An assessment of the socio-economic importance of *Melia volkensii* Based Enterprises in Kenya




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KEFRI/JICA PROJECT

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Cover photograph
Main Melia volkensii enterprises

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ABSTRACT

This Melia market study as part of Extension is one of the four components of the Project on the Development of Drought Tolerant Trees species for the Drylands of Kenya, which is implemented by the Kenya Forestry Research Institute (KEFRI) and Japan International Cooperation Agency (JICA). This study targeting the Melia based enterprises in Kenya was carried out in Taita Taveta, Makueni, Kitui and Embu counties using a set of semi-structured questionnaires. A total of 424 respondents were sequentially sampled for the survey in the four counties with 213 respondents for round-wood/Melia timber enterprises and 211 respondents for Melia seeds/seedlings enterprises. The objectives of the study were to review, analyze and document the current status of production and distribution of quality seeds, seedlings and timber; map the M. volkensii seeds, seedlings and timber market chain and players; assess the social and economic characteristics of Melia wood producers and seed collectors; and make recommendations on how to enhance the contribution of Melia enterprises to livelihood diversification in the dry lands of Kenya. The study revealed that M. volkensii was a very important drylands species for both domestic and income generation purposes. A cost benefit analysis showed that the seed, seedlings, round wood and timber enterprises were economically viable at 10%, 15% and 20% discount rates. It was, thus recommended that stakeholders' awareness creation and training be undertaken to enhance the rate of adoption and adaption of this tree species at the farm level in the dry lands.

ACRONYMS AND ABBREVIATIONS

ACIAR	Australia Centre for International Agricultural Research
ASK	Agricultural Shows of Kenya
BTC	Belgium Technical Cooperation
FAO	Food and Agriculture Organization
FFS	Farmers Field Schools
ICRAF	International Centre for Research in Agro-Forestry
INRMU	Integrated Natural Resource Management in Ukambani
JICA	Japan International Cooperation Agency
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
KU	Kenyatta University
MEWNR	Ministry of Environment, Water and Natural Resources
MOA	Ministry of Agriculture
NGO	Non-Governmental Organizations
SOFEM	Social Forestry Extension Model Project
SPSS	Statistical Program for Social Sciences
TARDA	Tana Athi River Development Authority

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1.0 INTRODUCTION

1.1 Background

Inhabitants of the arid and semi-arid lands (ASALs) depend heavily on woodland resources for their livelihood needs. The available woodland resources cannot sustainably meet increasing demand caused by increase in the population as well as migration of farmers from high rainfall/potential areas to the ASALs hence accelerating degradation of natural resources and affecting living standards of local people. Tree planting offers a solution to curb degradation as well as assisting in diversifying income sources for the ASAL population.

Tree planting has the potential to mitigate climate change effects. Kenya's national development program, Vision 2030, recognizes climate change as an important challenge and proposes formulation of programs to address it. In this respect, the Vision recommends tree planting to mitigate effects of climate change. However, in development of tree planting programs for ASALs, selection of commercial tree species would provide alternative income generating options for the inhabitants. *Melia volkensii* (Gurke) has been recognized as an important tree species because of its adaptation to dry land conditions, fast-growth and production of high quality timber.

1.2 Characteristics and ecological requirements of Melia volkensii

Melia volkensii (Melia) belongs to the family Meliaceae. The species is endemic to the ASALs of eastern Africa extending from southern Somalia to northern Tanzania (Broadhead *et al.*, 2003; Milimo, 1986; Milimo 1989; Tedd, 1997). The species grows naturally across the drylands of eastern, northern and coastal areas of Kenya (Milimo, 1989; Mulatya, 2000) (Figure 1). Its natural distribution range lies between 400 and 1600 meters above sea level. Melia grows in well-drained sandy clay and stony soils; although it is also found on sites classified as imperfectly drained soils (Muok, *et al.*, 2001).

Its natural range is characterized by dry bush land and wooded grassland. *Melia volkensii* is fast growing, tolerant to dry conditions and is compatible with most crops, though its management through root and crown pruning are recommended to minimize competition (Mulatya *et al.*, 2002; Stewart and Blomley, 1994). In Kenya, the species is found in several counties including; Kitui, Makueni, Tharaka Nithi (Tharaka), Embu (Mbeere), and Taita-Taveta (Dale and Greenway, 1961). It is known by different local names such as; Mukau (Kamba, Mbeere and Tharaka), Kirumbutu (Taita) and Mpenda bure (Swahili) (Mwamburi *et al*, 2004).

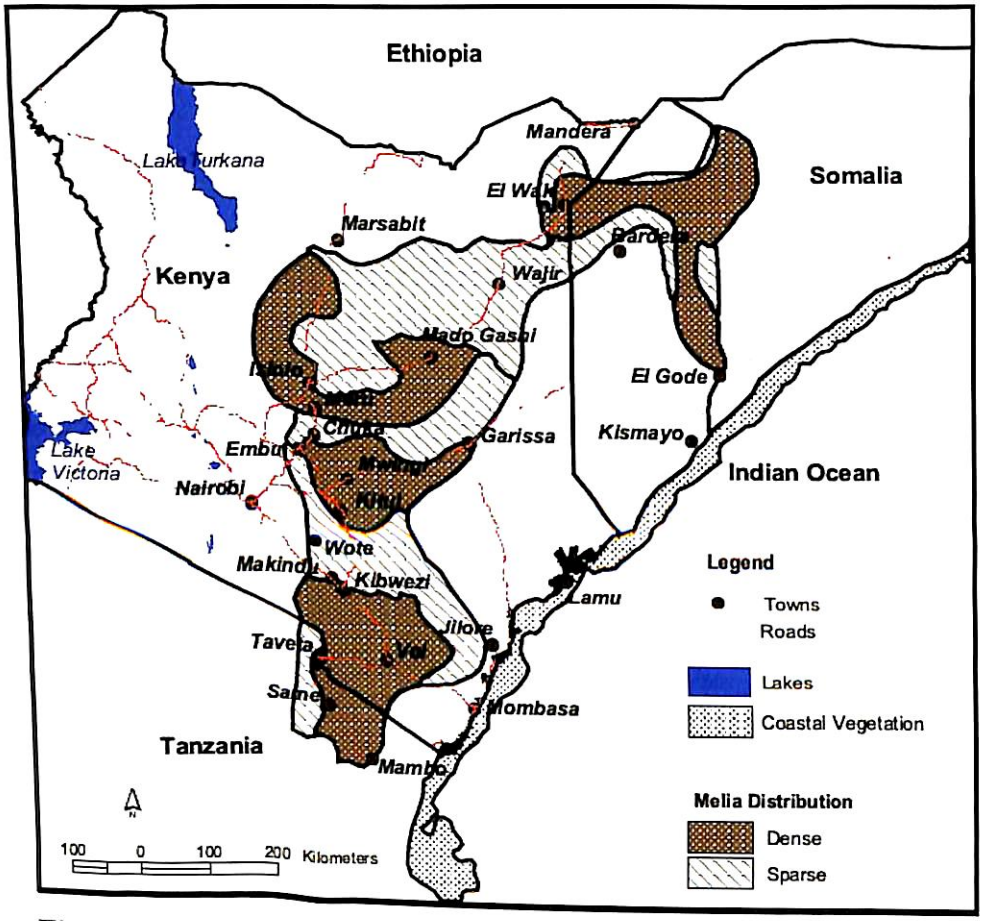

Figure 1: Distribution of Melia volkensii in drylands of Kenya

(Source: Kamondo *et al.*, 2006)

Melia produces high quality which is termite resistant and durable timber within a period of 10 years (Mulatya, 2000). The rotation age is relatively shorter than for most common indigenous timber tree species. Its timber characteristics compare favorably with that of *Ocotea usambarensis* and *Vitex keniensis (*Kidundo, 1997; Blomley, 1994; Mulatya and Misenya, 2004). Melia wood is suitable for making assorted furniture, acoustic drums, containers, mortars, door and window frames and door shutter rafters. The tree also produces poles, beehives, medicine, mulch, green leaf manure and fodder, can be used wood carving and bee forage and provides environmental services (Rajab and Bentley, 1988; Sharook *et al.*, 1991; Kidundo, 1997; Mulatya and Misenya, 2004; Wekesa *et al.*, 2012). Leaf extracts have been traditionally used as insecticide for control of ticks and fleas.

1.3 Research and development activities on Melia volkensii

The Kenya Forestry Research Institute's (KEFRI) research agenda in the drylands mainly focused on identification and screening of both indigenous and exotic tree

and shrub species suitable for dryland conditions and local uses. Results of these research activities identified *M. volkensii* as performing better than most of the other dryland species (KEFRI, 2011; Kidundo, 1997). Research on Melia has focused on; improvement of germination, promotion of the species on-farm, spacing and other silvicultural aspects, and selection of superior trees for breeding fast growing and drought tolerant lines. Research and development in Melia is carried out in collaboration with partners particularly; Kenya Forest Service (KFS), Japan International Cooperation Agency (JICA), Belgium Technical Cooperation (BTC), ACIAR, ICRAF, and farmers. Main milestones achieved by KEFRI and its partners on *M. volkensii* research and development include the following:

Identification of Melia as a fast growing tree species producing quality timber in 10 to 15 years and recommended it for plantation establishment (Kidundo, 1997; Kimondo 2002, Tedd, 1997, Muturi *et al* 2003, Mulatya 2000).

- Identification of potential of *M. volkensii* for domestication due to its faster growth on farm than in the wild. The growth potential depends on amount of rainfall and site characteristics.
- Development of the Melia nut cracker (Lugadiru, 2004): As the seed is enclosed in a hard nut, the need for a simple nut cracker was conceptualized in the 1990s to enable fast extraction of seeds to support an expanded tree-planting program under KEFRI/JICA social forestry training project.
- Identification of optimal spacing: Pilot plantation trials at Tiva have shown that optimal growth rate for dry land tree species occurs at square spacing of 4.0 m to allow mechanized weeding and over time has been adopted as a practice for establishment of Melia. However KEFRI's experience has shown that a well managed 1 ha Melia plantation at a spacing of 4.5m x 4.5 m can produce a wood volume of 40-60 m^3 at age of 12 years with diameter at breast height ranging from 30-45 cm.
- Promotion of planting of *M. volkensii* on the farms and public land: Since the year 2000, KEFRI's Kitui Centre has provided leadership in the promotion of planting of *M. volkensii* on the farms and public land in Kitui County. In addition, the Forest Department (currently KFS) in collaboration with Integrated Natural Resource Management in Ukambani (INRMU) project undertook planting of Melia on the farm lands and public forestland.
- Establishment of *M. volkensii* model farms: So far hundreds of *M. volkensii* model farms have been established in eastern Kenya and recipient farmers trained on best practices. In 2010, one of the *M. volkensii* model farmers was honored with a presidential award for exemplary work on commercialization of *M. volkensii* and championing environmental conservation.
- Identification and geo-referencing 100 superior trees from the existing populations both wild and on farm for seed orchard establishment and breeding for drought tolerance and climate change mitigation by KEFRI / JICA.
- Tree breeding system; DNA analysis; Establishment of Progeny test sites and Extension (ongoing): These components are currently being implemented

under the framework of the project on Development of Drought Tolerant Trees Species for the Drylands of Kenya. The project is jointly implemented by the governments of Japan and Kenya since July 2012 for a period of 5 years.

1.4 Institutional support

KEFRI and KFS were the main organizations that supported the development and promotion of Melia enterprise. Other participating government organizations included: departments of Agriculture and Livestock production in the Ministry of Agriculture, Livestock and Fisheries; University of Nairobi and Kenyatta University. There is an emerging interest from Non-Governmental Organizations (NGOs) such as ICRAF, World Vision, Nyumbani village, Wildlife Works, and the private sector in the development of *M. volkensii*. In 2008 Nyumbani Village planted 83,550 tree seedlings on 19.5 ha as part of its commitment to renewable energy and renewable resources.

Projects managed jointly by KEFRI/JICA/KFS such as Social Forestry Extension Model Project (SOFEM) have been involved in provision of the following services: linking seed collectors, seed vendors, nursery owners and tree producers to the market; training farmers on Melia propagation, management, processing and marketing; purchasing seeds and seedlings from the farmers; and providing technical advice on Melia. These institutions promoted *M. volkensii* as a multi-purpose tree species for; income generation, livestock fodder from fruits, timber production for building and provision of firewood.

1.5 Justification for the study

Melia grows naturally in ASALs where incidences of poverty are highly pronounced with an average of 65% of the population living below the poverty line as compared to the national average of 26% (Thornton *et al.*, 2002; Barrow and Mogaka, 2007). This makes diversification of sources that increase food ando income in such areas a priority. (Wekesa *et al.*, 2012)

The adoption of Melia was enhanced by; ready market for its products, drought tolerance, employment opportunities from various enterprises, readily available seeds, fast growth, provision of windbreak and shade. Planting of *M. volkensii* also contributes towards realizing the 10% forest cover by the year 2030. The economic prospects for investing in *M. volkensii* seeds and seedlings enterprise are high due to the technical, financial and research support available from facilitating institutions. Despite the realization of the potential of *M. volkensii* as a commercial tree-crop, development of *M. volkensii* timber, seed and seedlings enterprises have not been widely established among the target communities and local economies of the areas where the tree is commonly planted. This study was therefore conducted to investigate socio-economics importance of the timber, seeds and seedlings enterprises within the *M. volkensii* value chain.

1.6 *Study objectives*

The overall objective of the study was to evaluate the socio-economic importance of Melia based enterprises in the dry lands of eastern Kenya. The specific objectives of the study were to:

- Review, analyze and document the current status of production and tribution of Melia seeds, seedlings, round-wood and timber;
- Map market chains and players for the Melia seeds, seedlings, round-wood and timber
- Assess socio-economic characteristics of Melia seed collectors and timber producers
- Make recommendations on how to enhance contribution of Melia enterprises to diversification of income generation sources in the dry lands

2.0 METHODOLOGY

2.1 Study Sites

The study was undertaken in Makueni, Kitui, Embu (Mbeere) and Taita Taveta counties. These counties fall under agro-ecological zones IV to V but patches of agro-ecological zone III also occur. Maximum temperatures in these counties range from 25–32^{0}C while minimum temperatures from 15–20^{0}C.The altitude ranges between 500 and 1000 m above sea level (a.s.l). Rainfall is bi-modal with an annual range of 500 to 900 mm, poorly distributed and occurring with high intensity. The long rains (October - December) are more reliable for crop production than the short rains (March - June).

2.2 Data collection methods

Eight sets of semi-structured questionnaires were developed, pre-tested and administered through personal interviews to each of the following categories of respondents; seeds and seedlings enterprises represented by seed collectors, seed traders/vendors, nursery operators and facilitators and Melia round wood/timber enterprise represented by producers, timber processors, timber merchants, and facilitators in all the study areas. The facilitators included government and non-government organizations involved in promoting planting and marketing of Melia among the community members either through: training; provision of nursery materials and seedlings; or support in marketing of Melia seeds, seedlings and timber. Facilitators included; KEFRI, KFS, Ministry of Agriculture, Livestock and Fisheries, NGOs and the private sector.

