

Full Length Research Paper

Economic viability of *Melia volkensii* (Gurkii) production on smallholdings in drylands of Kenya

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Abstract

The *Melia* (*Melia volkensii*, Gurkii) was being promoted in the drylands of Kenya as a source of wood biomass for domestic and commercial purposes. However, little was known about its profitability in smallholder production systems. This study established economic viability of *Melia* using net present value (NPV) and annual equivalent value (AEV) on data collected from 92 smallholder farmers and 20 processors/traders in four drylands districts of Kenya. Results showed that one hectare (ha) under *Melia* required an investment of US\$ 15,586 (discounted to 2010 prices) for a 10 year rotation cycle, covering tree establishment to timber production. Harvesting and processing jointly done together were the most expensive operations, contributing about 85% i.e US\$ 13,184 of total cost. Fencing, commonly done using tree branches, was the least expensive operation (0.1% of total cost). Profitability of *Melia* depended on extent of integration into existing farming systems, market outlets and level of value adding. The highest profitability was achieved when intercropped with green grams at initial stages of establishment accompanied with value adding into timber. In this situation, one ha of *Melia* stand gave NPV of US\$ 15,128 translating to a discounted annual profit margin of US\$ 2,055 for 10 years. Comparatively, profitability of *Melia* was higher than *Eucalyptus camaldulensis* and *Grevillea robusta* in a similar environment. Although *Melia* had economic and ecological benefits in drylands, product value addition was a prerequisite to realizing good returns.

Keywords: Annual equivalent values, costs, drylands, economics, *Melia*, net present value.

INTRODUCTION

The drylands which cover over 80% of Kenya's land mass are difficult environments prone to vagaries of nature. Livelihood options are limiting and crop production is risky making food insecurity and poverty rampant. Estimates on poverty indicate that level of poverty and especially spread of food insecurity in the drylands is enormous. Incidences of poverty are pronounced in the drylands with an average of 65% of the drylands population living below the poverty line compared to the national average of 26% (Thornton *et al.*, 2002; Barrow and Mogaka, 2007).

In trying to achieve their economic ends the communities in the drylands were observed to be engaged

in different farm activities (Jayne *et al.*, 1998). Among the farm activities were the growing of crops and trees to supplement returns from the main rangeland activities like livestock rearing (GoK, 1986; ETC, 1996; Jayne *et al.*, 1998). The crops grown were wide and varied depending on the need and preference of the farmer. Common trees under production were the *Mangifera indica* (Mango) and *Melia volkensii* (*Melia*) valued for fruit and hardwood timber production, respectively.

The *Melia* is one of the indigenous timber species in drylands. It naturally occurs in eastern, north eastern and coast provinces of Kenya. It is able to grow as tall as 30m depending on rainfall, altitude and soil types (Mulatya and Misenya, 2004). Although there are other dryland species, which have been developed and extended in various planting programmes such as *Eucalyptus*, *Grivillea*, *Senna* and *Leuceana* over a longer period, studies rate *Melia* as

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among the best (Kidundo, 1997; Mulatya *et al.*, 2002).

The worthiness of *Melia* stems from its growth characteristics and uses. Mulatya *et al.* (2002) noted that *Melia* has fast growth and exerts minimal competition to crops. Under good management, the tree could be harvested from as early as at 5 years of age as poles and fodder as well as firewood. From 10 years of age, its log can be sawn into high quality timber for quality furniture making as well as construction (Kidundo, 1997; Mulatya *et al.*, 2002). The *Melia* too has other uses including wood carving, fuelwood, fodder (fruit and leaves), medicine (bark), bee forage, mulch and green leaf manure (Stewart and Blomley, 1994; Mulatya and Misenya, 2004). Mulatya and Misenya, 2004 observed that the dark heartwood of *Melia* compares favourably with highly prized hardwood species of Camphor (*Ocotea usambariensis*) and Meru oak (*Vitex keniensis*). Its wood is durable and termite resistant and is suitable for making acoustic drums, containers, mortars, door and window frames, and door shutter rafters and poles (Mulatya and Misenya, 2004).

Although growing of *Melia* by smallholders in the drylands was on the increase, little was known on its desirability and economic efficiency at farm household level. As rational producers, farmers tend to opt for those options that increase and or diversify food and cash income generation on their farms. Observations by World Bank (1987) showed that the rational choice for a household as a whole is to grow crops and trees in order to maximize income generation with which to satisfy its overall needs. This thesis raises a number of pertinent questions on desirability and economic suitability of *Melia* in the farmers' context that require empirical investigation. Socio-economic studies done had concentrated on gathering information on farmers' knowledge and practices about *Melia* growing and use in their fields (Stewart and Blomley, 1994; Kidundo, 1997; Mulatya and Misenya, 2004). However, little empirical evidence was presented on economic viability of *Melia*. Little was known on financial implication of *Melia* production on the farm. Quantification of the necessary inputs and their costs, and returns from *Melia* production was not sufficient. Furthermore, how *Melia* compares with other timber woodlot tree species had not been systematically quantified. This study, therefore, explored these issues to generate empirical evidence on economic efficiency of *Melia* production by smallholders who are food insecure and resource poor. It was, therefore, hypothesized that production of *Melia* on smallholdings was economically un-viable limiting its promotion. The key objective pursued was to determine economic viability of *Melia* production on smallholdings in the drylands.

