

**Macadamia
Cultivation
in Kenya**



Introduction

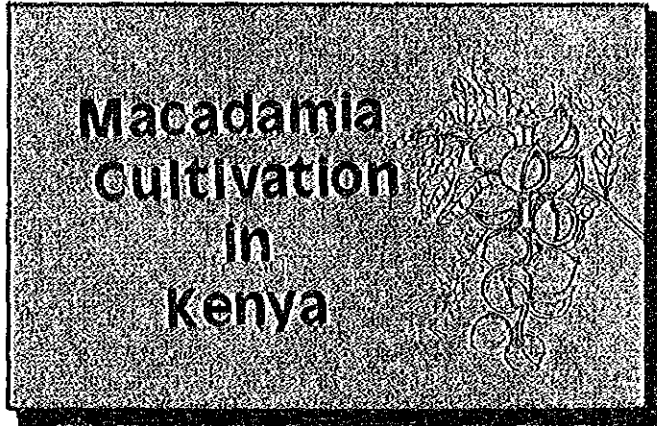
There are two types of Macadamia nuts in the world known as Macadamia integrifolia (Smooth shelled type) and Macadamia tetraphylla (Rough shelled type). Macadamia originated from Australia and moved to Hawaii where improvement was made and it became the most popular nut in the world. Currently Macadamia is grown commercially in Hawaii, Australia, Kenya, Brazil, Guatemala, Costa Rica and Malawi. In Kenya Macadamia nut was introduced as an alternative cash crop to coffee in 1968. But because macadamia does not breed true to type, the resultant seedlings were inferior in both yield and quality. However, during 1972 surveys, showed few high yielding varieties (clones) with good nut quality and high shelling percentage and oil content were identified. These (Varieties clones) produce between 38 kgs and 55 kgs of nuts per tree per year in contrast to 5-12 kgs of nuts per tree annually for the inferior varieties. Since 1977 the Government of Japan through Japanese Technical Cooperation Agency (JICA) has been cooperating with the Government of the Republic of Kenya in the development of high yielding macadamia varieties (clones) using superior varieties which are recommended for planting by farmers. Among them KRG-1, KRG-3, KRG-4 and KRG-20, EMB-1 are suitable for areas ranging between 1450-1900M above sea level with 1200mm to 1800mm rainfall.

The purpose of this very comprehensive paper is to provide growers and extension staff with a reference for the appropriate cultural practices for macadamia production, identification of major diseases and pests and their control and sources of planting materials. We hope this paper titled, "Macadamia Cultivation In Kenya" will be yet another useful service and source of information for the horticultural farmers.

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Macadamia Cultivation in KENYA.

Killimo cha Macadamia nchini KENYA.

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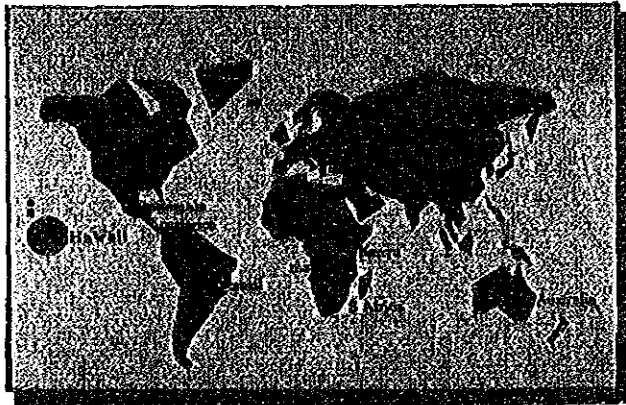


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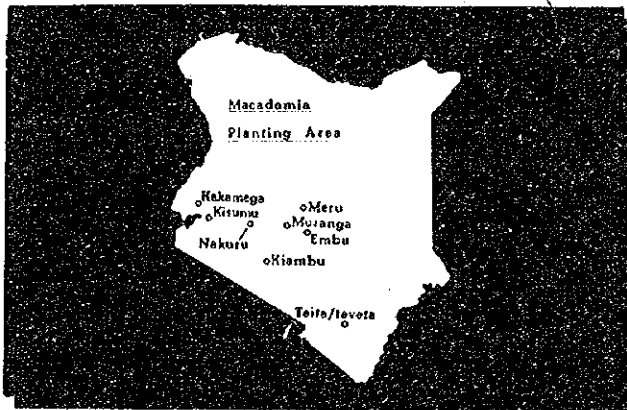
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Macadamia Spp originated in the North Eastern part of Australia. When it became famous it was bred in Hawaii and alot of improvement was done on its breeding and it became a popular nut all over the world.