Sequential sampling procedures were applied in identification and selection of interviewees. The KFS staff and local leaders provided information on players in the *M. volkensii* value chain based on which interviewees were located, selected and interviewed. The interviewees also provided information that led to identification and interview of other players in the value chain. Melia producers gave information that led to identification of traders and sawyers who were then interviewed. The producers in the value chain gave information on number of *M. volkensii* trees planted, cost of production, and quantities of products sold, and their selling price. Timber processors provided information on; pricing of round wood/standing trees, sawing techniques, costs of sawing timber and products' prices. Melia timber merchants gave information on their products' sources, quantity flows, pricing, demand and challenges faced.

2.3 Sample size

A total of 424 respondents were sequentially sampled in the four study counties. A total of 213 respondents were interviewed on Melia round wood and timber enterprises while 211 respondents were interviewed on Melia seeds and seedlings enterprises (Table 1). The sampled sites included Mwatate, Voi, Kasigau and Kirumbi (in Taita Taveta County), Kibwezi, Mtito Andei, Wote, Kathonzweni, Makindu and Kambu (in Makueni), Mwitika, Ikutha, Zombe, Mwingi, Tseikuru, Kyuso, Kabati, Kyusyani and Kitui (in Kitui County) and Kiritiri, Ishiara, Siakago and Kirie (in Embu County).

Table 1: Selected Respondents in Melia enterprises

County	Round wood/Timber enterprise		Seeds/Seedlings enterprise	
	Category	**Number Interviewed**	**Category**	**Number Interviewed**
Makueni	Producers	33	Seed collectors	30
	Merchants	15	Vendors/traders	6
	Processors	9	Nursery owners	31
	Facilitators	8	Facilitators	8
Taita Taveta	Producers	10	Seed collectors	8
	Merchants	6	Vendors/traders	7
	Processors	5	Nursery owners	5
	Facilitators	6	Facilitators	5
Kitui	Producers	30	Seed collectors	33
	Merchants	23	Vendors/traders	19
	Processors	8	Nursery owners	19
	Facilitators	11	Facilitators	9
Embu/Mbeere	Producers	26	Seed collectors	20
	Merchants	11	Vendors/traders	0
	Processors	7	Nursery owners	6
	Facilitators	5	Facilitators	5
Subtotals	Producers	99	Seed collectors	91
	Merchants	55	Vendors/traders	32
	Processors	29	Nursery owners	32
	Facilitators	30	Facilitators	61
Grand Total		213		211

2.4 Data analysis

Data collected was coded, cleaned and entered into the computer using MS Excel and SPSS version 20. The data was analyzed by use of descriptive statistics and results presented inform of graphs and tables. The key aspects analyzed and presented included:

- Mapping and characterization of the key players in the seeds and seedlings market value chain;
- Status of production and distribution of seeds and seedlings.

To determine the economic potential of *Melia* production at different stages of management and in different farming systems, a cost-benefit analysis was done using the following equation:

$$BCR = \frac{\sum_{t=1}^{r} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{r} \frac{C_t}{(1+r)^t}}$$

Where B_t is the benefit in time t, C_t is the cost in time t and r is the discount rate. If the cost-benefit ratio (BCR) exceeds one, then the project might be a good candidate for acceptance.

3.0 MELIA VOLKENSII SEED AND SEEDLING ENTERPRISE

Interview with Melia seed collectors, seed vendors and nursery owners explored the production dynamics to demonstrate the socio-economic importance of *M. volkensii* seed and seedlings based enterprises in the drylands of eastern Kenya.

3.1 Melia seed collection and handling

3.1.1 Socio economic characteristics of seed collectors

Land holdings among seed collectors varied widely across the four counties surveyed (Table 2). It ranged between 0.04 ha to 300 ha with an average of 4.15 ha. Majority of the seed collectors owned 2 acres (15%) followed by those who owned 3 and 10 acres (13.8%).

Table 2: Land holding by seed collectors

County	Land holdings (ha)		
	Mean	Minimum	Maximum
Kitui	3.95	0.30	16.00
Makueni	6.94	0.10	120.00
Taita Taveta	1.35	0.40	2.40
Embu	4.35	0.02	20.00

The sizes of the seed collectors' households interviewed varied from one county to another. Kitui had the highest average household size of 7 with a range from 2 to 18 persons (Table 3).

Table 3: Household sizes of all seed collectors

County	Household size		
	Mean	Minimum	Maximum
Kitui	7	2	18
Makueni	5	2	13
Taita Taveta	5	1	11
Embu	6	1	18

Majority of the seed collectors in all counties combined had a household size ranging from 3 to 8 with highest number having 5 household members. There were very few seed collectors with less than three and above 10 family members (Figure 2).

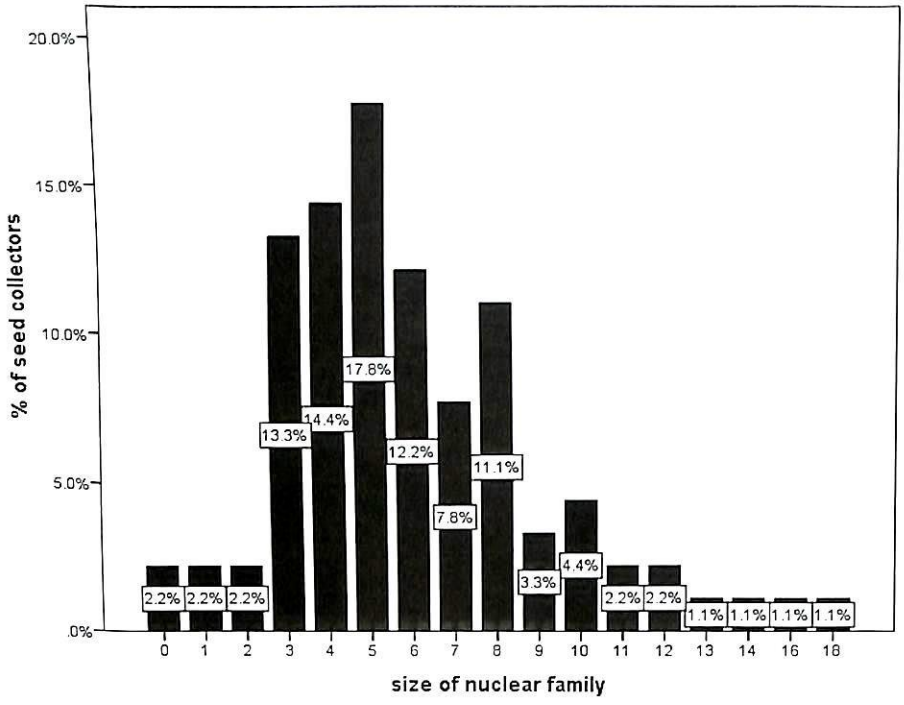

Figure 2: Nuclear family sizes of all seed collectors

Out of the 91 respondents interviewed, 72% were males while 28% were females (Table 4) indicating that Melia seed collection was a male dominated activity.

Table 4: Demographic characteristics of Melia seed collectors

Demographic factor	Variable	Counts	Percentages
Gender	Male	65	72
	Female	25	28
Age	21-30 years	15	17
	31-40 years	25	28
	41-50 years	14	16
	>50 years	36	40
Education	No formal education	4	4
	Primary level	38	42
	Secondary level	35	39
	Tertiary level	13	14

Most of the Melia seed collectors were aged above 50 years (40%). Very few young people were involved in this enterprise. Majority of the respondents involved in *M. volkensii* seed collection had primary (42%) and secondary (39%) school levels of

education (Table 3). More than half of respondents (55%) indicated that small scale farming was their major source of livelihood. Other sources of livelihood included; large scale farming, livestock farming, permanent employment, business and tree nursery (Table 5). Tree nurseries were indicated by only (10%) of the respondents as a major source of livelihood.

Table 5: Major sources of livelihood

Source of livelihood	Count	Percentage
Small scale farming	74	55
Large scale farming	8	6
Livestock farmer	16	12
Permanent employment	4	3
Business	19	14
Tree nursery	13	10
Total	134	100

The study revealed that the highest average income was obtained from; sales of farm produce, followed by sale of Melia products, livestock products, employment and business. Majority of the respondents depending on tree nurseries as source of livelihood indicated that sales from *M. volkensii* standing tree and/or timber gave the second highest source of income (Figure 3). This implies that though very few respondents were depending on *M. volkensii* related enterprises as major and alternative income sources, the income gained from such enterprises were generally high.

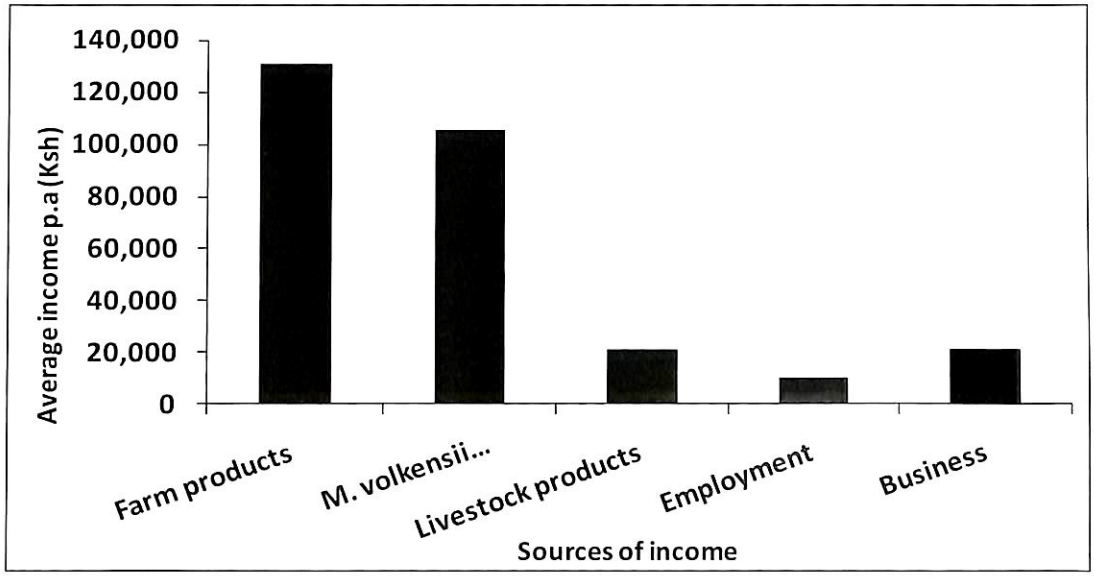

Figure 3: Sources of annual income for Melia seed collectors

The main sources of *M. volkensii* fruits were seed vendors (42.2%), farmers (36.7%) and neighbors (20%). Majority of seed collectors (62.6%) were assisted by an average of 3 family members in collection of Melia fruits with 50.5% of them hiring at least 4 casuals in *M. volkensii* collection during peak collection period. Some of the seed collectors (43.5%) involved both the family members and domestic and/or casual workers in the *M. volkensii* seed collection.

3.1.2 Melia fruit collection periods and quantities

It was noted that quantities of *M. volkensii* fruits collected varied over the year with peak period ranging from June to September. The peak month for the respondents interviewed was August when the highest amount of Melia fruits/nuts were collected (Figure 4).

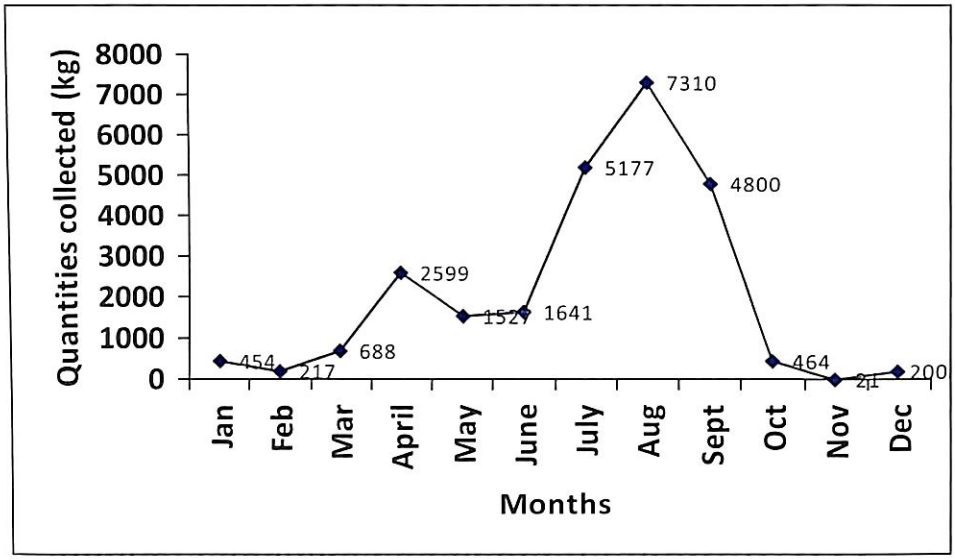

Figure 4: Quantities of Melia fruits collected per month in 2012

About 45.5% of all the seed collectors reported that there were local rules and regulations governing the collection of Melia fruits/seeds. Analysis based on the counties revealed that existence of such rules was mainly indicated by seed collectors in Kitui and Makueni counties (Table 6).

Table 6: Existence of seed collection rules and regulation

County	Percentage (N=88)
Kitui	17
Makueni	15.9
Taita Taveta	6.8
Embu	5.7
Total	45.5%

The local rules and regulations included:

- Selection of mature mother trees
- Collection of mature fruits with yellowish color and brown dots (Photograph 1)
- Collection from un-infected mother trees and seeds
- Collection of fresh fruits from the trees
- Collection of ripe fruits from trees with straight boles

Photograph 1: Mature and ripe M. volkensii fruits

In Mbeere (Embu County), most of the farmers collected Melia nuts from goat shed (Photograph 2) for their own use in the farm since they believed that such nuts having been chewed by livestock would yield rates of germination in the farm.

Photograph 2: Melia nuts collected from goats shed in Mbeere

The seed collectors reported that the availability and supply of Melia fruits/nuts varied as follows: high (75.3%), medium (19.1%) and low (5.6%). Majority of the respondents (95.6%) indicated that the quantities of seeds collected ranged from 1 kg to 300 kg per day and that an average of 57.2 kg of Melia fruits were collected per person per day (Figure 5). About 34.5% of the seed collectors indicated that they collected 50 kg per day, 19.5% were collecting 100 kg per day, 9.2% were collecting 20 kg per person per day and 8.0% were collecting 10 kg per day. For those hiring casual laborers for collection of the fruits, average cost of Ksh 285 was incurred per person per day.