MATERIALS AND METHODS

Selection of study sites

The study covered Embu, Makueni, Kitui, and Tharaka-

Nithi Counties in the Eastern Kenya Drylands. Multistage sampling procedures were used in the selection of the study sites. The selection of sample units was based on the concentration of *Melia* production on smallholdings. The tree was concentrated mostly in the lower and drier parts of the counties. The farm holdings within *Melia* production zones were relatively larger averaging 15 areas. The farms were mostly utilized for crop production, as pastureland and tree production. On average more land was used as pastureland with small area under crop and tree cultivation. The districts with high concentration of *Melia* that were selected for the study included Mbeere, Kibwezi, Kitui South and Tharaka in Embu, Makueni, Kitui, and Tharaka-Nithi Counties, respectively.

Sample selection and size

With the assistance of local administration and extension officers a list of smallholders involved in *Melia* production was compiled. Random numbers were then applied to randomly select 92 smallholders involved in *Melia* production who were surveyed in 2010. Information on traders involved in the business of *Melia* products was not readily available and sequential sampling was applied in their selection for the interviews. *Melia* producers were able to give information on traders and sawyers who were then requested for the interviews. It was observed that *Melia* products traders and sawyers who were not many operated mostly in local trading centers scattered all over production points. In total 20 traders and sawyers were interviewed with an average of one to two traders and sawyer per centre.

Data collection methods

Two sets of semi-structured questionnaires were developed and administered through personal interviews to smallholders and traders in the target sites. Smallholders gave information on number of *Melia* trees planted, cost of *Melia* production, and quantities of benefits including their sales and pricing. Timber sawyers, on the other hand, provided information on pricing of sawlogs/standing trees, costs of sawing timber and products prices. *Melia* products traders too gave information on their products sources, quantities handled per unit time, pricing, and demand conditions. Researchers and extensionists acted as sources of information on tree planting programmes and level of organization of different players in the industry.

Data analysis

To determine the economic potential of *Melia* production at different stages of growth and in different farming systems, cost-benefit approach was used. In addition, Ordinary

Table 1. Operations and their cost implication in Melia production on 1 ha

Operation	Total cost (US\$)*
Seedlings	156
Land preparation	230
Pitting	155
Planting	30
Fencing (tree branches)	19
Weeding	62
Pruning/yr	100
Patrolling/security	453
Harvesting and processing	13,184
Timber transport to market	516
Land rental fee	647
Depreciation & maintenance	32

Least Squares (OLS) method was applied to establish relationships between variables. Collected data was compiled and analyzed using excel spreadsheet package. Simple correlations and means were used to clean the data for final analysis. To achieve the study objectives averages of key variables were computed. In cases where it was possible comparisons of means between districts were carried out.

The concept of opportunity cost was used in the quantification of the costs. Cost is viewed as a measure of what must be given up to get something by way of production or purchase. The value of what must be given up is considered as the opportunity cost Nicholson, 1991. Shadow prices for the inputs were applied. Net Present Value (NPV) and Annual Equivalent Value (AEV) were then used to carry out financial investment analysis. The Net Present Value is the present value of all benefits (revenues) less the present value of costs. For ease of comparison, all financial figures were expressed in the US\$ where US\$ 1 = KES 80 at time of data collection.

Mathematically this is expressed as: n

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

Where B_t is benefit in each year, C_t is cost in each year, t is time period, n is the rotation period and r is the discount rate.

The annual equivalent value (AEV) combines all costs and benefits into a single sum that is equivalent to all cash flows during an analysis period spread uniformly over the period. It is an annual payment that will pay off the NPV of an asset during its lifetime i.e.

$$AEV = NPV \cdot \frac{r(1+r)^t}{[(1+r)^t - 1]}$$

RESULTS AND DISCUSSION

Cost components and benefits in Melia production

The Melia production operations on smallholdings included

seedlings acquisition, land preparation, pitting, planting and fencing off the planted area. Others included weeding, pruning, patrolling, harvesting, sawing and transportation of materials and products to the market. In total 1 ha Melia woodlot required an investment of US\$ 15,585 discounted to 2010 prices for a 10-year rotation cycle which covers tree establishment to sawing into timber. Harvesting and processing jointly done together were the most expensive operations in Melia production making about 85% of the total cost compared with land rent and transportation cost for products to the market, which were second and third in ranking contributing 4.2% and 3.3% of total cost, respectively (Table 1). The operation with the least cost was fencing which was commonly done using tree branches contributing a paltry 0.1% of the total cost. The other operations with least costs were planting of Melia seedlings, and depreciation and maintenance cost for equipment and tools used contributing 0.2% of total cost.

