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Macadamia Nut Production and Research in Kenya

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ABSTRACT

Macadamia nut is an important high value export market cash crop and is mostly produced in Central, Eastern, Rift Valley and Coast Provinces in Kenya. The national average yield is 28%, 16% exportable nut and 12% for local markets. In 2008 the area under macadamia was well above 2000 ha, producing 13,510 Mt with an estimated value of $4,887,194 (Ksh 351,878,000 (1 Ksh = 0.72 US$)). *Macadamia tetraphylla* (rough shelled macadamia) was first introduced from Australia in 1946 forming the nucleus mother tree material for Kenya's macadamia industry; macadamia is produced as a complimentary cash crop to coffee. Promising clones of *M. integrifolia* and hybrids selected for observation and evaluation resulted in the development of macadamia clones that have improved nut yields from the original 5-10 kg/tree/year to up to between 50-80 kg/tree/year, depending on the clone. Studies have been done on various crop husbandry practices that provided recommendations on spacing, propagation techniques and pest and disease management. The productivity in the 1980s was 3.4 Mt/ha, in the 1990s 3.5 Mt/ha and from 2000 it has risen to 5.3 Mt/ha. Nut production in the country has showed growth that has been triggered by competition and provision of integrated services to the farmers. The government is putting in place an appropriate policy, institutional and legal framework to sustain this growth and provide the right environment for nut production and marketing by farmers.

Keywords: *Macadamia tetraphylla*, *Macadamia integrifolia*

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INTRODUCTION

The Kenya macadamia nut industry is currently made of approximately 900,000 trees of varying ages from one year to over 30 years, grown by over 100,000 small-scale farmers with an average of 6-100 trees per grower. Annual production is about 4,000 metric tons of nuts-in-shell producing an estimated 800 metric tons of marketable kernels. Macadamia nut is considered as a crop for retirement due to its long payback period and the low returns in the first 5-8 years of production. The production in Kenya is broadly classified into two main systems, typical small-scale enterprise characterized by individual farmers owning 5-200 trees of various ages, under a wide range of husbandry standards. The farmers intercrop with coffee, fruit (avocado and banana) and food crops (corn, potatoes and beans). A handful of large-scale private production outfits maintain high quality consistent husbandry standards (KARI 1993; Kuiru 2005a; Gain 2006).

The first tree was introduced in Kenya in 1944 from Australia via Hawaii. More seed material was later imported from Hawaii, Australia and California namely *Macadamia tetraphylla*, *Macadamia integrifolia* and various hybrids (Waithaka 1995; Kenya Nut annual report 2003; Kuiru 2005a). Wide-spread production started in the late 1960s and was especially promoted among smallholders in the coffee-growing zones and a few coffee estates as a complimentary cash crop to coffee. Most of the planting was in Central, Eastern, Rift Valley provinces and Taita/Taveta District of the Coast Province with the leading districts being greater Meru, Embu, Kirinyaga and Thika. Seedlings supplied were mainly of *M. tetraphylla* and *M. integrifolia*. Given that most of the farms in the country are intercropped, the area and yield are estimates (**Table 1**). The national average yield is 28% with only 16% exportable nut and 12%

Table 1 Area and productivity of macadamia nuts 1980-2008.

Year	Area (Ha)	t/Ha
1980	957	1.4
1982	388	1.2
1984	3957	2.6
1986	432	5.6
1988	382	6.4
1990	2158	3.5
1992	601	3.0
1994	1489	2.0
1996	924	3.4
1998	1496	4.8
2000	2268	4.4
2002	854	5.1
2004	2150	5.6
2006	1558	5.4
2007	1693	5.6
Est. 2008	1732	5.5

Source: MoA, annual reports

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Invited Mini-Review

Table 2 Nut and kernel characteristics of the seven tentatively recommended clones (2003).