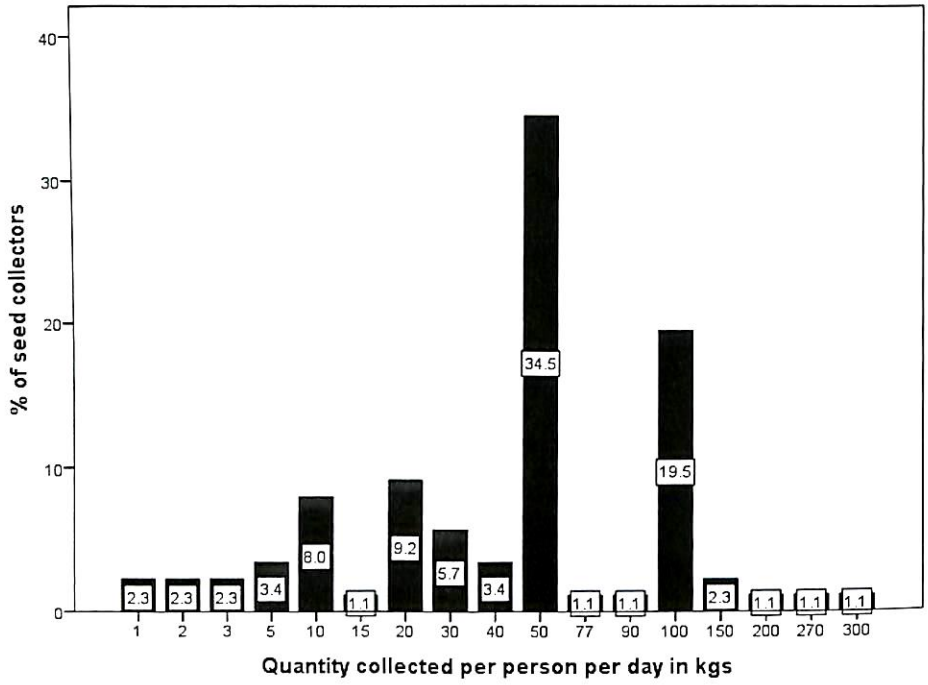

Figure 5: Quantity of Melia fruits collected per person per day

Majority of the seed collectors were local residents of the study areas with an average of 23 years of residence. About 93.4% of the seed collectors reported to have observed a lot of changes in vegetation cover in their areas of residence over time. The levels of vegetation had been observed to change: reduced (59.1%), no change (17%) and increased (23.9%). Majority of the seed collectors also indicated to have observed a change in density of *M. volkensii* trees over the years. The *M. volkensii* seed stand in the collectors farms had: reduced in quantities (57.1%) due to cutting of Melia to get timber for sale and domestic use, increased in quantities (33%) for those who had started planting where the trees were not growing previously, and no change (7.7%). Mean distance to the *M. volkensii* seed market centers or collection points was about 17.82 km. Collected Melia fruits were transported to the market mainly by head-load (Figure 6). Most of the respondents transported their fruits as head-load due to lack of funds to hire more convenient means of transport.

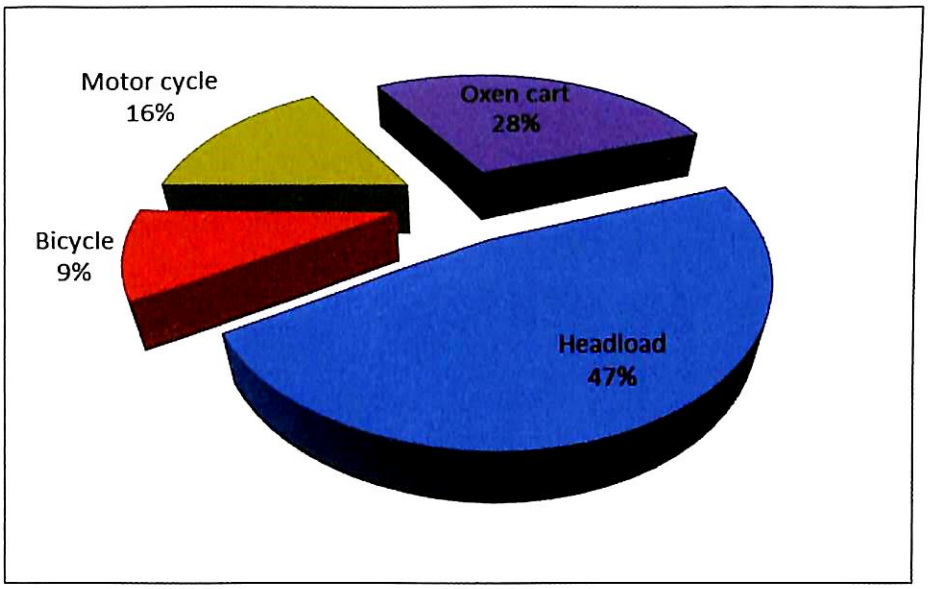

Figure 6: Mode of transport used by seed collectors

3.1.3 Seed extraction methods

The main tools of Melia seed extraction was by use of a piece of wood/board (63.1%) cracking by using a knife (21.5%) or panga (7.7%) (Photograph 3); and use of nut cracker fabricated by KEFRI (7.7%). About 65.5% of the seed collectors indicated that they had some formal skills on *M. volkensii* seed extraction especially collectors from Kitui and Makueni counties where KEFRI had played an important role in disseminating information and skills on Melia propagation and management in the nursery. It was however noted that most of the respondents were not extracting seed though they had knowledge on how to do it. About (34.5%) of respondents had no formal skills in *M. volkensii* seed extraction. Out of the 22 seed collectors who were involved in seed processing for sale and own use, processing technologies used were; cracking the nuts to extract seeds (40.9%), de-pulping (31.8%) and others methods of seed extraction (27.8%). Training seed collectors on *M. volkensii* extraction was conducted by KEFRI (56.1%), KFS (19.7%) and other farmers (24.2%).

Photograph 3: Melia seed extraction in Mbeere, Embu County

3.1.4 Trade in Melia fruits/nuts/seeds

Majority of Melia seed collectors were collecting their *M. volkensii* fruits/nuts/seeds for use in their own tree nurseries (68.1%). About 13% of the respondents were using the fruits in their nursery as well as fodder for goats. The rest of the seed collectors sold their *M. volkensii* products in the form of fruits (19.8%), extracted seeds (7.7%) and nuts (4.4%) as shown in Figure 7 below.

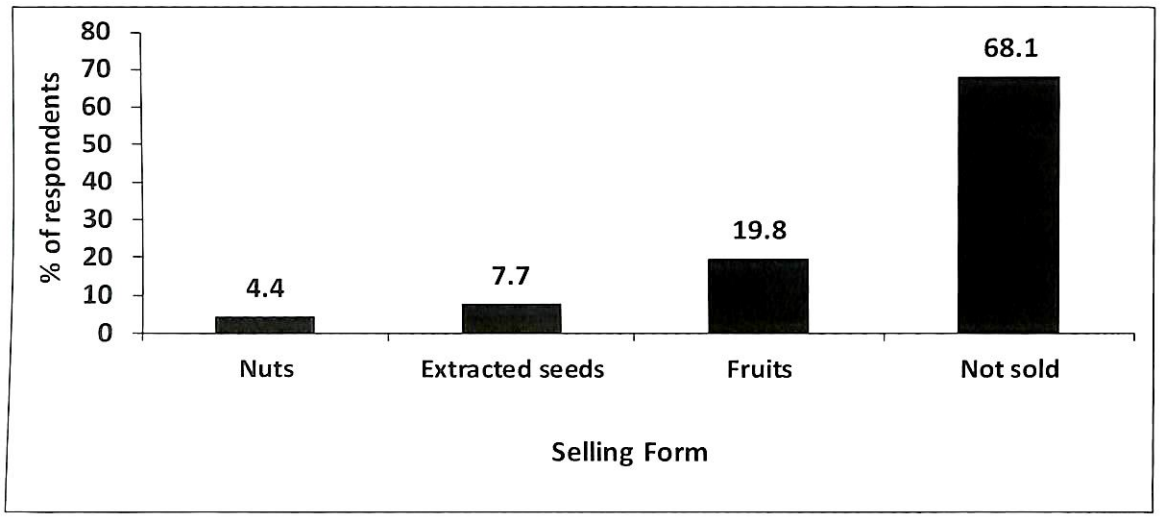

Figure 7: The forms of M. volkensii propagation material

Quantities of *M. volkensii* fruits sold increased over time (Figure 8). This increase was attributed to increase in the number of seed collectors selling the fruits/nuts/seeds. It was observed that the number of those involved in both collection and sale increased from year to year as there was increased awareness on importance of *M. volkensii*.

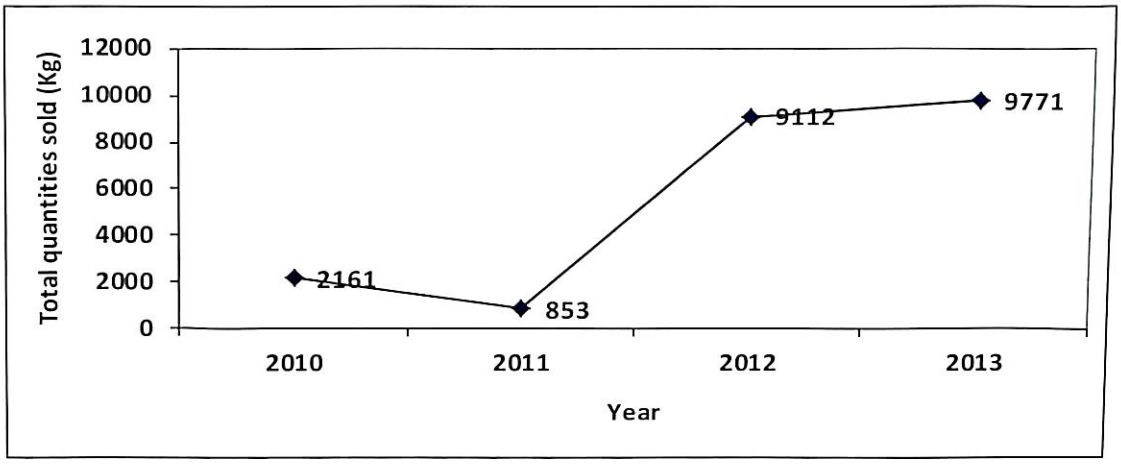

Figure 8: Total quantities of M. volkensii fruits sold

Average annual sales were not steady over the years covered from 2010 to 2013. The annual volumes of Melia seeds sold over the years were influenced by the number of seed collectors involved in the selling of Melia fruits i.e. 7 persons in 2011 and 19 persons in 2013 (Figure 9).

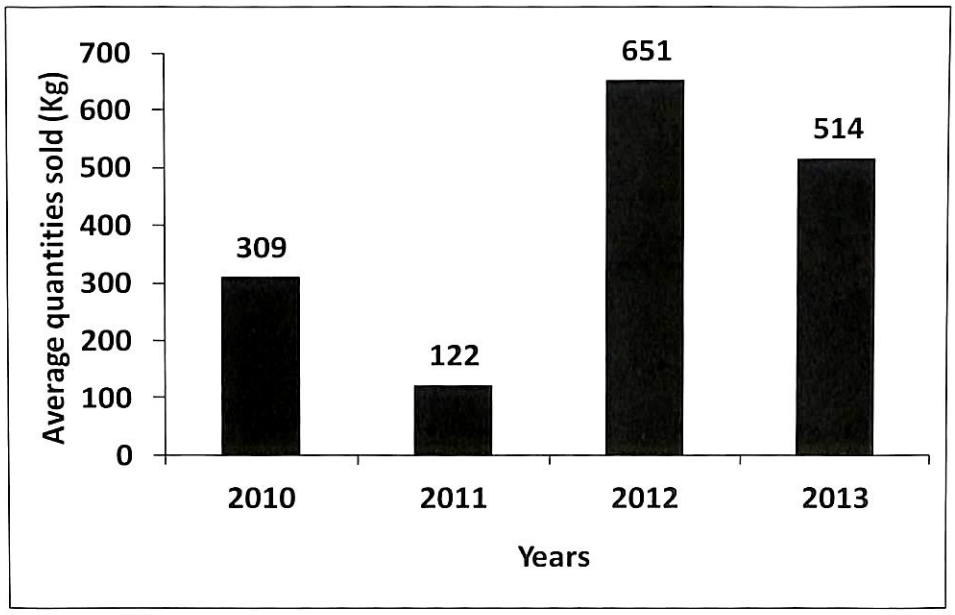

Figure 9: Average sales of Melia fruits in the last 4 years

Most of the seed collectors were not aware of any specific characteristics of *M. volkensii* fruits/nuts/seeds that their buyers considered while purchasing Melia fruits/nuts/seeds. Only 7.7% of the seed collectors indicated that their buyers considered buying well sorted and tested seeds. For the rest of the seed collectors, their buyers bought the fruits/nuts/seeds without indicating any particular characteristic (70.3%), not aware of any required characteristics (17.6%) and lastly un-graded (4.4%).

Main price determinants for *M. volkensii* fruits/seeds were seed collectors (44.4%), trader/seed vendors (16.7%), and market forces (13.9%) among other unexpected factors (25%) as indicated by the interviewed seed collectors. The sources of market information were buyers (41.9%), KEFRI (32.3%), other farmers (19.4%) and KFS (6.5%). The modes of payment indicated by respondents involved in selling were cash on delivery (39.6%), payment after sale (2.2%) and advance payment (1.1%).

3.1.5 Awareness and training

The study revealed that farmer to farmer extension played a significant role in disseminating information and skills on *M. volkensii* seed extraction especially in Kitui, Embu and Makueni. About 47.5% of the seed collectors indicated that they had trained other seed collectors on *M. volkensii* seed extraction mainly in groups. Seed collectors in Taita Taveta lacked skills on seed extraction as no training had been undertaken in the county. Number of farmers trained varied from one county to another. The numbers of farmers trained were 31, 20, and 27 for Kitui, Makueni and Embu Counties, respectively. Training charges were only incurred in areas where there were Farmers Field Schools facilitated through KFS. In such cases the facilitators were paid on monthly basis depending on the number of times they facilitated the FFS group.

3.2 Seed vendors

3.2.1 Socio economic characteristics of seed vendors

There were more female *M. volkensii* seed vendors (56.3%) than males (43.8%) among those surveyed. There was a proportionate increase in number of seed vendors with increase in age. Most of the seed vendors were over 40 years in age (62.5%), 41-50 years (28.1%) and over 50 years (34.4%) while the rest were below 21-40 years, that is, 21-30 years (18.8%) and 31-40 years (18.8%).

3.2.2 Marketing of Melia seeds

In all the study sites, majority of the seed vendors started Melia seeds and fruits business in 2010. Melia products traded by seed vendors included; fruits (73.2%), nuts (22%) and seeds (4.9%). Majority of the respondents (81.3%) made own collections of *M. volkensii* fruits. The fruits were delivered either by the collector (9.4%) or collected by the vendor from the field (6.3%) or they were collected by order (3.1%). Although, *M. volkensii* fruits could be collected throughout the year, peak *M. volkensii* fruits marketing occurs in the month of August to October every year (Figure 10). This marketing period coincides with peak collections period.