The harvesting and processing involved felling and sawing of mature Melia trees into timber. The two costs were variable depending on location and whether one was using hired sawing services or otherwise. As a common practice, trees were felled and sawn into timber as a joint operation using hired chain saw services. In very few incidences, producers fell trees and split them into timber using own chain saw facilities. Comparatively, using own sawing facilities was less costly than hired ones. The cost for splitting timber using own facilities was lower than that of using hired chain saw services by 25% (Table 2). Within different sites, the cost for sawing timber using hired services was highest in Kibwezi District and least in Mbeere (Table 2). Equally, the costs of splitting timber using own facilities were variable in the districts with highest registered in Kibwezi and least in Tharaka.

The key products derived from Melia woodlots include timber, poles, posts, and saw logs. Others are by-products during timber processing and included off-cuts, sawdust, firewood and leafy parts used as fodder for livestock. The Melia trees were split into timber of different sizes. The Melia timber was sawn into small sized planks, which were

Table 2. Cost of sawing timber using chain saw

District	Sawing costs (US\$/m ³)	
	Hired	Own
Kitui	76.3	58.5
Mbeere	74.2	60.6
Tharaka	77.3	47.9
Kibwezi	77.4	60.8
Mean	76.3	56.9

Table 3. Profitability (NPV and AEV) for Melia planted under different integration arrangements

Integration arrangement	Net Present Value (NPV) in US\$	Annual Equivalent Value (AEV) in US\$
Intercropped Melia with products sold at farmgate	9,980	1,356
Intercropped Melia with products sold at local centre	15,128	2,055
Pure Melia woodlot with products sold at farmgate	6,319	859
Pure Melia woodlot with products sold at local centre	11,468	1,558
Intercropped Melia sold as standing trees	3,467	471
Pure Melia woodlot sold as standing trees	2,632	358

popular in furniture making. However, other timber sizes were split too depending on size of the tree. The production and marketing of Melia poles and posts was minimal in the districts. Only a small number of posts and poles was sold in local centres by timber dealers. Others were sold through the farm gate and roadsides. Posts commonly marketed were those for fencing and construction.

Profitability of Melia production on smallholdings

Profitability of Melia on smallholdings depended on level of integration into existing farming systems, market outlets and whether sold as value added products. The highest profitability was when Melia was intercropped with green grams at initial stages of establishment and sold off as sawn timber in local markets. When intercropped with green grams and its products sold in local markets, Melia had a net present value (NPV) US\$ 15,128 at a ten-year rotational period (Table 3). The least profits were realized when Melia was sold off as standing trees.

Among the districts, average profit margins for Melia were highest in Kibwezi (US\$ 9,131) and Kitui (US\$ 8,623) as in Table 4. Kibwezi District had highest margins when Melia was produced as an intercrop in a ten-year rotational period with its products sold in a local centre. The least profit margins were realized in Mbeere District when Melia was sold off as standing tree.

Comparative Financial Competitiveness of Melia Production on Smallholdings

At all levels of integrating trees into the existing farming

systems, Melia had comparatively higher levels of profitability than other woodlot species. Just like Melia, other woodlot tree species had highest profitability when the tree was produced as an intercrop with green grams at initial stages of establishment with products sold off in local markets. When intercropped with green grams and its products sold in local markets, Melia's net present value (NPV) and annual equivalent values (AEV) were higher by 67% and 93% than those for *Grevillea robusta* and *Eucalyptus camaldulensis*, respectively (Table 5). The rotational age for Grevillea and Eucalyptus was 15 years.

DISCUSSION

The study provided empirical data in understanding economic dynamics of Melia production on smallholdings. Melia was observed to be a high cost woodlot species with most of the costs incurred at initial stages of establishment and at harvest and processing stages. Most of the operations in Melia production were carried out at tree establishment and harvest stages making capital outlays high and accounting for 15% and 80% of the total costs, respectively. The highest costs were incurred at harvest and splitting stages as a result of high labour and capital inputs. Harvesting and splitting of timber require skilled labour whose cost when combined with cost of machine usage (fuel and depreciation) became astronomical. The hired harvesting and splitting services were higher than those of using own facilities because of the profit margins that sawyers put on their services which averaged about 30%.