Aina za macadamia zilichimpuka Kaskazini Mashariki mwa Australia. Ilipokuwa mashuhuri, ilikuwa ikilimwa huko Hawaii na marekebisho mengi yalifanywa kwenye mbegu zake na ikawa kokwa iliyoenea kote duniani.



*Distribution of
Macadamia in the world.*



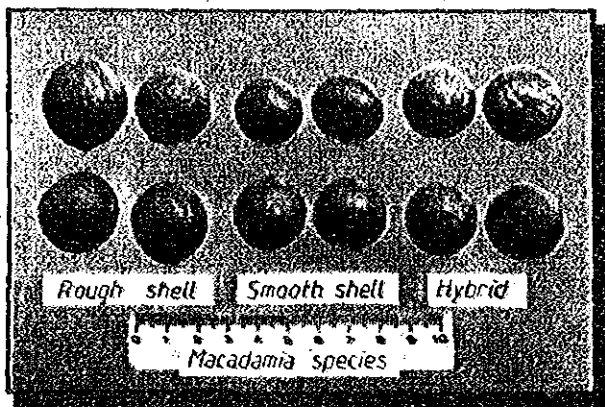
Macadamia planting in Kenya.

Some seed nuts were imported to Kenya about 1968, they were widely distributed to small scale farmers, particularly in the central region.

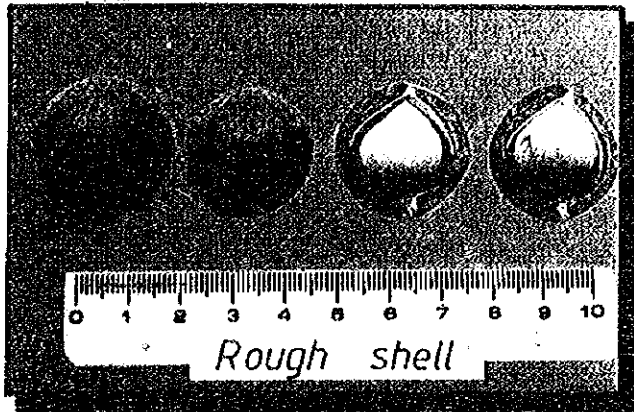
Baadhi ya mbegu za kokwa ziliingizwa nchini Kenya mnamo mwaka wa 1968 na zikagawanywa wakulima wadogo, na hasa katika eneo la kati.

Macadamia Spp are easily distinguished by three different types of shell, which are rough shell, smooth shell, and hybrid in between rough and smooth shell.

Aina za macadamia hubainishwa rahisi kwa aina tatu tofauti za banja, ambazo ni, banja ngumu, banja laini na ya mchanganyiko (Hybrid) baina ya banja ngumu na laini.



Characteristic shell types.



Rough shell type.

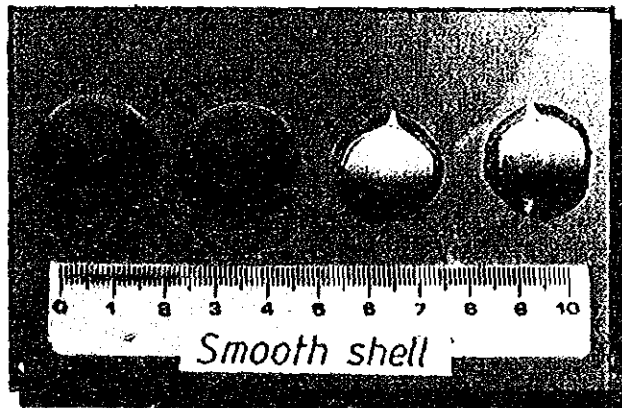
Rough shell types also called tetraphylla lines are of poor quality for commercial purpose because of low kernel recovery percentage and low oil content.

Aina ya banja ngumu, ambazo pia huitwa "Tetraphylla lines" ni za hali duni kwa haja za kibiashara kwa sababu ya kiwango cha chini cha kokwa na mafuta.