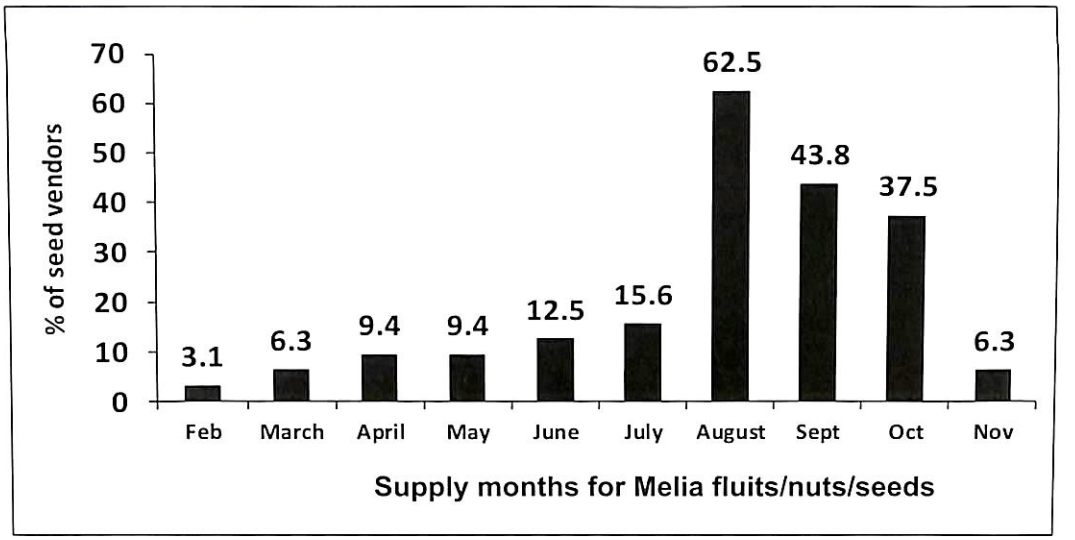

Figure 10: Monthly Melia fruit/nuts/seeds supply

An average of 328 kg of fruits per vendor was traded annually between 2010 and 2013. The highest annual average of 716 kg/vendor was traded in 2010 when there was increased awareness on *M. volkensii* production in the region. This could also be attributed to increasing demand for Melia seedlings within the sites. The average quantities traded in 2011, 2012 and 2013 were 194 kg, 232 kg and 170 kg, respectively. The average buying price for Melia fruits was Ksh11.45 per kilogram while average selling price was Ksh18.25 per kilogram (Table 7). The prices increased with time due to increase in interest in planting of Melia by farmers and other stakeholders.

Table 7: Melia fruits buying and selling price

Year	Buying Price (Ksh)	Selling Price (Ksh)
2010	9.50	16.00
2011	11.50	18.00
2012	12.30	20.00
2013	12.50	19.00
Average	11.45	18.25

3.2.3 Mode of payment for purchase and sale of Melia fruits/nuts/seeds

Majority of the seed vendors (71.9%) did not make any payment towards the purchase of *M. volkensii* fruits/nuts/seeds since they undertook own collection. Where Melia fruits/seeds were purchased seed vendors were paid in cash upon delivery of the fruits/ nuts/seeds (25%) while the rest purchased through advance payments (3.1%) (Figure 10). In Kitui and Taita Taveta, most of the vendors doubled as seed collectors while in Makueni, some of the vendors were purchasing Melia fruits from seed collectors. Melia fruits/nuts/seeds markets were more developed in Makueni compared to the

other counties. Individual farmers and government organizations such as KEFRI based in Kitui and Makueni counties were the key buyers of Melia fruits from Taita Taveta for own use. There were no seed vendors in Mbeere (Embu County) hence the county is not featuring in Figure 11 below.

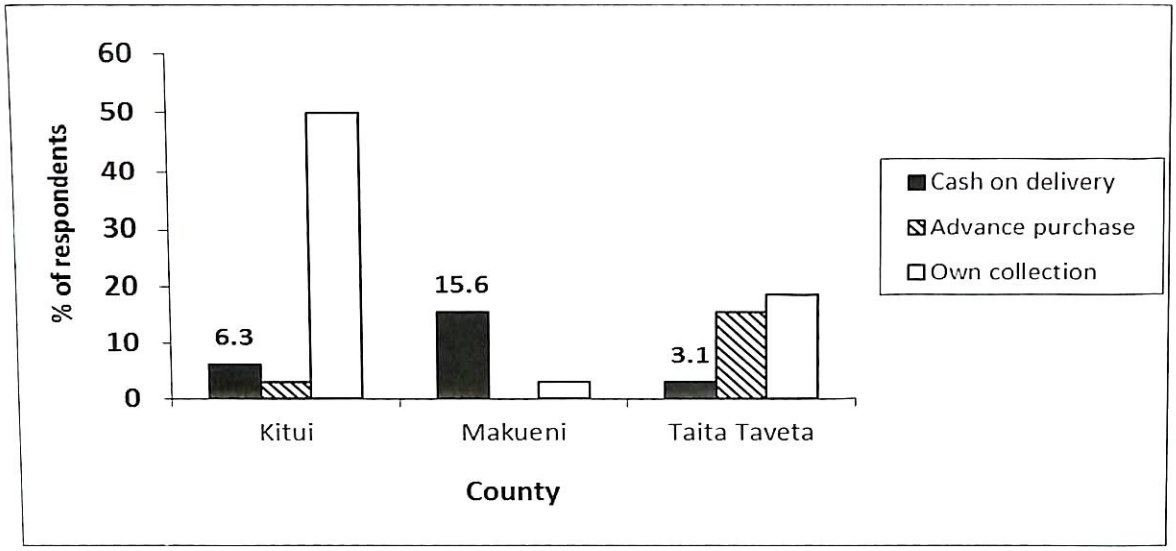

Figure 11: Mode of payment to seed collectors per County

3.2.4 Cost of Melia seed collection

Most of the vendors (81.2%) did not incur any direct costs on collection of fruits as they carried out own collection. However, 18.8% of the seed vendors incurred costs in paying climbers to collect Melia fruits. Climbing/collecting costs ranged from a minimum of Ksh 150 to a maximum of Ksh 1, 000.Transport costs were incurred by 12.5% of respondents with costs varying from a minimum of Ksh 100 to a maximum of Ksh 2, 000. Average costs were Ksh 1, 125 and Ksh 475 for seed collection and transport respectively.

3.2.5 Main buyers of Melia fruits/nuts/seed from vendors

Consumers of *M. volkensii* fruits/nuts/seeds varied from county to county with the bulk of the market share dominated by the farmers (43.8 %) in all the counties (Figure 12). However, the main buyers were local farmers in Makueni and Taita Taveta counties, and Nyumbani village (NGO) in Kitui County. KEFRI was mainly contracting the seed vendors. KEFRI sourced *M. volkensii* seeds from all the counties. KFS and Nyumbani Village sourced their *M. volkensii* seed requirements mainly from Kitui County.

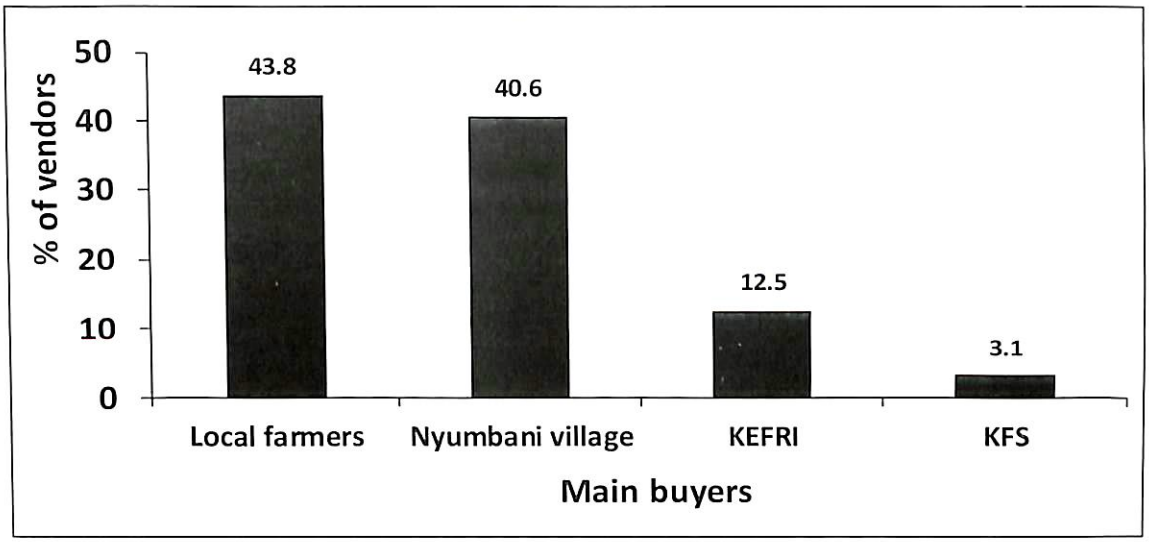

Figure 12: Main buyers of Melia fruits/nuts/seeds from vendors

3.2.6 Buyer's preference

Most of the seed vendors (90.6%) emphasized that their clients preferred mature healthy looking fruits with good seeds that would easily germinate after pre-treatment. Maturity was determined by color of Melia fruits and size. Mature fruits were expected to be yellowish with brown dots. Only 6.3% of the vendors indicated the preference for extracted seeds by their clients.

3.3 Nursery owners

3.3.1 Socio economic characteristics of nursery operators

The *M. volkensii* nursery owners varied in age from 21 to over 50 years. The age brackets were 21-30 years (10.3%), 31-40 years (37.9%), 41-50 years (24.1%) and over 50 years (27.9%). It can be deduced that the level of participation of young people in *M. volkensii* seedling production was relatively low. The nurseries were owned by men (75.4%), women (21.3%) and institutions (3.3%). The main economic activities of nursery owners included small scale farming (56.9%), large scale farming (32.8%), livestock production (5.2%), permanent employment (3.4%) and other activities (1.7%). A few non-governmental organizations such as Nyumbani Village were producing *M. volkensii* in large scale (Photograph 4).

Photograph 4: Melia volkensii nursery at Nyumbani Village, Kitui

3.3.2 Nursery operations

Nursery owners interviewed in Kitui and Makueni counties started their tree nursery activities as early as in 1975 and 1993 respectively while those interviewed in Embu and Taita Taveta counties started in 2004 and 2005 respectively. The number of nurseries in both Makueni and Kitui counties increased from 2009 when KEFRI made breakthrough in *M. volkensii* seed propagation and training of farmers on *M. volkensii* nursery establishment and tree management through its drylands research programme. Most of the tree nurseries are either owned by individuals (88.5%) or groups (11.5%). Other common tree seedlings in the *M. volkensii* producing nurseries were; *Mangifera indica (Mango), Moringa oleifera (Moringa), Azadirachta indica (Neem), Cuppressus lusitanica cypress* and *Senna siamea (Senna)* (Table 8).

Table 8: Common seedlings in the Melia nurseries

Name of Species	Count	%Responses
Melia volkensii	61	23.0
Mangifera indica	40	15.1
Moringa oleifera	29	10.9
Azadirachta indica	27	10.2
Cuppressus lusitanica	20	7.5
Senna siamea	15	5.7
Carica papaya (Pawpaw)	15	5.7
Grevillea robusta	9	3.4
Acacia species	7	2.6
Eucalyptus species	6	2.3
Ashok species	5	1.9
Oranges species	5	1.9
Christmas tree species	3	1.1
Balanites aegyptiaca	3	1.1
Jacaranda mimosifolia	2	.8
Lemon	2	.8
Grapes	1	.4
Catha edulis (Miraa)	1	.4
Total responses	**265**	**100.0**

3.3.3 Melia seedling production

Nursery owners had an average annual production of 9,316 seedlings of all species per nursery with a range of 500 to 60,000 seedlings per nursery. In terms of income, each nursery generated an average of Ksh 74,805 with a range from Ksh. 500 to Ksh 1 million per year. Melia seedling producers use four methods for production of *M. volkensii* seedlings, root cutting (23 %), seeds (67.2%), stem cuttings (6.6%) and wildlings (3.3%). Seedling production from seeds was the most popular method in Kitui and Makueni. Average *M. volkensii* seedling production per nursery from 2010 to 2013 was 5,438 seedlings. The highest production was recorded in 2010 (Figure 13). The high numbers could be attributed to increase in demand for Melia and increased awareness among the farmers on the importance of the tree species for timber.

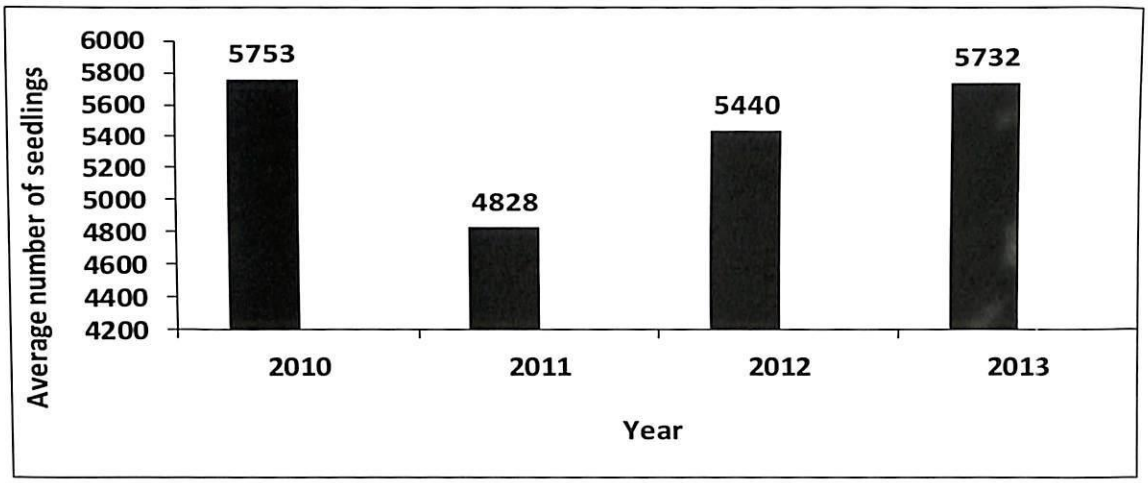

Figure 13: Annual Melia seedlings production per nursery

Nursery owners indicated that the health of Melia seedlings improved generally as from 2007 to 2009. However, since 2010 to date, the health status of the seedlings has been slightly unstable as reported by nursery owners (Figure 14). During the survey, it was noted that some of the causes for reduced health status were; failure to maintain hygienic conditions during seedling propagation processes, collecting infected Melia fruits and poor management of the seedlings in the nurseries. It was also observed that some of the Melia seed collectors were obtaining Melia fruits and storing them in covered buckets while not de-pulped hence resulting in seeds getting infected before extraction. In some of the nurseries, pricking out was done when the sprouts had already overgrown hence affecting their health in the process of potting and increasing seedling mortality.

