	Mbeere	Kitui	
Individual farmers	52	80	155	287
FFG	4	4	10	18
FFN	3	4	5	12
FF input suppliers	5	7	27	39
FF product trader	20	20	43	83
Private companies	3	4	5	12
Key informants	3	3	3	9
Collaborating institution	2	2	2	6
Total	92	124	280	466

Descriptive statistics (frequencies, percentages, mean, ranks) generated through the IBM SPSS Statistics 21 (IBM Corporation, New York, USA).

3. RESULTS AND DISCUSSION

3.1 Socio Economic Characteristics of the Respondents

3.1.1 Age distribution

As a social variable, age of farmer influences farmer's maturity and decision-making ability as regards to receiving and processing information related to adoption of new technologies [23]. It is believed that with age, farmers accumulate more personal capital and, thus, show a greater likelihood of investing in innovations.

The results (Table 2) show that over 90% of the populations surveyed were 31 years of age and above. Large proportion of population was over 51 years in Kitui and Mbeere as well as between 31-50 years of age in Tharaka forest zones. This finding is similar to that of Appiah et al. [11] and Ogada [24] who observed the widespread of adoption of farm forestry among several age groups in Kenya. The adoption of FFE by all the age groups in these areas may offer an advantage for increased investment and improved technology utilization and hence, innovativeness and sustainability. However, the large proportion of population above 51 years of age indicates that majority of the respondents in the three forest zones may be less likely responsive towards new technology. It is advisable younger people participation in farm forestry farming initiative be encouraged, as younger household are more flexible and hence likely to adopt new technologies.

3.1.2 Education level of farmers

The literacy level in the study areas was relatively fair, with 12.9% admitting to have no formal education (Table 2). Majority of the farmers (51.3%) had formal education up to

primary school level indicating that they are literate but cannot necessarily process very complex issues. Therefore, interventions involving high level of information analysis would be difficult to sell in all forest zones. About 24.2% and 11.6% of the household heads had education up to secondary school and post-secondary level, respectively; they are literate and can handle more complex issues. These results are consistent with those reported by Appiah et al [11] and Ogada [24] in Western Kenya. In Central Kenya, study by Oeba et al. [25] reported a significant correlation between knowledge in agro forestry and level of education. In this study, college graduates tended to be more interested in agro forestry than their counterparts with less academic qualifications. This implies that education plays a significant role in understanding the need to conserve the environment through various practices and hence engagement in FFE activities. There exists a positive correlation of between farmers` level of education on income level, as farmers who are better educated adopts new farm forestry technologies making higher cash income from their livelihoods [11].

Table 2. Socio-economic characteristics of farmers in from Kitui, Tharaka and Mbeere forest zones

Characteristic	Kitui		Mbeere		Tharaka		Total	
	N	%	N	%	N	%	N	%
Age (years)								
20 – 30	10	5.3	2	5.7	6	8.7	18	5.7
31 – 50	85	45.2	33	54.1	24	34.8	142	44.7
Over 51	93	49.5	26	42.6	39	56.5	158	49.7
Educational level								
No formal education	23	12.2	13	18.8	5	8.2	41	12.9
Primary education	93	49.5	27	39.1	43	70.5	163	51.3
Secondary education	45	23.9	24	34.8	8	13.1	77	24.2
Tertiary education	27	14.4	5	7.2	5	8.2	37	11.6
Gender								
Male	82	52.9	34	42.5	22	42.3	138	48.1
Female	73	47.1	46	57.5	30	57.7	149	51.9
Marital status								
Married	172	91.5	59	85.5	54	88.5	285	89.6
Single	9	4.8	3	4.3	4	6.6	16	5.0
Widow	5	2.7	7	10.1	1	1.6	13	4.1
Divorced	2	1.1	0	0	2	3.3	4	1.3
Household size								
1 – 5	83	44.4	97	51.9	7	3.7	163	51.9
6 – 10	41	71	18	26.1	2	2.9	138	43.9
More than 10	7	53.4	23	39.7	4	6.9	13	4.1
Average farm size								
Less than 1 Acre	53	29.1	14	23	10	17.5	77	27.5
2-20 Acres	45	69.8	45	73.8	45	78.9	219	72.3
More than 20 Acres	2	1.1	2	3.3	2	3.5	6	2.0