Although the costs of establishment of Melia compared favourably with costs computed for other woodlot species,

Table 4. Melia woodlot profitability (NPV in KES) in the districts on 1 ha

Integration arrangement	Kibwezi	Kitui	Mbeere	Tharaka
Intercropped Melia with products sold at farmgate	9,667	9,740	9,127	11,385
Intercropped Melia with products sold at local centre	16,798	16,331	13,067	14,317
Pure Melia woodlot with products sold at farmgate	6,766	6,188	5,337	6,984
Pure Melia woodlot with products sold at local centre	13,897	12,780	9,917	9,278
Intercropped Melia sold as standing trees	4,030	3,839	3,192	2,807
Pure Melia woodlot sold as standing trees	3,633	2,858	1,826	2,211
Average	9,131	8,623	7,078	7,830

Table 5. Profitability (NPV in US\$) of Melia, Grevillea and Eucalyptus under different integration arrangements

Integration arrangement	Melia	Grevillea	Eucalyptus
Intercropped Melia with products sold at farmgate	9,980 (1,356)*	5,696 (895)	6,669 (687)
Intercropped Melia with products sold at local centre	15,128 (2,055)	7,564 (779)	8,728 (899)
Pure Melia woodlot with products sold at farmgate	6,319 (859)	3,861 (398)	5,901 (608)
Pure Melia woodlot with products sold at local centre	11,468 (1,558)	5,764 (593)	7,975 (821)
Intercropped Melia sold as standing trees	3,467 (471)	2,555 (263)	2,926 (301)
Pure Melia woodlot sold as standing trees	2,632 (358)	722 (74)	2,158 (222)
Average	8,165 (1,110)	4,360 (500)	5,726 (590)

*Figures in parenthesis are annual profitability expressed as annual equivalent values (AEV in US\$)

its costs were higher. The challenges of Melia propagating made its seedlings to sell at higher prices than other trees in order for farmers to recover the massive investment in terms of propagation structures, labour requirements and inputs. Equally, achievement of good Melia bole within shortest time period required frequent pruning and weeding to enhance growth rates. It was observed that it costed US\$ 1205 to establish one ha Melia upto to canopy closure i.e. at around three to four years when the Melia canopies in adjacent rows touch and shade out the ground vegetation. In an analysis by UIA (2011) it was observed that on average in Uganda it costed US\$ 730 per hectare to establish a plantation up to canopy closure by year three with *Pinus caribaea* and 1-2 years with *E. grandis*. In a study by McKean (2004) in Kwazulu-Natal, the costs of establishment and maintenance of the *Eucalyptus* plantation spread over the first three years were estimated at R255 400. The financial value of benefits derived from year 4 to year 6 would be R271 600, leaving a net benefit of R16 200 (annualized value = R2700). If, however, establishment of the *Eucalyptus* plantation were fully funded, the community would benefit by R527 000 over 6 years (annualized value = R87 833).

Profitability of Melia depends on the level of integration into other farming activities on the farms. The margins were

higher in an intercrop possibly as a result of extra benefits derived and complementarity that existed between Melia and other farm enterprises. Most profits were realized if efforts were made towards processing of the products from Melia. Studies done by Mulatya *et al.*(2002) indicated that although Melia caused a reduction in the yields of maize, the overall benefits derived were higher than when it would have been produced as a monocrop.

Kitui District had favourable Melia production conditions explaining why the profit margins depicted by NPV and AEV figures were higher. In addition, there were fewer alternatives for timber production making Melia to fetch better prices in the market. This was unlike Tharaka and Mbeere Districts where there were more alternative sources of timber making timber prices to be lower. The Melia species intercrop with green grams gave better results as a result of better utilization of the resources. The initial costs including ploughing and weeding were shared out by Melia and the intercropped legume.

CONCLUSION AND RECOMMENDATIONS

The products produced and marketed from Melia woodlots were many and included timber, trees, off-cuts and

sawdust. *Melia* has high economic and environmental conservation potential in the sites covered. The NPV and AEV done indicated that it was economically viable to invest in *Melia* production with leguminous crops intercropping at initial stages and selling it off as sawn timber in local markets. Further conversion of timber into quality furniture would lead to diversification and enhanced value thence their demand.

To help commercialize and increase producer profitability, there was need for intervention strategies that would enable producers add value and diversify products through further processing, and expand into existing markets and penetrate into the non-traditional national and export markets. This would enhance diversity of products and lead to reduced competition and value of the products increasing their profitability to producers. This could be applied under cottage industry arrangement with producers in rural areas encouraged to set up timber workshops as home based production units for the products. The chain saw technology applied was wasteful and there was need to sensitize producers on application of latest innovations in sawing timber. Further research was necessary in establishing yield and growth models for *Melia*. There was need too for rapid market analysis as source of market information and intelligence for the producers of products in the timber value chain.

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