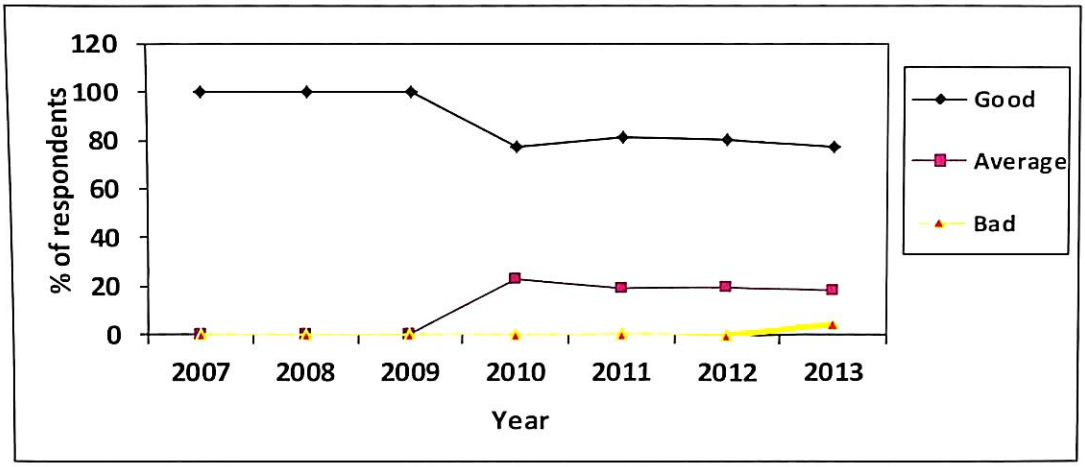

Figure 14: Trend in Melia volkensii seedling health status

The major health problem observed during the survey was root rot which was attributed to ecess watering.

3.3.4 Marketing of Melia seedlings

Nursery owners (80.3%) indicated they were unable to satisfy the demand for *M. volkensii* seedlings. The number of nurseries stocking Melia increased because the demand for Melia seedlings has been increasing since 2010. The number of nurseries with *M. volkensii* seedlings seem to have dropped in 2013 (Figure 15) but in reality this may not be the case since some of the nursery owners had sold some of their seedlings at the time of this survey.

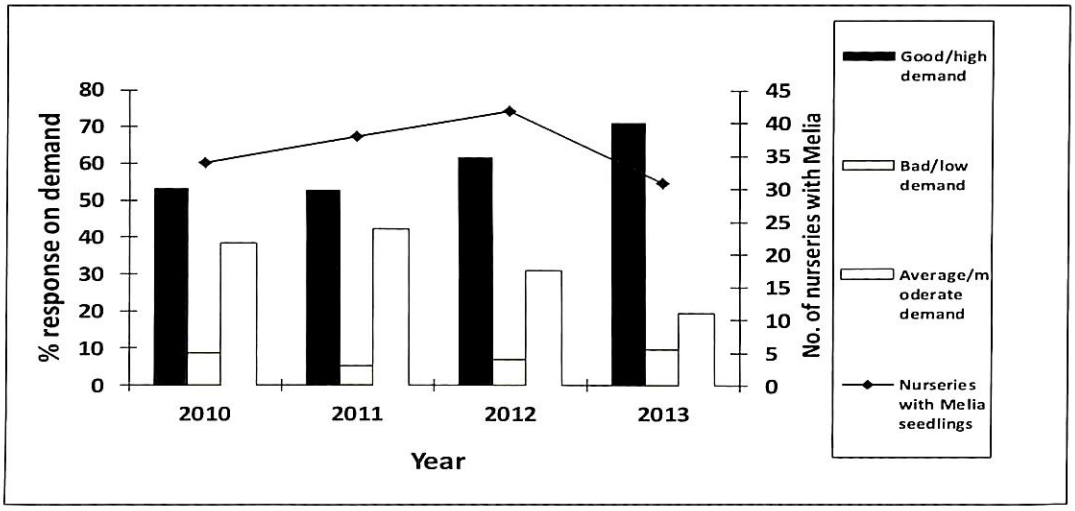

Figure 15: Demand for Melia volkensii seedlings

3.3.5 Availability of Melia seedlings

Melia seedlings were more readily available during the long rains (October-December) than during the short rains (March-June) in all the study areas (Figure 16). The nursery owners indicated that during the long rains the demand for seedlings was higher than during the short rains but there was also incidences over-supply of the seedlings during the long rains due to lack of information on the existence of Melia nusseries in the study site.

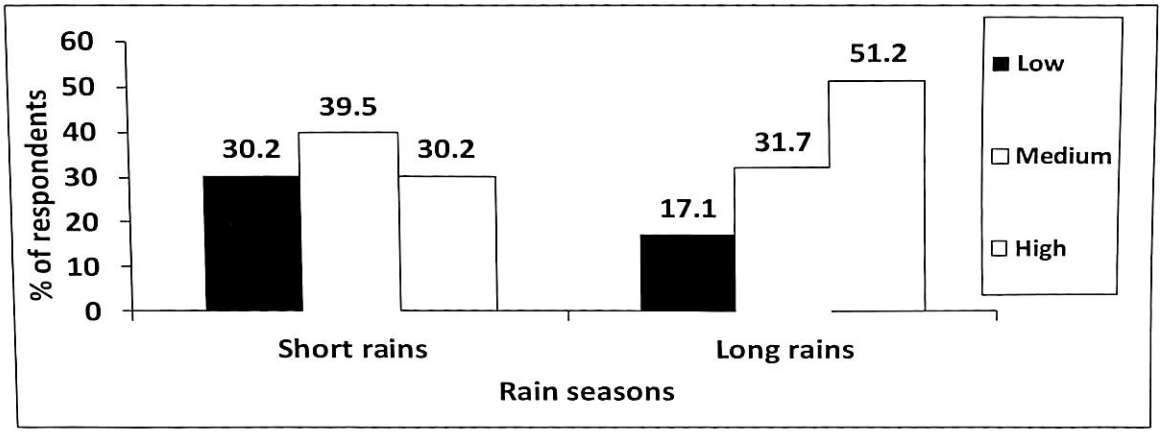

Figure 16: Seasonal availability of M. volkensii seedlings

The selling prices ranged from Ksh 10 to Ksh 150 per seedling during the long rains and short rain seasons. However, most of the nursery owners sold the Melia seedlings between Ksh 30 and Ksh 50 per seedling in both seasons depending on availability/ supply of Melia seedlings. Number of seedlings sold in 2012 decreased compared to 2011 (Figure 17) and this was attributed to low rains received towards the end of 2012 especially in Makueni and Kitui. In Mbeere (Embu) and Taita Taveta counties, there were very few respondents selling *M. volkensii* seedlings.

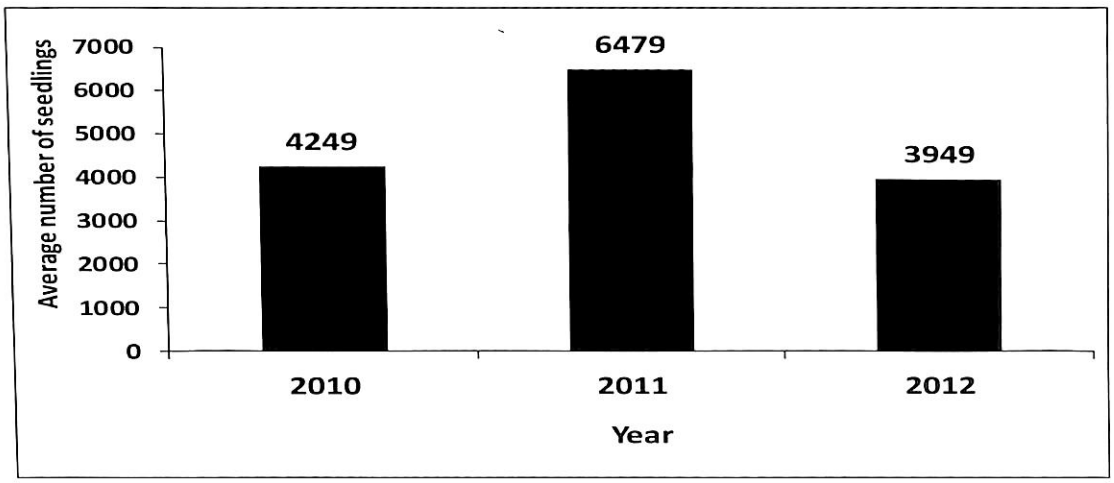

Figure 17: Average number of seedlings sold in the last 3 years

In 2011 Melia seedlings' market was dominated by the local farmers (84%) as the final consumers of the Melia seedlings, project under government organizations such as KEFRI and KFS (12%) and other groups / Non-governmental organizations (5%) such as Nyumbani village.

The nursery owners were the key price determinants (76%) for the seedlings. They were able to agree on what price to offer within their area of operation. Prices were also determined based on negotiation with the buyer (20%) and the seasonal seedling supply/demand (4%). If the demand was higher in relation to the supply or availability of seedlings, then the prices would increase.

4.0 MELIA ROUND WOOD AND TIMBER ENTERPRISES

The main benefits of investing in Melia production as described by the respondents included high quality timber (26.2%), secure source of income and employment (21.3%), provision of services (11.5%), ready market (9.8%) and fast growth (9.8%). Other advantages included; premium price offered for the timber, drought tolerance, pests and disease resistance and low management costs (Table 9).

Table 9: The advantages of investing in Melia timber enterprise

Benefits	Count	%Responses
High quality timber	16	26.2
Source of income / employment	13	21.3
Provision of services	7	11.5
Fast growth	6	9.8
Ready market	6	9.8
Pests and disease resistance	4	6.6
Melia timber attracts a premium price	3	4.9
Drought tolerance	3	4.9
Minimum management cost	3	4.9
Total	61	100.0

4.1 Melia Producers

4.1.1 Socio-economic characteristics of Melia timber producers

Melia producers were aged 50 years and above (55.1%), 41-50 years (28.8%), 31-40 years (13.3%) and between 20-30 years (3.1%) (Figure 18).

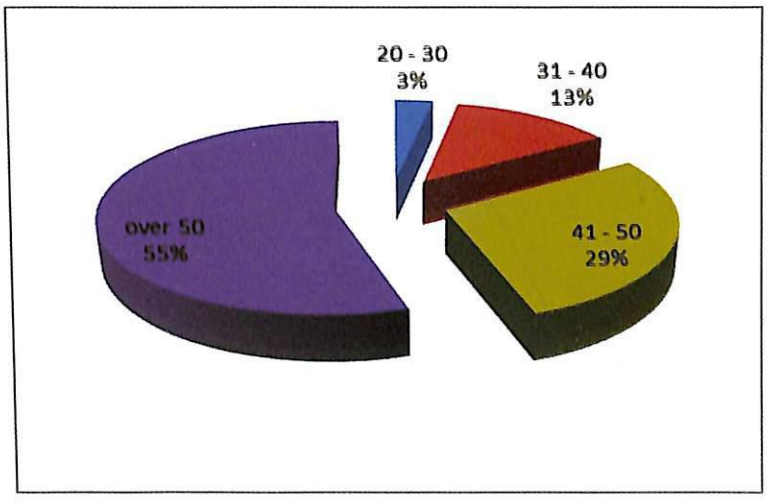

Figure 18: Age categories for Melia producers

The level of education of Melia producers varied from tertiary to non-formal education (Figure 19). Formal education is a proxy variable on the level of conceptualizing new technologies, experience and level of management. However, most of the respondents had attained primary level of education.

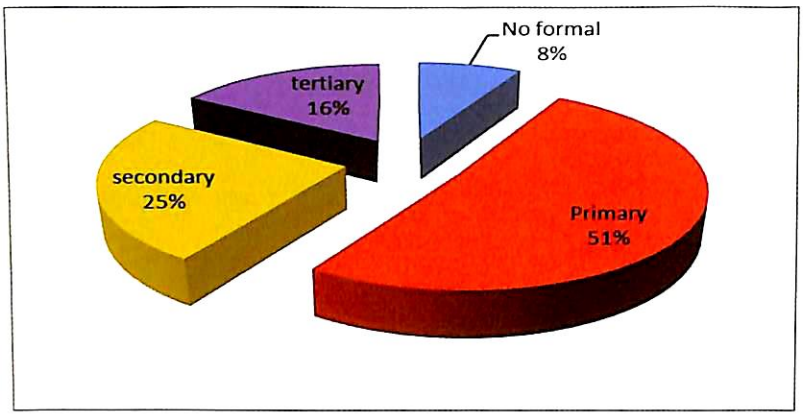

Figure 19: Education levels among Melia producers

Average family members among Melia producers consisted of an average of 7 nuclear family members and 4 dependents. The average land holding was 21 acres which was big enough to accommodate tree growing. Makueni and Kitui owned the largest average land sizes of 25 and 30 acres respectively, whereas Taita Taveta respondents owned the smallest average land size (5.3 acres).

4.1.2 Economic activities of Melia producers

The main source of monthly income among the Melia producers was: crop farming, Livestock production and Melia timber. Other sources of income included business (7%), formal employment (6%), sale of forest products (5%) and donations/remittances (6%) from family members and relatives (Figure 20).

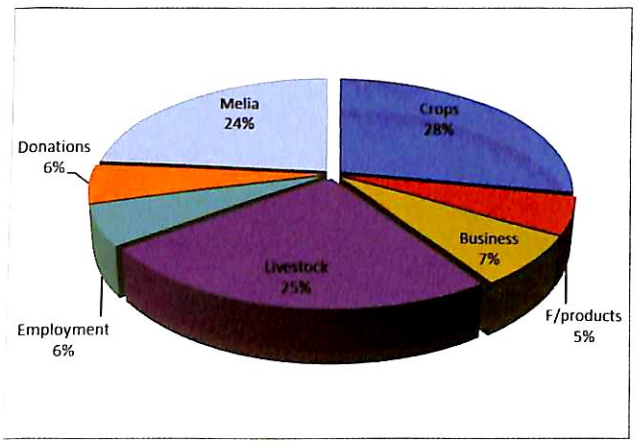

Figure 20: Income sources for Melia producers

The average monthly income was estimated at Ksh 52,746 per household. Crop farming contributed an average of Ksh 3,710; *M. volkensii* contributed Ksh 7,261 whereas livestock sales contributed Ksh 3,500. Most of the respondents were involved in crop and livestock farming. Only a few respondents had other sources of income including business, forest products, employment and donations. Financial contributions from *M. volkensii* productions were substantial (Table 10). Respondents from Taita Taveta had no income arising from salary, business or forest products.

Table 10: Average income from different activities

Source of income	Average monthly income (Ksh)
Crop farming	3,710
Business	7,471
Forest products	7,254
Livestock farming	3,500
Employment	15,119
Donations/remittance	8,431
Melia timber	7,261

4.1.2.1 Crop and livestock production by Melia farmers

Melia producers in all the study sites practiced mixed farming where they grew maize, cow peas, pigeon peas, green grams, sorghum and millet in various proportions (Figure 21). Farming was limited by unreliable rainfall in all the study areas. It was reported that farmers received good harvest once in every five years due to un-reliable rainfall in most of the study areas.