3.1.3 Family size

The mean family size among the households surveyed was less than 6 persons per household for Tharaka and Mbeere and between 6 to 10 persons per household for Kitui. The large family size in Kitui is highly indicative of the extended family system in the study area where parents and other relations dwell together as a household. According to Ogada

[24], large family sizes are associated with higher demand for forests products due to high consumption and can act as an incentive to participate in FF enterprises. More family labour would also be readily available since relatively large household size is an obvious advantage in terms of labour supply [11,25]. However, it is often postulated that the larger the family size, the less likely the person would spend on modern farm inputs. Therefore, households with relatively smaller number of members are more likely to spend and therefore adopt modern farm inputs. The other two zones are characterized by smaller family size indicating a likelihood of higher adoption rate of new technologies in the two zones.

In Kitui County, it was established that approximately 51% of the population was not economically active leading to higher dependency syndrome in the area. This could be considered as the social factor festering the prevalence of poverty at large in the Kitui sub-zone [1]. These results show that interventions requiring relatively huge resource mobilization from individual households would not be viable in the Kitui zone.

3.1.4 Gender differentiation and marital status

Gender differentiation is often associated with division of labour, decision-making, resource management and socio-economic roles played in livelihood acquisition [26]. With exception Kitui, women headed many of the household in both Mbeere (57.5%) and Tharaka (57.7%) forest zone (Table 2). Field observations also showed that membership in most farm forestry groups were predominantly female. This is in contrast to earlier studies on household characteristics in Western Kenya [26] and elsewhere [14,15,27] where males are head and make decisions concerning productive and cash related activities. It is presumed that male-headed households may be better resourced and informed to participate in farm forestry. However, similar to results of this study, Appiah et al. [11] also reported higher number of female-headed households in Rachuonyo District in Western Kenya. Any interventions targeting farm forestry groups should be geared towards participation of women farmers in the study areas, as women are twice as likely as men to be involved in agricultural innovative activities [28].

In situations where couples work together, better social and financial capital would be achieved. Therefore civil status is an important determinant of resource mobilization and enterprise viability. The analysis of the marital status of the surveyed population showed that 89.6% and 10.4% of the households were married and single headed, respectively. These results indicate that the majority of households were married and may have a better social and financial capital and may likely be efficient in resource mobilization. However, single headed households may have comparative advantage in adoption decision making over married couples.

3.1.5 Average farm size

Economic perspectives have shown that farm or enterprise operational size is often an important consideration for purposes of business break-even and profit maximization. This is explained by the concept of economies of scale such that as the size of operation increases so does the profit margin but up to a point beyond which diseconomies of scale set in. On farm characteristics, majority of farm forestry farmers owned an average farm size of between 2 and 20 acres households in the three forest zones. This implies that the study areas comprises of small-scale farmers. This finding agrees with [1] that Kenyan farmers are small-scale farmers that cultivate small area of land. Similarly, [27,24,11] in their studies found the average farm size of their respondents to be 0.4-4.8 hectares, respectively. This

relatively small farm size will inevitably lead to subsistence farming which do not encourage commercial farming. Trees within the smallholder farming systems have been reported to play critical livelihood role in many households such as income, shade, fuel, medicine and ecological benefits [11]. These results therefore indicate that farm forestry enterprises in the area of study are viable particularly in relation to operational sizes, upon profit maximization.

3.2 Farm Forestry Enterprises, Products and their Market Value Chain Analysis

3.2.1 Farm forestry enterprises and products

Farm forestry has proved to be an important enterprise for small- and large-scale farmers worldwide [4-6]. Farmers can make income or save money by growing trees through on-farm use and sale tree products such as timber, fuel wood, seed, flowers or oils for sale or on-farm use or lease land to grow trees or enter into a joint FFE venture where the costs and returns are shared. They can also explore opportunities for growing trees for environmental values such as carbon sequestration, climate change resilience, shelter, erosion control, watershed and biodiversity protection [4]. Tree farming can be practiced as woodlots, alley farming, home gardens, boundary planting, wide space planting of trees in croplands, and in pastureland.