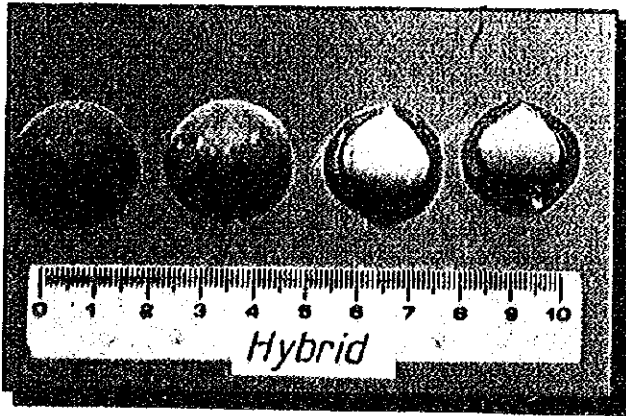
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However, smooth shell types also called *Integrifolia* lines are round in shape and are of good quality with high oil content and kernel recovery percentage is high.

Walakini, aina ya banja laini ambazo pia huitwa "*Integrifolia* lines" zilizo mviringo ni bora na huwa na kiwango cha juu cha mafuta na utoaji wa kokwa pia ni wa kiwango cha juu.



Smooth shell type.



Hybrid type

The quality of hybrid is a bit inferior to *Integrifolia* lines but do better at high altitudes of more than 1750m.

Ubara na hybrid ni duni kidogo kuliko ule wa "Integrifolia lines" lakini hukua vyema zaidi katika kimo kinachozidi mita 1750 kutoka usawa wa bahari.

Existing Macadamia trees grown in Kenya have very low yields because they were planted from seed and about 75% are rough shell types. The average is between 5-12 kg per tree a year.

Miti ya macadamia inayokuzwa nchini Kenya huwa na mazao ya chini sana, kwa sababu hupandwa kutoka kwa mbegu na kadiri ya asili mia sabini na tano (75%) aina ya banja ngumu. Mazao ya wastani ni kilo 5-12 kwa kila mti kwa mwaka mmoja.



Macadamia farmer showing poor fruiting.



Good harvest.

They should yield four to five times the present yields for macadamia to be a good cash crop to farmers.

Yatakiwa kuzaa mara nne hadi tano kulliko yanavyozaa sasa ili macadamia uwe mmea mzuri wa kiuchumi kwa wakulima.

The following six varieties are tentatively recommended at different altitudes; KRG-1, KRG-3, KRG-4, MRG-20, EMB-1 (smooth) and KMB-3 (hybrid).

Zifuatazo ni aina sita mbalimbali zinazo pendekezwa kujaribiwa vimo mbalimbali. KRG-1, KRG-3, KRG-4, MRG-20, EMB-1 (laini na KMB-3 mchanganyiko (Hybrid)

RECOMMENDED VARIETIES

Smooth		Hybrid
KRG1	MRG20	KMB3
KRG3	EMB1	
KRG4		



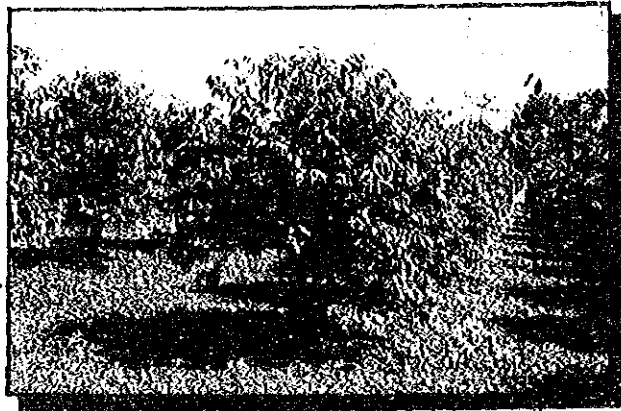
Potential recommended variety.

These varieties can produce between 38kgs and 55kgs per year, when they are 15 years old.

Aina hizi zaweza kuzaa baina ya kilo 38 na kilo 55 kwa mwaka, zinapofika umri wa miaka 15.

The most suitable places for growing macadamia are the same as the main coffee growing areas. These areas are between 1450-1900m above sea level with 1200mm to 1800mm precipitation.

Sehemu zinazostahili sana kwa kukuzia macadamia ni sawa na zile zinazokuzwa kahawa. Maeneo haya huwa baina ya mita 1450 - 1900 "pimaji" pamoja na milimita 1200 hadi 1800 za mvua.



*Suitable
Agri-ecological zones.*



*Macadamia orchard
in wider
Agri-ecol. zone.*

Each of the recommended varieties have suitable growing place; but when orchards have irrigation systems, macadamia can be planted in a greater variety of regions.

Kila namna inayopendekezwa ina sehemu inayofaa kukuzwa. Lakini viunga vya shamba vnapotumia njia ya kunyunyizia maji macadamia yaweza kupandwa katika sehemu mbalimbali.