Variety	Nut diameter (mm)	Nut weight (g)	Kernel diameter (mm)	Kernel weight (g)	1st grade kernel ratio (%)	Kernel recovery (%)	Shell thickness (mm)	Yield at 15 yrs in shell (kg)
MRG-20	24.84	7.54	16.27	2.24	95.77	32.58	2.7	55.0
KRG-15	24.75	7.07	16.98	2.53	91.99	39.33	2.5	80.0
KMB-3	24.48	6.15	16.21	1.90	94.30	34.78	2.4	60.0
EMB-1	23.62	6.47	15.99	1.99	95.50	33.51	2.5	70.0

Means from at least 50 data units per year
Source: adapted from Nyaga *et al*. (2003)

for the local markets. The productivity in was 3.4, 3.5 and 5.3 Mt/ha in the 1980s, the 1990s and from 2000, respectively. The increased productivity can be attributed in part to improved husbandry courtesy of research and improved market prices. Currently the average yield from a mature tree is estimated at 10-20 kg/year (Most of the trees are very old and neglected). The effects of the political turmoil on macadamia nut production in the country has not been conclusively quantified, however is deemed to be significant because of geographical advantages. Medium to large-scale estates (pure stand) that have adopted good agronomic practices have reported yields up to 80 kg/year. Nuts are harvested from end of November to March with the peak being January and February. For instance, the average production in Eastern province is between 25-28 kg per tree per year which is low when compared to the potential yield of 85 kg per tree per year if the orchards are well maintained. Grafted macadamia trees bear fruit after about three years. With the high prevailing prices there is renewed farmer interest, leading to increased inputs for higher yields. Production challenges include pests and disease damages (i.e. stink bug, nut borer, and anthracnose), drop of young fruits in the lower zones due to moisture stress, inadequate training of extension staff and farmers on crop husbandry practices (CABI 2004; Wabule *et al*. 2004; Kiuru 2005; Gain 2006).

MACADAMIA NUT PRICE AND QUALITY

The market for macadamia nuts is inefficient, in fact, the demand is higher than actual sales because the current market is not representative of relatively competitive levels. There are at most two main outlets for the nuts with three other outlets that are not consistent. The inefficiencies arise from a number of factors, including the monopolistic behaviour on the part of firms, absence of cottage industries, and lack of functional market institutions.

The government commissioned the Kenya Nut Co. Ltd. processing and marketing factory in 1974 which came to operation in 1975 to spearhead and invest in the development of the macadamia nut industry in Kenya. The company has been instrumental in the developed of the industry since then, having a monopoly in the marketing up till the mid 1990s when several other players entered the market. The crop has a low labour requirement and a gross margin of $5,746 in its 15 years of production. In shell nuts are sold to either processors or exporters are made direct or through middlemen. The farm-gate prices of NIS changed from $0.32 in January 2004 to the current ones of $1.1-1.4/kg with the average free on board value of Kenyan nuts being reported as $2.62 (Kiuru 2005a; Muthoka *et al*. 2006).

Competition from processors (both new and old) and traders continue to strengthen the price of nuts (between $0.8-2.1/kg). Due to prevailing high prices, farmers are harvesting immature nuts (shaking the trees) and delivering them to processing companies with very high moisture content (over 20%). Most of the small processing companies have no drying equipment; consequently the nuts are developing moulds, impacting negatively on quality. There is a lack of a structured marketing, thus quality is the prerogative of the parties involved. As a result of the high returns, the demand for planting material has increased. These are available from two processing companies and about three other established nurseries which supply grafted seedlings. On average it takes approximately 1.5–2 years to get a grafted seedling ready for the open field. As a result the propagation of seedling requires extra caution and attention (Kiuru 2005; Muthoka *et al*. 2006).

RESEARCH INTERVENTIONS

Research carried at KARI-THIKA resulted in several outputs: through selection and breeding, the centre developed clones that have improved nut yields from the original 5-10 kg per tree per year to up to between 50-80 kg per tree depending on the clone (**Table 2**). Released clones for commercial cultivation include KMB-3 for coffee and tea zones at altitudes of 1,750 to 1900 m above sea level (asl), KRG-15 and EMB-1 for coffee zone at an altitude of 1,550 to 1,750 m asl while MRG-20 is for marginal coffee zone of 1,400-1,550 m asl. Macadamia hybrids are reported to perform better than pure *integrifolia* or pure *tetraphylla* in the high altitude areas, elevations of above 1750 m asl (Ondabu *et al*. 1997). All clones had acceptable nut and kernel diameter, and satisfactory first grade kernels.