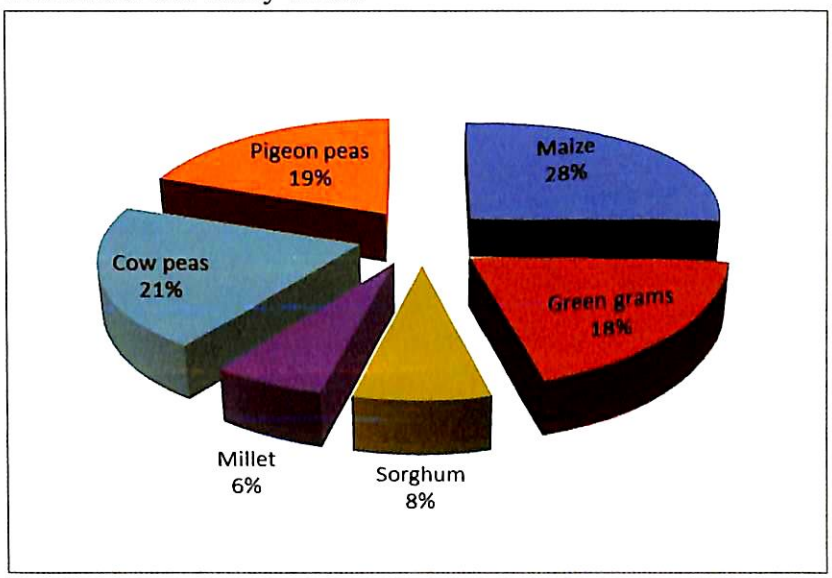

Figure 21: Crops grown by Melia producers

The livestock kept per household consisted of poultry, goats, sheep and cattle. Sheep rearing was however not practiced in Taita Taveta.

4.1.2.2 On-farm tree growing/Planting

Tree planting was expanding fast, though some farmers were managing naturally regenerating trees. At least 52 % of the respondents had established their Melia plantations while 48 were managing natural regenerations. The common on-farm trees (Figure 22) include *M. volkensii* (Melia), *Azadirachta indica* (Neem), *Mangifera indica* (Mango) and *Annona cherimola* (Matomoko). Famers were mainly investing in trees that could boost their income levels. The average Melia trees per farmer in all the study sites were as follows: Makueni registered the highest number of trees per farm at 1,769 followed by Kitui at 519 Melia trees per farm. Mbeere and Taita Taveta registered the least number of trees per farm at 123 and 53 respectively.

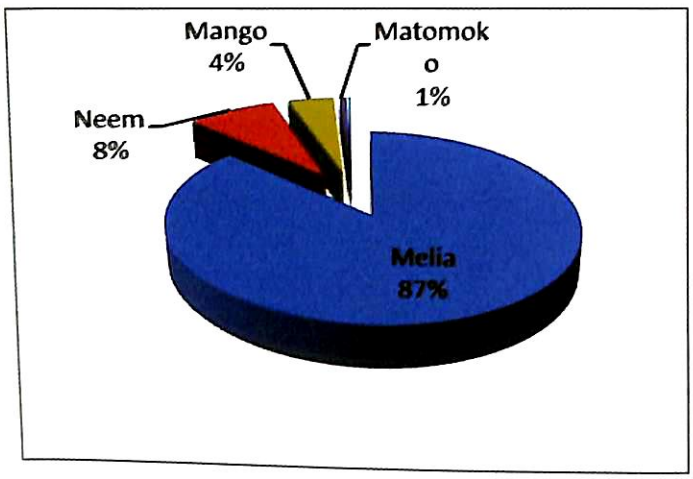

Figure 22: Trees species planted by Melia farmers

Photograph 5: On-farm Melia plantation in Mbeere

These trees were planted using different arrangements depending on the size of land among other factors. Most of these trees, especially Melia were grown on the farmland (52 %), compounds (33%), woodlot (12%), boundary (1%) and terraces (1%). These trees were managed through weeding, (19%), thinning (5%) and pruning (75%). Some farmers in Kathonzweni (Makueni County) and Mwingi (Kitui County) were planting their Melia trees at a spacing of 1x1 m resulting in to intense competition for water and nutrients as compared for the recommended spacing of 4 x 4m spacing that produce high quality timber trees.

Challenges faced by the Melia farmers include damage of trees by livestock (40.2%), inadequate skills in seed extraction and nursery management, poor prices and lack of inputs and difficulties in accessing the harvesting authority and movement permits (Figure 23). It was observed that goats and donkeys browsed *M. volkensii* mainly by bark striping the trees resulting in death of Melia trees.

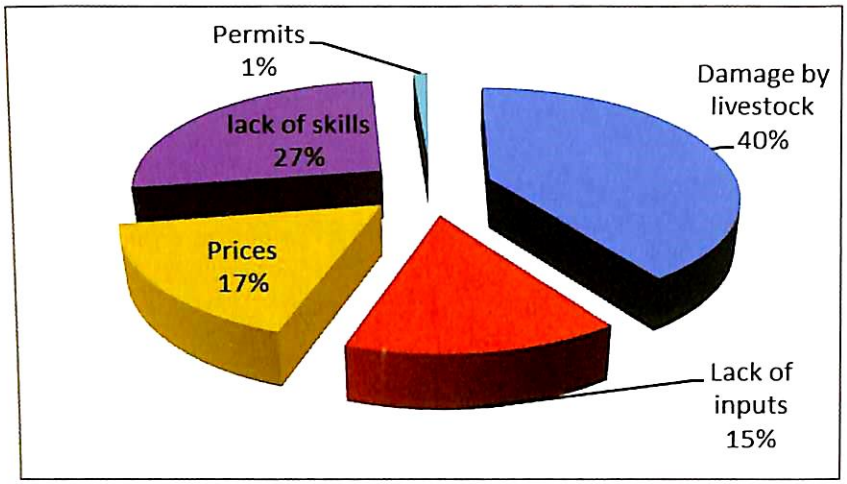

Figure 23: Problems encountered by Melia producers

4.2 Melia Harvesting, Processing and Trade

4.2.1 Harvesting, processing, and sale of Melia trees

The *M. volkensii* trees were harvested at an average age of 11 years and sold at the farm gate price of Ksh 2,734 per mature tree (round-wood) across all the counties. The unit price per tree was Ksh 2,063, Ksh 1,950, Ksh 2,605 and Ksh 3,969 in Kitui, Taita Taveta, Mbeere and Makueni respectively. A large proportion of the interviewed farmers were selling their trees as either timber or round wood or timber to maximize on profits. Some of the farmers were paying their timber processing fees in the form of timber itself. The power saw was the most preferred timber processing tool (84.6%). The other tools included the pit saw (12.8%); panga/axe (1.3%) and bench saw (1.3%). The power saws were popular in all the study sites while the pit saws were common in Taita Taveta. The bench saw were common at the wood workshops while panga and axes were mainly used when smuggling timber.

The preferred mode of transport for timber included pick-up trucks (47.2%), motorcycle (25%), oxen cart (16.7%) and head-load (11.1%). The choice of mode of transport varied depending on the delivery distance and quantity of timber. Unit transport cost for a single post of *M. volkensii* was Ksh 29 (Table 11) with Embu and Taita Taveta Counties registering the highest transport cost of Ksh 32. The *M. volkensii* round-wood producers rated the farm gate Melia producers price as good (25.6%), fair (43.6%) and poor (30.8%). Quality of the tree, distance to the market and supply (quantity) were other factors influencing the selling price for *M. volkensii* timber at the farm gate. When asked to comment on the supply of Melia timber it was rated as low (64.7%), medium (31.8%) and high (3.5%).

Table 11: Estimated cost of transporting one Melia post to the market

County	Cost (Ksh)			
	Mean	Minimum	Maximum	Range
Kitui	22	10	50	40
Taita Taveta	32	20	50	30
Embu	32	10	80	70
Makueni	25	12	50	38
Mean cost	**29**	**10**	**80**	**70**

It was established that most of the farmers, were selling their Melia as either in the form of round wood (47.1%) or timber (52.9%) in all the study areas. The farm gate (51.9%) was the most preferred market outlet. Other farmers preferred to dispose-off their timber at the local market (30.4%) or outside the county (1.3%). Apart from Taita Taveta, farmers from other counties did not seek appropriate authorization/permits (27.8%) for sale of Melia timber products. Local merchants (47.5%) and local farmers (50.8%) formed the bulk of the Melia timber market. A small percentage of producers sold their Melia timber to the processors (1.6%). Otherwise there was a small market for the Melia poles (1.2%). Farmers preferred to sell their produce at the farm gate in order to avoid paying transportation cost (74.2%), sold to neighbors (19.4%) and selling by order (6.5%). Apart from timber, the other benefits associated with Melia production include provision of firewood (35.3%), provision of fodder (32.6%), soil conservation (9.6%), seeds (8.3%), shade (7.3%), by products (4.6%), bee keeping (1.8%) and provision of medicine (0.5%).

4.2.2 Sale in Processed Melia Timber

It was established that each Melia tree produced an average of 140 feet of timber of various sizes and length after processing. The timber sizes processed were 8"x1", 6"x1", 4"x2", 3"x2" and 2"x2". Timber size 10"x1" was very rare among the processors. The timber was processed, transported and sold at average price of Ksh. 14, Ksh. 3 and Ksh. 44 per feet respectively (Table 12). It was observed that there were few Melia timber processors and merchants who operated in local trading centers scattered all over production areas.

Table 12: The farm gate transaction cost for different Melia timber sizes

Timber Size	Transaction cost (Ksh/Ft)			
	% Respondents	Processing	Transport	Selling Price
8x1	18	16	3	53
6x1	24	15	3	43
4x2	22	14	3	49
3x2	19	13	3	41
2x2	17	12	3	33
3x3	-	11	2	46
Mean		**14**	**3**	**44**

4.2.3 Future plans of Melia producers and processors

The Melia producers proposed a number of measures to improve the profitability of the Melia enterprise including: processing at farm gate, formation of producers' associations, creating awareness, opening timber outlets, and encouraging on-farm Melia tree planting (Figure 24).

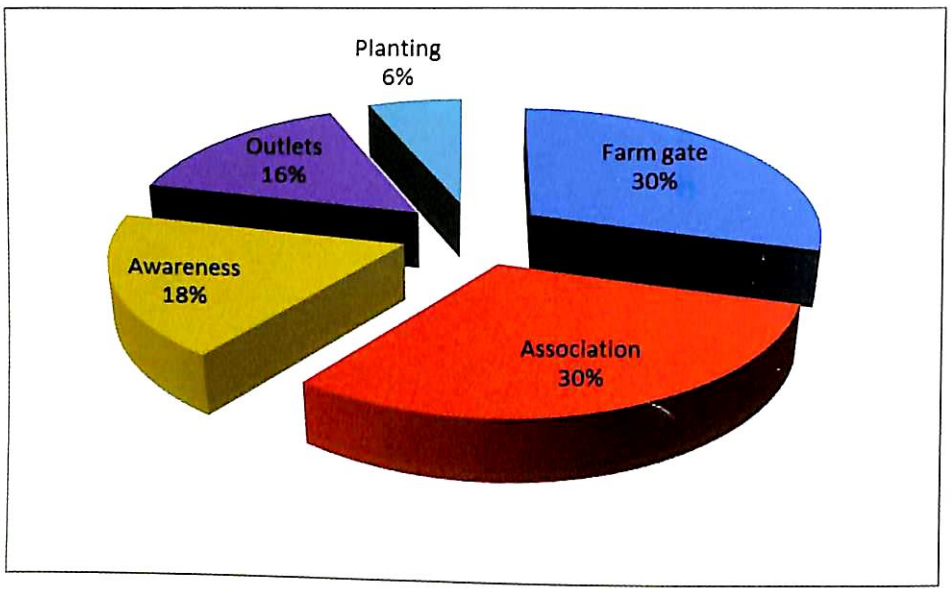

Figure 24: Future plans of Melia producers

The Melia producers indicated that they required technical and financial support areas in; Melia seed extraction (19.6%), Melia seed propagation (30.4%), Melia tree management (27.8%) and acquisition of tools (22.2%). Majority of the processors (60.7%) indicated that the future of Melia timber processing was uncertain. On the other hand 32.1% believed the future was bright while 7.1% believed that the situation was not badly off as many would want us to believe.

Photograph 6: Melia timber sawing techniques using: Pit saw (left) Power saw (right)

4.3 Melia timber merchants

4.3.1 The characteristics of the timber merchants

The timber merchants had experience averaging nine years within the range of one to thirty three years. The businesses consisted of wood workshops (80.3%), timber yards (11.5%) and hardware stores (8.2%). The respondents were either the business owners (68.6%) or workers (31.4%). Most of the Melia timber was finding its way into the hands of the wood workshops mainly for the production of furniture. Wood workshops were the ultimate users of the timber, making the market channel short i.e. producer-workshop-consumer. This demonstrates the scarcity of the Melia timber resource in the market. Few timber yards and hardware stores were observed to stock small quantities amounts of the Melia timber (Photograph 7).

The Melia timber merchants sourced their timber either as round wood (10%) or timber (90%). The surveyed merchants (30%) were stocking Melia timber. The other timber species stocked include *Grevillea robusta (25%)*, *Eucalyptus* spp (18%), *Cupressus lusitanica (10%)*, *Pinus patula* (9%) and *Commiphora baluensis* (4%). Other species (4%) were *Senna siamea (Mufesi), Cordia abbysinica (Moringa). Juniperus procera, Ficus thonningii* and *Leucaena leucocephala.*

Photograph 7: Melia timber stockist

In terms of timber stock volume, *M. volkensii* represented 5% of the total volume of timber in stock at the time of the survey (Figure 25). The leading timber species in terms of timber stock volume were *P. patula* (36%), *Cupressus lusitanica (31%), and Grevillea robusta* (19%). The average timber stock in the various yards was as follows: *M. volkensii* (743 feet), *Grevillea robusta* (2,660 feet) and Eucalyptus spp (738 feet) as reported in all of the counties. *Commiphora baluensis* (554 feet), *Pinus patula* (5,055 feet) and *Cupressus lusitanica* (4,273 feet) were reported in Kitui and Makueni counties. Cedar (50 feet), *Ficus thonningii* (20,000 feet) and *Leucaena leucocephala* (1,000 feet) were reported in Makueni while *Cordia abbysinica* (300 feet) and *Senna siamea* (200 feet) were reported in Mbeere. Most of the merchants reported to have obtained their timber from famers (74.2%). A small proportion of merchants sourced their timber from government forest (6.5%) while the rest sourced their timber from hardware stores (19.4%).

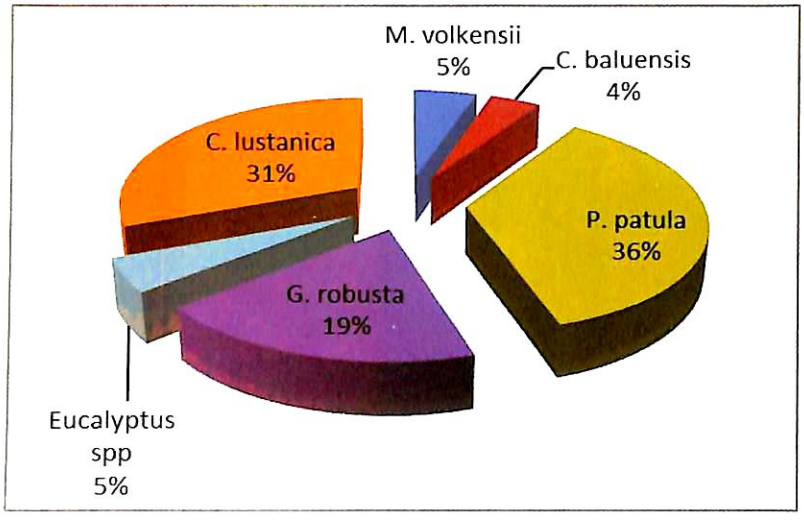

Figure 25: Proportion of timber in running feet

4.3.2 Buying and selling of Melia timber

The main buyers of Melia round wood and timber included timber processors, wood workshops, hardware stores and local farmers (Figure 26).