In this study, the major viable farm forestry enterprises in the three forest zones were tree nurseries, wood lot (timber, fuel and charcoal) and mangoes/fruit orchard, bee-keeping, and charcoal production (Fig. 1). This data concurs with various studies in Kenya where home gardens, woodlots, boundary planting, trees in pasturelands, trees in croplands, multipurpose tree gardens and perennial-crop combinations are the most adopted agro-forestry practices [11,24,25,29]. The main product in the beekeeping enterprise in three zones was honey (100%).

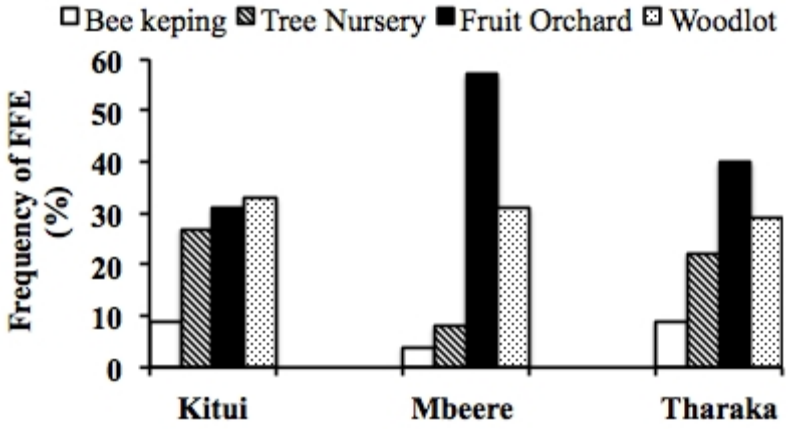

Fig. 1. Major viable farm forestry enterprises in the three forest zones

In the fruit orchard enterprise, the major product was mango (95%). Other products observed within the same enterprise though not substantial included: pawpaw (2%) avocado (1%), oranges (1%) and tamarind (1%) (Table 3). The study also reported a large proportion FFE in Tharaka and Kitui having wild fruits such as tamarind (*Tamarindus indica*), baobab

(*Adansonia digitata*), and indigenous *Vitex* species, which may be important for juice, jam production and sisal particularly in Kitui. The enterprise on wild fruits deserves special mention because these fruits are diverse and widely distributed in most ASALs of Kenya. They provide not only food for humans and their livestock but are a very good source of essential nutrients. Emphasis on the development of this enterprise will result in spill-over benefits as communities will conserve these tree species and hence the indigenous vegetation associated with these species, and which is under threat from charcoaling and farming activities.

In woodlot enterprise, farmers were mainly growing trees for timber and charcoal (Table 3). Majority of farmers preferred exotic tree species such as *Grevillea robusta*, *Calliandra* spp, *Jacaranda* spp and *Moringa* spp. due to their high commercial value as poles, fuelwood, timber and medicine [11,27,29]. However, indigenous tree species such as *Erythrina tomentosa*, *Croton* spp, *Prunus africana*, *Olea africana*, *Cordia abbysinica* and *Sesbania sesban* were also common. The tree nursery enterprise involved the sale of tree seedling of mainly the exotic tree species in addition to passion fruits, avocado, pawpaw and mangos as the most common fruit seedlings in the private nurseries.