For the recommended varieties two crop spacing recommendations found suitable 10 m × 10 m for intercropped macadamia or pure stand of KMB-3, and 7.5 m × 7.5 m for a pure stand of KRG-15, EMB-1 and MRG-20. Improvement of grafting techniques: Top-wedge was recommended for use in young seedlings and the splice method for overgrown seedlings (**Table 3**).

Training and pruning were reported to result in a 38% nut increase. In the intercropping trials, studies showed that intercropping macadamia with legumes and other annuals during the early stages of orchard establishment increased the gross-margin per unit area and maximized utilization of land (KARI 1993).

Detailed studies have been carried out on major pests: macadamia stinkbug *Bathycoelia distincta* Distant and nut borer *Ephestia* sp. and *Cryptophlebia leucotreta* Meyr. The stinkbug was observed to cause 55-70% of nut losses in areas lower than 1,600 m asl while the nut borer damage on kernels was 1-2% at lower altitude but increased up to 5-7% at higher altitudes above 1700 m. Preliminary results of research work carried out at KARI/Thika have shown that parasitoid wasps e.g. *Tetractrichus* spp., *Anastatus* spp., etc could be used to control the Macadamia stinkbug, *B. distincta* with up to 55% success (Pere *et al*. 1990; Nakagawa 1991; Kobayashi *et al*. 1993, 1996). Damage by nut borers, which is most serious at high altitudes, is normally higher on husks than on kernels and cultural control is through regular nut collection, dehusking and regular cleaning of the storage area. Nakagawa (1991), Sikinyi (1993) carried out surveys on diseases and several disease pathogens affecting macadamia were isolated. These included *Phytopthora* spp., *Pythium* spp., *Botrytis* spp., *Rhizoctonia* spp., *Pestalotia* spp., and *Phytopthora cinnamommi* was prevalent, and an integrated pest management disease control option is being developed.

Table 3 Comparison in percentage takes with different grafting method.

Grafting method	Percentage take
Side wedge	70-100%
Splice	70-100%
Top-wedge	90-100%

Source: KARI (1993)

CONSTRAINTS AND OPPORTUNITIES IN THE MACADAMIA COMMODITY CHAIN

The macadamia value-chain is relatively short: at the primary end are the farmers, who produce, harvest, dry and store the nuts. These farm-dried nuts are sold on the farm and are purchased by processing companies through brokers. Advisory services, training of nursery men and provision of planting materials are provided to the farmers by processors, brokers, extension staff from the Ministry of Agriculture and the research institution KARI.

Productivity among the small-holdings is low and the quality of the nuts inferior when compared to the large-scale producers. The low productivity and poor quality are a reflection of the poor prices which the commodity attracted during the period when only one market outlet prevailed. With the improved nut prices there has been an increased demand for high quality seedlings, this has pushed high the cost of planting materials. Other constrains included inadequate value-addition, lack of modern equipment for production and processing, nuts are export 'in-shell' this makes it difficult for the cottage industries to develop, inadequate access to information, inadequate information on the right varieties for the various agro-ecological zones, inadequate extension services for macadamia, unethical business practices due to a large number of brokers, lack of farmer awareness on the final products, insect pest damage to nuts thereby lowering quality, and high cost of farm inputs (Muthoka *et al*. 2006).

The country has an unexploited cottage industry, and there is potential for development for alternative uses of macadamia and macadamia by-products in the food and beauty, building, and feed industries. Studies carried out at KARI-THIKA showed that macadamia has low cholesterol levels (Sikinyi 1993). The country has favourable climatic conditions for the production of high quality macadamia. Kenyan macadamia producers are yet to benefit fully from the increased demand for macadamia products due to that fact that the crop had been neglected for several years until recently.

POLICY FRAMEWORK

According to the national nut crop development policy, gazetted in November 2007, the objective is to promote the development and growth of a vibrant nuts sub-sector that will improve farmer's income, increase foreign exchange earnings, create employment, reduce poverty and enhance their living standards through increased production, processing and marketing of nuts. Attention is focused on potential areas of production, farm support services (research and extension) and seedling and nursery development as well as creating the enabling environment for broader partnership in the development of the sub sector.