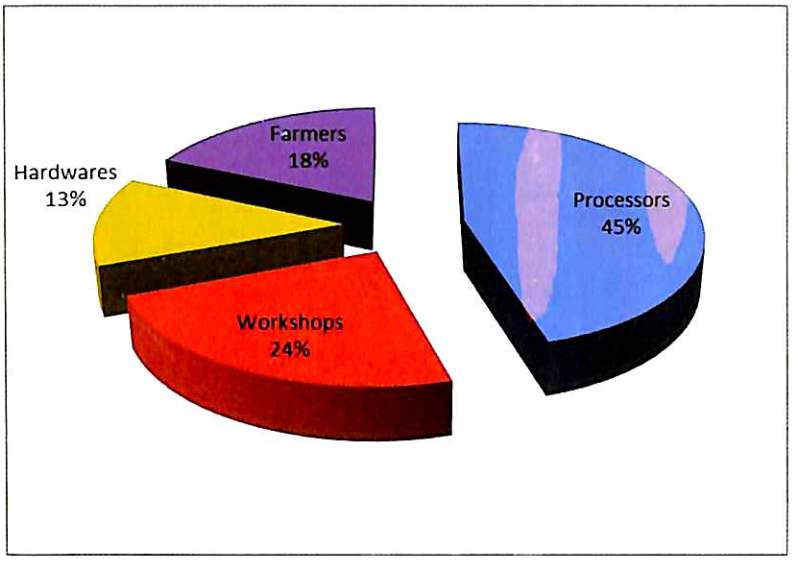

Figure 26: Melia timber market segments

Respondents observed that there was a bright future for the Melia enterprise based on the following factors: fast rate of planting (56.7%) especially in Makueni and Kitui, viability of the enterprise (30%) and increasing number of demonstration plots in various areas for awareness creation and training purposes. Timber yards and hardware stores were the only outlets involved in the selling of Melia timber. The timber size of high demand was sizes 6"x1" and 4"x 2". They were purchased from farmers (Table 13) at a price of Ksh 44 and Ksh 48 per feet respectively and sold to the wood workshops at a price of Ksh 48 and Ksh 56 per feet respectively.

Table 13: Pricing of timber by size

Timber size	Timber pricing (Ksh)			
	Buying Price		Selling Price	
	N	Mean	N	Mean
12x1	1	80		
10x1	1	60		
8x1	26	54	9	67
6x1	46	44	13	48
4x2	46	48	12	56
4x1	1	50	1	55
3x2	29	40	6	54
3x3	16	43	8	46
2x2	25	32	7	35

Other Melia products which were purchased and sold on small scale were offcuts and shorts. Offcuts were measured in pieces or tones fetching Ksh 20 per piece or Ksh 1,200 per ton. The shorts were measured in pieces which were bought at between Ksh 50 and Ksh 100. The average distance to the nearest market in all the study areas was 19 km. The range was higher in Kitui and Makueni where Melia timber was sourced up to a maximum of 100 km away. Transport costs were averaged at Ksh 3 per foot and were mainly influenced by distance, mode of transport, and timber size. It was more expensive to transport timber in Mbeere and Makueni at about Ksh 4 per feet where the main mode of transport was by vehicle. It was cheaper to transport timber in Kitui at Ksh 1 per foot where there was a wide range of means of transport to select from. Timber was transported using oxen cart (8.6%), motorcycle (35.7%), pick-up trucks (21.49%), bicycle (21.4%), lorry 4.3%), tractor (2.9%) and public service vehicles (5.7%).

4.3.3 Secondary value addition

Value addition processes for Melia timber included furniture production (37.8%), Timber molding (24.4%), timber planning (18.1%), timber seasoning (11.0%) and wood carving (5.5%). Other value addition processes were; timber sawing and re-sawing, and timber preservation. Some of the furniture products (Photograph 8) include coffee tables, stools, beds, doors, frames, cupboards, wall units, side boards. The prices for the various items ranged between Ksh 377 – Ksh 35,000 (Table 14).

Table 14: Pricing of furniture made from Melia

Item	N	Minimum	Maximum	Mean
Ordinary stool 1x1	3	250	500	377
Door frame	4	500	1,400	975
Ordinary table 4x2	2	2,500	3,000	2,750
Coffee table 20" x 4'	8	25,000	4,500	3,250
T-door	2	2,500	4,500	3,500
Bed size 3x6	7	3,000	6,500.	4,071
Bed size 4x6	5	4,000	9,500	5,700
Panel door	1	6,000	6,000	6,000
Bed size 5x6	3	6,000	9,000	7,167
Bed size 6x6	3	6,500	8,500	7,500
1 set of arm chairs	2	7,000	8,000	7,500
Side board 5 x 20	1	9,000	9,000	9,000
Cupboard 4x6	2	12,000	20,000	16,000
Wall unit	4	15,000	20,000	17,250
Dining set	2	15,000	35,000	25,000
Wall unit 6 x 6	2	30,000	40,000	35,000

Photograph 8: Melia timber Furniture: arm chairs (left) and Bed (right)

5.0 DYNAMICS IN MELIA VOLKENSII ENTERPRISES

5.1 Types and status of Melia enterprises

There were four Melia product-based enterprises namely: seeds, seedlings, round wood and timber. The seed and seedlings enterprises structure were under development with three players (seed collectors, seed vendors and consumers) in its market value chain while the timber enterprise had four players (producers, processors, merchants and consumers) (Figure 27). Key benefits generated from the four Melia enterprises were income from sales of Melia fruits, seedlings, round wood and timber. The other benefits included: off cuts, poles, saw dust, firewood mainly used for domestic purposes. Some of the costs associated with the four enterprises include: seed collection, seedling production, tools, labor, land preparation, pitting, planting, fencing, harvesting and processing, transport, intercropping and security.

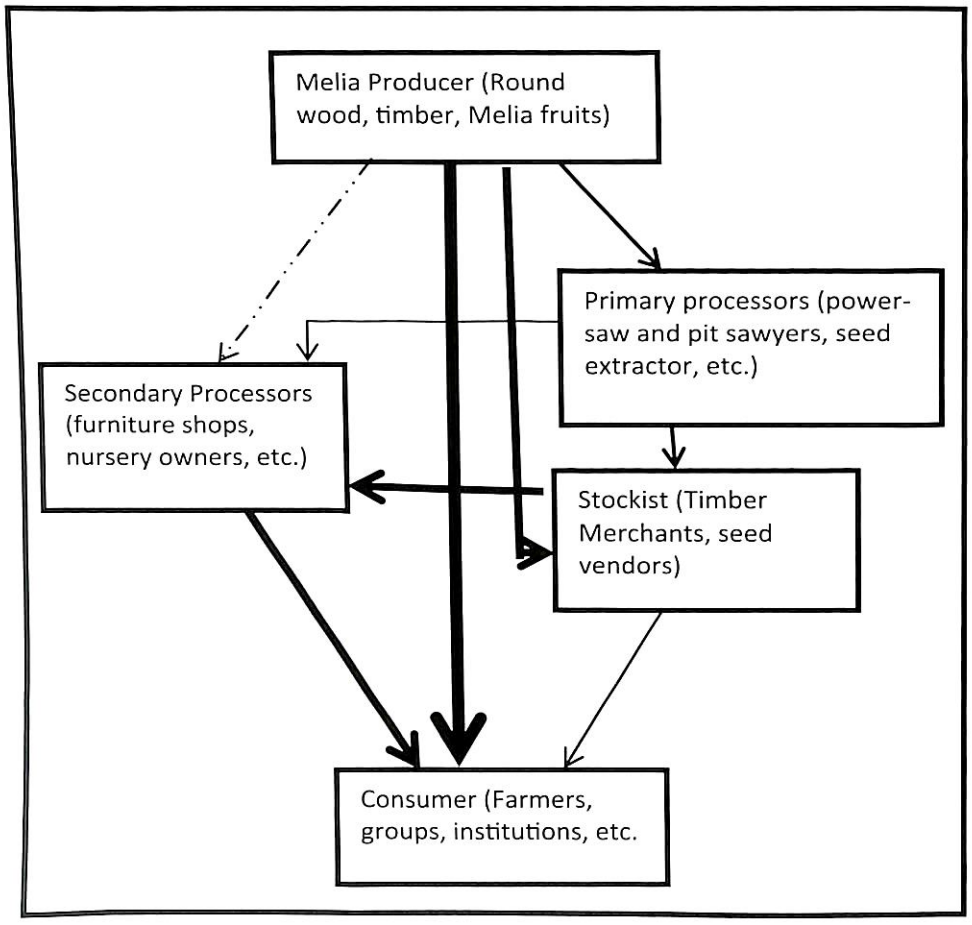

Figure 27: A generalized Melia products market chain

5.2 Cost benefits analysis of Seedling production and distribution

Cost benefit analysis was done for seedlings over a six year period. The seed enterprise was poorly developed and at its infancy stage in all the counties as most of the players played more than one role i.e. vertical integration. This could be attributed to the fact that most of the respondents were not collecting seeds for sale but for own use. The seed collectors and vendors were able to place a value on costs incurred in the process of seed collection and vending such as transport and labor costs. Most of the seed collectors were selling Melia fruits to the prospective buyers who extracted the seed for their own nurseries and/or selling to other nursery operators.

In the nursery enterprise, 50% of the cost was attributed to seed extraction related to cost of nut cracker and labor (Table 15). Most of the other cost items were less than 10% of the total cost. The only benefit for the seedling enterprise was gained from seedling sales and for calculation of the cost benefits analysis; a total of Ksh 235,193 was realized for a nursery with an annual Melia seedlings capacity of 5,731 seedlings. Kitui was the leading county in seedlings production at 9,592 Melia seedlings per annum per nursery. Average production was 3,550, 1,283 and 820 seedlings for Makueni, Taita Taveta and Embu counties respectively. The seedlings were sold at an average price of Ksh 44. The high cost of Melia seed extraction contributes to the high seedling prices at the nursery compared to other tree seedlings. Cost benefit ratios for Melia seed enterprise were 4.3 at 10%; 4.25 at 15% (NPV = Ksh. 2,922,080) and 4.19 at 20%. For Melia seedling enterprises, the cost benefit ratios were 1.88 at 10%; 1.87 at 15% (NPV = Ksh. 525,041) and 1.867 at 20% showing that it was economically viable to engage in Melia seedling production (Appendix 1 and 2).

Table 15: Cost implication in seedling enterprise

Cost items	**Cost (Ksh)**	**% of total cost**
Nut cracker	12,750	8.9
Labor cost on seed extraction cost	59,389	41.3
Germination propagators' total cost	4,290	3.0
Melia nuts cost	4250	3.0
Fungicide cost	1,336	0.9
Cost of polythene bags	4,401	3.1
Nursery Soil cost per year	11,934	8.3
Cost of nursery tools	7,069	4.9
Wages for nursery attendants	13,430	9.3
Security Cost	4,592	3.2
Miscellaneous costs	9,029	6.3
Watering/year.	11,467	8.0
Total cost	**143,936**	**100.0**

The Melia seed and seedling enterprises were economically viable to communities in the drylands because of the following:

- Melia had the potential to improve livelihood of farmers in the drylands through income generation (26%).
- Melia as a major source of hardwood in drylands with great potential for timber production in the dryland communities (15%).
- Melia well adaptable to the drylands (7%)
- Melia being important for environmental conservation (7%)

5.3 *Cost benefits analysis of Melia round-wood and timber enterprises*

Two wood-based enterprises were considered namely Melia round wood and timber. At farm level, the farmer could sell the Melia tree as round wood or convert it to timber for domestic use or sale. To enhance growth performance of the trees, most farmers intercropped the trees with various agricultural crops. Routine crop tending alongside the trees for the first six years helped to reduce the tree maintenance costs thus enhancing profitability of tree enterprises. Cost benefit analysis was undertaken based on one hectare land size and using discount rates of 10%, 15% and 20% to assess the financial viability of Melia round wood and timber enterprises.

The cost associated with round wood and timber enterprises considered in the analysis were; weeding, intercropping and pruning. Cost benefit ratio results were 1.65 at 10%; 1.12 at 15% (NPV = Ksh. 32,605) and 0.79 at 20% for Melia round wood. For timber enterprise, the ratios were 2.56 at 10%; 1.90 at 15% (NPV = Ksh. 293,100) and 1.39 at 20%. The annuity returns were Ksh 16,065 at 10%; Ksh 2,717 at 15%, and Ksh. 4,599 at 20% for round wood. For timber, the annuity returns were Ksh 51,392 at 10%; Ksh 24,425 at 15% and Ksh 9, 331 at 20% over a period of 12 years (Table 16, Appendices 3 and 4). Most of the costs were incurred at the enterprise establishment stage. This implies that the enterprises are more economically viable at a lower interest rate and on large scale.

Table 16: Melia timber enterprise benefit and costs

		Round-wood	%	Timber	% Total
Benefits	Timber	1,323,500		2,835,400	
	Offcuts			100,000	
	Intercrop	82,200		82,200	
	Total	1,425,700		3,017,700	
Cost	Land preparation	12,313	3.5	12,313	0.8
	Pitting	18,750	5.3	18,750	1.2
	Seedlings	25,000	7.1	25,000	1.6
	Fertilizer or manure	17,500	4.9	17,604	1.1
	planting	5,000	1.4	5,000	0.3
	Intercrop	45,500	12.8	45,500	2.9
	Weeding	109,375	30.9	90,625	5.8
	Pruning	53,438	15.1	44,888	2.9
	Processing			1,012,500	64.8
	Transport			222,758	14.3
	Fencing	35,000	9.9	34,722	2.2
	Misc.	32,500	9.2	32,500	2.1
	Total	354,375	100.0	1,562,151	100.0
Gross Margin		**1,071,325**		**1,455,549**	

6.0 CHALLENGES AND STRATEGIES IN THE MELIA ENTERPRISE DEVELOPMENT

Challenges faced in development of Melia enterprise were technical, social, economic and environmental in nature and respondents proposed various strategies to address the problems.

6.1 Seed and seedlings enterprise

The challenges facing the Melia seeds and seedlings enterprises were mainly technical and economical (Table 17).