Table 3. Major viable farm forestry enterprise products in the three forests zones

FF enterprise	Products	Frequency (%)
Bee keeping	Honey	100
Fruit orchards	Avocado	1
	Mangoes	95
	Oranges	1
	Paw paws	2
	Tamarind - *Tamarindus indica*	1
Tree nursery	Tree seedling - *Cupressus lusitanica, Eucalyptus saligna, Grevillea robusta*, *Aberia caffra*, *Eucalyptus* spp, *Jacaranda mimosifolia,* passion fruits, avocado, pawpaw mangoes	100
Woodlots	Charcoal - *Grevillea robusta*, *Calliandra* ssp)	14
	Firewood - *Grevillea robusta*, *Calliandra* spp)	3
	Medicine - *Moringa* spp.)	1
	Poles - *Grevillea robusta, Eucalyptus* spp, *Jacaranda mimosifolia*)	8
	Timber - *Grevillea robusta*, *Eucalyptus* spp)	74

3.2.2 Value chain analysis and constraints to farm forestry enterprises

Value chain can be defined as the full range of activities required bringing a product to final consumers passing through the different phases of production, processing and delivery [30,31]. The farm forestry value chain can therefore be defined as a market-focused collaboration among different stakeholders who produce and market value-added products related forest resources. Value chain analysis (VCA) is essential to an understanding of markets, their relationships, the participation of different actors, and the critical constraints that limit the growth of enterprises and consequently the competitiveness of producer [30]. In value chains, goods and products flow up the value chain and money flows down the chain where each of the direct actors performs one or more specific functions, thereby incurring some expenses and gaining some income, and thus “adding value” to the product. The

research finding in this study that may have implications of promoting and improving the farm forestry enterprises in the study areas is summarized in Table 4.

Although the value chain of different FFE were product specific, there were common actors and constraints identified by various respondents. For example, in the tree nursery enterprises value chain, the core processes includes: input supply, seed bed preparation, sowing, potting and pricking out, management, transportation, marketing and consumption (Fig. 2). The main actors in the value chain in three study areas were input suppliers (KFS, agro vets, Kenya Forestry Research Institute - KEFRI, individual farmers), producers (family members, casual laborers, individual farm forestry farmers, farm forestry groups and non-farm forestry groups who engage in production of seedlings) transporters (motor cycle, pickup, wheel-barrows bicycle, donkeys, donkey and ox carts and in some cases back loads), traders and consumers (farmers, private and public schools, universities, institutions such as hospitals, non-governmental organizations). In terms of volume of movement in the value chain, 46.13% of the seedling was sold at the farm gate, 20.5% used by the members of the FFG, 20.9% was sold to the market directly and 18.4% was wasted.

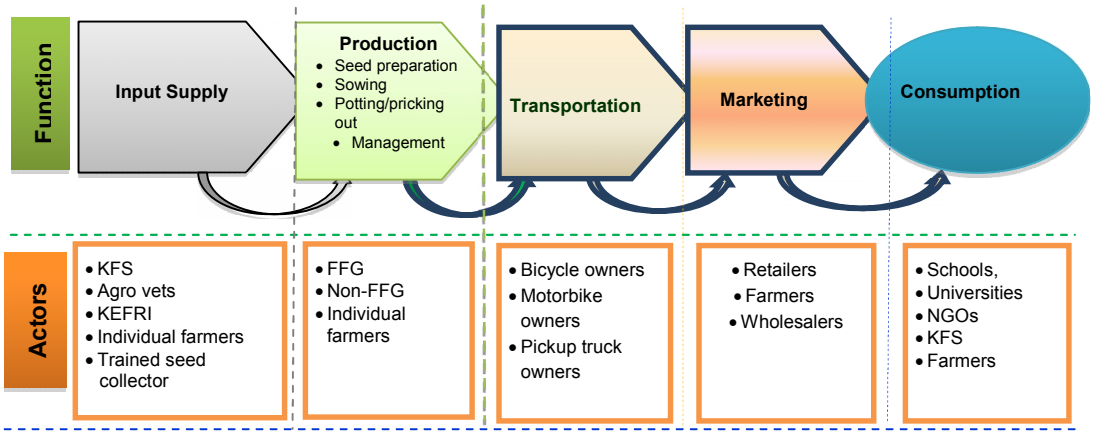

Fig. 2. Tree nursery seedling market value chain

In the fruit orchard enterprise, mango (*Mangifera indica*) production the main activity by respondents. Other fruits crop such as oranges, pawpaw, passions, avocado and tamarind were also grown, though not substantially. The arid to semi-arid climate characterized by annual rainfall of 300-800mm and annual temperature range between is 17-27ºC of the study areas favours mango production. The average acreage under mango production varies from 0.82 to 1.21 acre per household with regional disparities in the forest zones with an average yield between 14.77 - 24.8 tonnes per acre. The major channels in the mango value chain in the forest zones included fresh sale of mango at the farm gate, direct home consumption, sales to middlemen who in turn sell the produce in the market.