REFERENCES

CABI (2004) *Priority Tree Crops*, A study conducted by CAB International on behalf of the Eastern African Fine Coffees Association (EAFCA). CABI, Nairobi, Kenya, 5 pp

GAINS (2006) Kenya: Tree Nuts: Kenya Tree Nut Update Report 2006. Approved by Smith KN, U.S Embassy, Prepared by: Onsongo M. GAIN Report Number: KE6001 USDA Foreign Agricultural Service Global Agriculture Information Network, pp 1-6

KARI (1993) Kenya Agricultural Research Institute, National Horticultural Research Centre, 1993. Unpublished reports, pp 13-26

Kenya Nut Annual (2003) Global Agriculture Information Network GAIN Report number 3009 of 11/18/2003. USDA Foreign Agricultural Service, pp 1-10

Kiuru P (2005) Macadamia: A Profitable crop to grow. Farmer's Pride Magazine. June/July Issue, Nairobi, Kenya, pp 14-16

Kiuru P (2005a) Macadamia Nut Development Project: A Historical Perspective. KARI-THIKA. Kenya, pp 1-26

Kobayasshi T, Muriuki SJN, Muriuki SJM (1996) Studies on an integrated control of the Macadamia stinkbug *Bathycoelia distincta* Distant Horticultural Development Project, KARI, Thika, 23 pp

Kobayasshi T, Mutuanene BM, Muriuki SJM (1993) A Terminal report on Entomology in the Horticultural Development Project, KARI, Thika, 19 pp

Macadamia selection standards in Kenya (Revised) (1994) Horticultural Development Project Thika, Kenya Agricultural Research Institute. NHRC/ KARI annual reports. 1989-2005

MoALDM (1998) Annual report 1998 – Kenyan Ministry of Agriculture, Livestock Development and Marketing, 17 pp

Muriuki A, Muthoka NM, Ndungu BW, Kibaki J, Ndegwa AM, Mbugua GW, Gitonga JK, Chege BK, Waturu CN (Eds) (2005) Research Priorities at KARI-Thika, 2005. Report of the prioritization workshop held at KARI-Thika on December 6th to 8th, 2005, KARI-THIKA, Kenya, pp 27-30, 37-40

Muthoka NM, Ndungu BW, Kiuru PDN, Mbaka J, Muriuki SJN, Nyaga AN, Gathambiri CW, Irambu EM, Kinga'ra GW (2006) A baseline study on macadamia production in eastern and central provinces of Kenya. KARI-THIKA, pp 1-37

Nakagawa T (1991) Pest of Macadamia and its control. Horticultural Development project, KARI/Thika, pp 23-40

Nyaga AJN, Ondabu N, Kiuru P, Tominaga K (2003) Macadamia clonal selection in Kenya. Paper presented at KARI Adaptive Conference 2003, pp 234-239

Nyaga A, Ondabu N, Tominaga K (1994) Macadamia selection standard and analysis methods (revised). Horticultural Development Project, Thika, Kenya Agricultural Research Institute, 12 pp

O'Hare P, Vock N (1990) Growing macadamia in Queensland. Queensland Department of Primary Industries, Nambour, 30 pp

Ondabu N, Nyagah A, Tominaga K (1997) Cross breeding of Macadamia, a case study of the Kenyan Highlands, HDP Thika

Pearce DW, Turner RK (1990) *Economics of Natural Resources and the Environment*, John Hopkins University Press, Baltimore, 60 pp

Pere WM, Mutuanene BM, Nakagawa T (1990) Parasitoid activity of wasps on eggs of Macadamia stinkbug *Bathycoelia bequarti* Distant KARI Annual Report, 81 pp

Sikinyi T (1993) Macadamia cultivation Techniques in Kenya. A technical bulletin of Horticultural Development Project, Thika, pp 11-24

Wabule M, Wasilwa L, Nyaga A (Eds) (2004) Macadamia Production: Provincial Reports. Proceedings of the Macadamia Stakeholders Meeting, 15 June, 2004, KARI, Nairobi, Kenya, pp 1-15

Whiley AW, Winks CW, Stephenson RA, Winston EC (1988) Maroochy Horticultural Research Station Report No. 5, 1986-87. Department of Primary Industries, Queensland government, Brisbane 1988