Table 17: Problems facing the Melia seeds and seedlings enterprise

Enterprise	Challenge	Strategy
Melia seed	Limited skills and difficulties in seed extraction and propagation	Avail skills and knowledge on Melia seed collection, extraction and propagation
	Long distance to market centers	Use integrated transport system
	Farmers' limited financial resources	Source of income from sale of Melia fruits/seeds
	Delayed payment for Melia fruits/nuts/seeds, low prices offered for Melia fruits and Lack of market	Create awareness on the importance of Melia seeds to farmers, train seed collectors on nut cracking for seed extraction and create a forum for collectors and potential buyers to meet
	Long distance to Melia fruits collection sites and high cost of seed collecction.	On-farm planting of Melia trees for future use as sources of seeds and Conserve existing Melia trees for seed production and providing seed collectors with seed extraction tools/ equipment
	Very few Melia trees in the farms for fruit and seed production	Melia plantations establishment
	Lack of appropriate Melia seed extraction technology	Use local seed extraction technologies

Melia seedlings	Lack of established markets	Seek alternative outlets for Melia seedlings
	Lack /high costs of transport	Use the available means of transport
	Lack of knowledge and skills on Melia seed extraction and propagation and nursery management	Provide technical support
	In adequate quality seeds for nursery establishment and high costs of transportation of Melia seedlings	Enhance on-farm growing of *M. volkensii* for seeds production while promoting soil and water conservation and creating employment opportunities
	Poor quality seeds /Infection of Melia fruit/nuts/seeds.	Technical support
	Droughts and lack of adequate water for nursery use	Melia require very minimal watering in the nursery thus the low cost
Melia seed and seedlings marketing	Unsecure land ownership system (for siting group nurseries)	Adopt model farmer approach and use available land for planting Melia
	Lack of reliable market for Melia seeds/fruits/nuts/ seedlings	Link farmers to the Melia seeds market
	High cost of Melia seed collection and seedlings production	Make use of local labor force and technologies
	Lack of coordination in marketing of Melia seedlings among nursery operators	Technical support from institutions/ organizations such as KEFRI and other stakeholders
	Melia seeds are susceptible to fungal and other infections	Provide technical support services

6.2 *Melia round-wood and timber enterprise*

The problems faced in the development of the Melia round-wood and timber enterprise were mainly technical and economical (Table 18).

Table 18: Challenges facing the Melia round-wood and timber enterprise

Enterprise	Challenge	Strategy
Melia production	High costs of production	Enhance farmer's entrepreneurial skills
	Poor management skills	Encourage Melia tree planting through training on propagation, establishment and management
	Lack of seedlings	Provision of cheap seedlings
	Lack of information on the importance of Melia species	Invest in information dissemination
	High processing and transaction costs	Processing of round wood on site to boost income
	High cost of seedlings, tending and protection	Invest in mass production of Melia seedlings
	Lack of investment capital	Link to credit providers
	Damage by livestock	Invest in protection
	Un-reliable rainfall	Timely planting
Timber processing	Insufficient supply of Melia round wood	Melia timber from other areas and switching to alternative timber species
	Difficulties in accessing movement permits and authority to harvest on-farm trees	Create Association/Co-operative
	High cost of raw materials	Encourage domestication of Melia species
	Lack of appropriate technology	Provide information on available technologies
	Lack of market information	Provide information on markets
	Limited financial resources	Link to credit providers

Timber marketing	Short supply of timber	Sourcing of Melia timber from other areas
	Poor quality of timber	Training in silvi-cultural management skills
	High prices	Use of alternative timber species
	High transport costs	Encourage planting of Melia trees on the farms
	Lack of skills in production, processing and marketing	Enhance farmer training and awareness creation

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusion

The study revealed that Melia seed, seedling, round wood and timber enterprises are important alternative on-farm enterprises in Makueni and Kitui counties as attested by the high level of Melia planting at 1,769 and 519 trees per farm respectively. Despite the low rate of Melia technology uptake by the farmers especially in Taita Taveta (53) and Embu (123 trees), the stakeholders generally agree that *M. volkensii* enterprises have a great potential to improve the livelihoods of the dryland communities. Results of the Melia market chain analysis show that the market players continue to derive their livelihood from these enterprises. There is therefore need to promote on-farm growing of Melia in order to enhance income diversification in the dry lands and ensure food security. Drylands are wood deficit areas according MEW&NR, (2013) and Melia is likely to bost timber self-sufficiency in the long run. Farmers recognize the adaptability, fast growth, high quality timber and financial viability of Melia enterprises in the drylands as compared to other competing tree species. Apart from income generation and creation of employment opportunities, on-farm growing of Melia has the potential to attract financial benefits from carbon trade and improve tree cover to 10% as stipulated in the Constitution of Kenya 2010 and Vision 2030. Results of the study showed that it is economically viable for farmers to invest in Melia enterprise based on cost benefit ratios i.e. Melia seeds (4.25), seedlings (1.87), round wood (1.12) and timber (1.90) calculated at 15% interest rate.

7.2 Recommendations

It is recommended that:

- ***Capacity building:*** KEFRI and other development agencies need to build the capacities of key stakeholders on Melia seed collection, extraction, handling, seed pre-treatment and propagation, nursery operation, integrated pest management and cost effective harvesting and processing. It is important to train seed collectors on timely seed collection of mature and viable seeds. Nursery owners should be trained on business skills and marketing of seedlings to enable them generate better incomes. Such training should empower farmers interested in Melia enterprises to develop business plans to seek capital from the government and Non-Governmental organizations
- ***Melia information dissemination:*** There is need to undertake timely dissemination of information on Melia seed and seedling management, spacing, thinning and pruning regimes to enable farmers get good quality timber at the end of the rotation period. Information can be disseminated through print and electronic media, field days, study tours demonstration plots, community meeting with chiefs (barazas), ASK shows and open days especially in Taita Taveta, Embu counties and Mwingi in Kitui County.
- ***Incentive measures:*** Appropriate incentive measures need to be formulated

to encourage adoption of Melia planting in the drylands: Competitive prize awards schemes, sponsored farmer study tours, formation of Melia advocacy groups e.g. Miss Melia initiative, etc.

- ***Technical support:*** Given that the demand for Melia products is very high, there is need to scale up seedling production through technical support to nursery operators and individual farmers.
- ***Efficient technology:*** As the cost of Melia seed extractor remains high and the nursery operators continued to use of inefficient traditional methods of seed extraction tools such as knives and wooden boards, seed vendors should be encouraged to invest in this technology.
- ***Melia Producer Association:*** To enable development of Melia enterprises in the dry lands, there is need for farmers to form producer cooperatives or associations that will spearhead extensive plantation establishment and marketing of Melia products. Formation of Melia commodity interest groups (CIGs) can enhance commercialization of Melia seed and seedling enterprise. Development partners can strengthen farmers' nurseries to enable them access new markets for their seedlings. The cooperatives' or CIGs approach will enable farmers to bulk and process sawn timber and negotiate for better prices than selling their trees as round wood at low prices.
- ***Collaboration and Networking:*** KEFRI needs to strengthen its networks and collaborate with other institutions such as the Ministry of Agriculture, KFS and other government and Non-governmental organizations in enhancing on-farm adoption of Melia tree nurseries and plantations.
- ***Melia guidelines:*** Following the establishment of good quality seed sources such as those started by KEFRI/JICA Melia project in Kitui and Kibwezi, farmers will be able to access high quality Melia seeds in the future. To achieve this objective it is important to develop guidelines which can be used by farmers to invest in the Melia enterprise.
- **Emerging enterprises**: Research should be expanded to explore and develop emerging enterprises in the Melia value chain. Such enterprises include – bio-pesticide production, livestock feed, bio-energy production form nut shells.
- **Melia resource Mapping**: Mapping of the whole country to identify newer areas for promotion of Melia should be carried out.

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APPENDICES

Appendix 1: Cost benefit analysis for the Melia Seed enterprise (6 year period)

Item	Operation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Benefits	Seedlings sales	948,120	948,120	948,120	948,120	948,120	948,120	948,120
	Discount factor (15%)	1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323
	Present value of benefit	948,120	824,485	716,874	623,389	542,135	471,405	409,872
	Cumulative PV of benefits	235,193	1,059,678	1,776,552	2,399,941	2,942,076	3,413,481	3,823,353
Costs	Nut cracker	12,750						
	Purchase of Melia fruits	66,844	66,844	66,844	66,844	66,844	66,844	66,844
	De-pulping	16,711	16,711	16,711	16,711	16,711	16,711	16,711
	Labor cost in seed extraction	94,000	94,000	94,000	94,000	94,000	94,000	94,000
	Transport cost	22,560	22,560	22,560	22,560	22,560	22,560	22,560
	Total cost	212,866	200,116	200,116	200,116	200,116	200,116	200,116
	Discount factor (15%)	1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323
	Present value of benefit	212,866	174,020	151,307	131,576	114,426	99,497	86,510
	Cumulative PV of benefits	143,936	317,956	469,264	600,840	715,266	814,763	901,273

C-b ratio =	Cumulated PV benefits/Cumulated PV Costs				=	3,823,353/815,895	4.24
Profit =	Cumulated PV benefits - Cumulated PV Costs				=	3,823,353-815,895	2,922,080
Annuity =	3,007,458/6	=	487,013	p.a.	=	40,584 P.m.	

Appendix 2: Cost benefit analysis for the nursery enterprise (6 years period)

Item	Operation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Benefits	Seedlings sales	235193	235193	235193	235193	235193	235193	235193
	Discount factor (15%)	1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323
	Present value of benefit	235,193	204,524	177,829	154,639	134,483	116,938	101,674
	Cumulative PV of benefits	235,193	439,717	617,546	772,186	906,669	1,023,607	1,125,281
Costs	Nut cracker	12750						
	Germination propagators' total cost	4290			4290			
	Melia nuts cost	4250	4250	4250	4250	4250	4250	4250
	Fungicide cost	1336	1336	1336	1336	1336	1336	1336
	Cost of poly-tubes	4401	4401	4401	4401	4401	4401	4401
	Nursery Soil cost per year	11934	11934	11934	11934	11934	11934	11934
	Cost of nursery tools	7069						
	Payment cost for nursery attendants	13430	13430	13430	13430	13430	13430	13430
	Seed extraction cost	59389	59389	59389	59389	59389	59389	59389
	Security Cost	4592	4592	4592	4592	4592	4592	4592
	Miscellaneous costs	9029	9029	9029	9029	9029	9029	9029
	Water/yr.	11467	11467	11467	11467	11467	11467	11467
	Total cost	143936	119826	119826	124117	119826	119826	119826
	Discount factor (15%)	1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323
	Present value of costs	143936	104201	90601	81607	68517	59578	51801
	Cumulative PV of cost	143936	248137	338738	420344	488861	548439	600240

Cost benefit ratio =	Cumulated PV benefits/Cumulated PV Costs	=	1125281/600240	=	**1.87**	
Profit =	Cumulated PV benefits - Cumulated PV Costs	=	1125281-600240	=	525041	
Annuity =	525041/6 =	87507 p.a.	=	7292.236 P.m.		

Appendix 3: Cost benefit analysis on 1 ha Melia round wood (12 years period)

Item	Operation	Unit Cost	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Benefits	Round wood	-	-	-	-	-	-	-	-	-	-	-	-	-	1,323,500
	Intercrop	8,220	20,550	16,440	12,330	8,220	8,220	8,220	8,220	-	-	-	-	-	-
	Total benefits	8,220	20,550	16,440	12,330	8,220	8,220	8,220	8,220	-	-	-	-	-	1,323,500
	Discount factors		1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323	0.3759	0.3269	0.2843	0.2472	0.2149	0.1869
	Present value of benefit		20,550	14,296	9,323	5,405	4,700	4,087	3,554	-	-	-	-	-	247,362
	Cumulative PV of benefits		20,550	34,846	44,169	49,574	54,274	58,361	61,914	61,914	61,914	61,914	61,914	61,914	309,276
Cost	land preparation	4,925	12,313												
	Pitting	30	18,750												
	Seedlings	40	25,000												
	Fertilizer or manure	28	17,500												
	planting	8	5,000												
	Intercrop	2,600	6,500	6,500	6,500	6,500	6,500	6,500	6,500						
	Weeding	25	15,625	15,625	15,625	15,625	15,625	15,625	15,625						
	Pruning	17	10,688	10,688	10,688	10,688	10,688								
	Fencing	56	35,000												
	Misc.	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
	Total Costs		148,875	35,313	35,313	35,313	35,313	24,625	24,625	2,500	2,500	2,500	2,500	2,500	2,500
	Discount factor		1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323	0.3759	0.3269	0.2843	0.2472	0.2149	0.1869
	Present value of cost		148,875	30,708	26,700	23,218	20,192	12,244	10,645	940	817	711	618	537	467
	Cumulative PV of cost		148,875	179,583	206,283	229,501	249,692	261,936	272,581	273,521	274,338	275,049	275,667	276,204	276,671
	Cost benefit ratio	=	Cumulated PV benefits/Cumulated PV cost					=	309276/276671		=	**1.12**			
	Profit	=	309276 - 276671		=	32,605									
	Annuity from round wood	=	32185/12		=	2,717									

Appendix 4: Cost benefit analysis for 1 Ha Melia Timber enterprise

Item	Operation	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Benefits	Timber	-	-	-	-	-	-	-	-	-	-	-	-	2,835,500
	Offcuts	-	-	-	-	-	-	-	-	-	-	-	-	100,000
	Intercrop	20,550	16,440	12,330	8,220	8,220	8,220	8,220	-	-	-	-	-	-
	Total benefits	20,550	16,440	12,330	8,220	8,220	8,220	8,220	-	-	-	-	-	2,935,500
	Discount factor (15%)	1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323	0.3759	0.3269	0.2843	0.2472	0.2149	0.1869
	Present value of benefit	20,550	14,296	9,323	5,405	4,700	4,087	3,554	-	-	-	-	-	548,645
	Cumulative PV of benefits	29,550	43,846	53,169	58,574	63,274	67,361	70,914	70,914	70,914	70,914	70,914	70,914	619,559
Cost	land preparation	12,313												
	Pitting	18,750												
	Seedlings	25,000												
	Fertilizer or manure	17,604												
	planting	-												
	Intercrop	6,500	6,500	6,500	6,500	6,500	6,500	6,500						
	Weeding	15,625	12,500	12,500	12,500	12,500	12,500	12,500						
	Pruning	10,688	8,550	8,550	8,550	8,550								
	Processing													90,000
	Transport													300,000
	Fencing	34,722												
	Misc.	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
	Total cost	143,701	30,050	30,050	30,050	30,050	21,500	21,500	2,500	2,500	2,500	2,500	2,500	392,500
	Discount factor (15%)	1	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323	0.3759	0.3269	0.2843	0.2472	0.2149	0.1869
	Present value of cost	143,701	26,131	22,721	19,758	17,183	10,690	9,294	940	817	711	618	537	73,358
	Cumulative PV of cost	143,701	169,832	192,553	212,311	229,494	240,184	249,478	250,418	251,235	251,946	252,564	253,101	326,459
	Cost benefit ratio =	Cumulated PV benefits/Cumulated PV Costs				=	619559/326459		=	1.90				
	Profit =	Cumulated PV benefits - Cumulated PV Costs				=	615,821 - 326459		=	293,100				
	Annuity =	293100/12	=	24,425										

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