Field investigations and discussions with traders and producers identified the following production and marketing constraints that retard farm forestry subsector in the three forest zones: pest and diseases; lack of appropriate technology and knowledge; lack of credit facilities; lack of market information; high input cost; lack of clean planting material; prevalence of middlemen/ brokers, high cost of transport, lack of market and high taxation at the market (Table 4). The cost of inputs is a key determinant to the profit margins earned by FFE operators there by influencing their participation in farm forestry [24]. In addition,

commercialization of mango sub-sector is hinged on demand driven production that requires efficient markets for the produce. Market research and information dissemination is also essential for the market price determination. Promotion of FF activities to support the availability of effective market information networks through either FFN-based market research or development of linkages between farm forestry groups and processors in value chain map should be encouraged. This will ensure better prices for forest products and attractiveness of FFE thereby enhancing the further adoption of improved farm forestry practices.

Table 4. Constraints facing farm forestry and opportunities for FFE in the study areas

Constraint/Challenge	Opportunities
1. Lack of credit/credit delinquency	• Microfinance facilitation • Training and capacity building on credit servicing
2. Neglecting of farm forestry enterprises in favour of other competitive enterprises	• Sensitization of the farmers on the importance of farm forestry farming
3. Inadequate knowledge and skills on agrochemical application	• Investment in training and capacity building for the targeted groups (extension services
4. High cost of inputs	• Farm forestry networks to be empowered to set up agro vets for supply of inputs to farmers at affordable prices • Lobby the government to lower taxes on farm inputs
5. High cost of transport	• Investment in construction and rehabilitation of rural access roads
6. Lack of organized market	• Effective market information dissemination • Strengthen farm forestry network to carry market research

Respondents also identified that lack of access to credit as a major obstacle to participation to farm forestry adoption. Lack of access to credit has been reported to be a major constraint to farm forestry development in Kenya and elsewhere [11,24,28,29]. Access to credit is critical for business expansion and growth and has been recognized as important source of capital for sustainable commercial farm forestry enterprise [12]. It is also considered as an asset to individual farmers, FFN, FFG or any FFE operator and becomes crucial in facilitating business asset acquisition and market margins expansion of the FFE sub-sector agribusiness activities. In the study areas, farmers, particularly women had limited or no access to credit due to conditions put in place by commercial banks, lack of collateral, lack of awareness of other credit sources and high interest rates charged by micro finance institutions which concurs with other studies [28]. To improve the farm forestry enterprises uptake in these areas, the introduction of microfinance schemes to create access to grants and loans for farmers, particularly women, by government and development agencies is therefore critical with eventual outcome of improving the quality of life for rural households.

4. CONCLUSION

In Kenya, farm forestry has a strong potential in addressing problems of food insecurity and achieving the country's target forest cover (10%) by next decade through ensuring best use of the land, boosting field crop yields, income diversification and increasing resilience to climate change. We show that household, tree management and marketability characteristics influences farmers' participation decision in farm forestry. This implies that current and planned farm forestry initiatives and policies should be geared towards evaluation of local farm forestry operators needs taking into consideration the role played by gender, age and level of education. The policy directives involving institutional support through incentives such as economic incentives, technical assistance and creation of strong market opportunities will be key in formulating realistic objectives and targets to boost private investment in farm forestry enterprises for improved forest cover in Kenya. These initiatives should also aim at improving both formal and informal farm forestry education among rural communities, involving women and youth. This will ensure adequate information to keep farmers and FFE operators abreast with current trends and developments in agroforestry practices is available for improved livelihood of rural poor and sustainable environmental conservation.

CONSENT

Before any interview, respondent's consent was sought.

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COMPETING INTERESTS

Authors have declared that no competing interests exist

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