It is very important that each variety should be planted in its suitable place. Therefore when you want to establish new macadamia orchard, contact your nearest F.T.C. or Agricultural Extension worker.

Ni muhimu kwamba kila namna ipandwe katika sehemu inayofaa. Kwa hivyo wakati una potaka kuanzisha viunga vipya vya macadamia, ifahamishe F.T.C. iliyo karibu nawe au mfanyi kazi wa kilimo.



*Agricultural extension
worker with
macadamia farmer.*



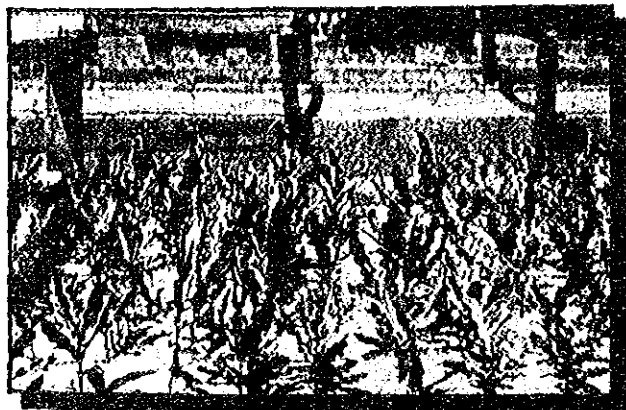
*Grafted seedling
in green house.*

Macadamia seedlings should be propagated by grafting. Seedlings obtained directly from seeds are low in yields and of poor quality.

Miche ya macadamia yatakiwa kuzalishwa kwa kupandikiza. Miche inayopatikana moja kwa moja kutoka kwa mbegu zina mazao machache na ya kiwango cha chini.

Good rootstock for grafting should be selected from mother trees which are high yielding and have medium to big nuts. After germination only vigorously growing seedlings are used.

Mashina mazuri ya kupandikiza yastahili kuchaguliwa kutoka miti asilia iliyo na mazao ya juu na yenye kokwa za kadri hadi kubwa. Baada ya kuchipuka, miche inayokua kwa upesi tu ndiyo inayotumika.



Good rootstocks.



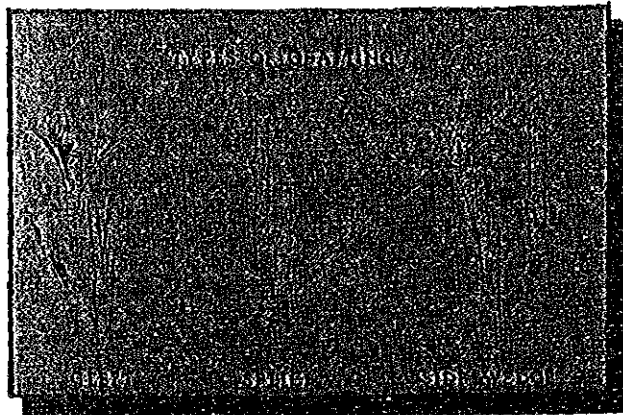
*Recommended
mother tree.*

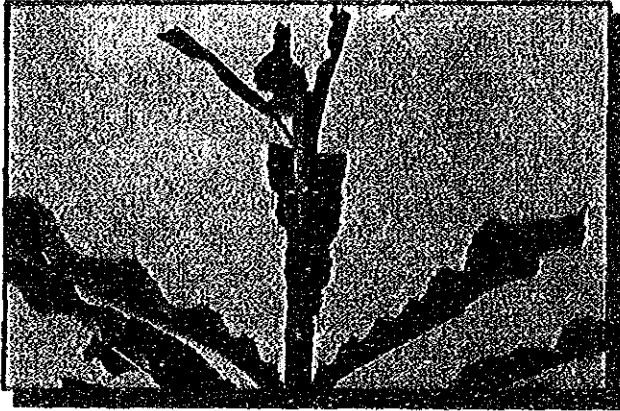
Scions used should be from recommended varieties only.

Chipukizi zinazotumiwa zinastahili kuwa za namna zilizopendekezwa tu.

There are three important grafting methods namely the cleft-grafting, the splice-grafting and the side wedge-grafting.

Kuna njia tatu muhimu za kupandikiza ambazo ni kupandikiza kwenye mwanya wa kati, kupandikiza kwa "kunganga" na kupandikiza kwa "kusengana" kwa upande.





Cleft Graft.

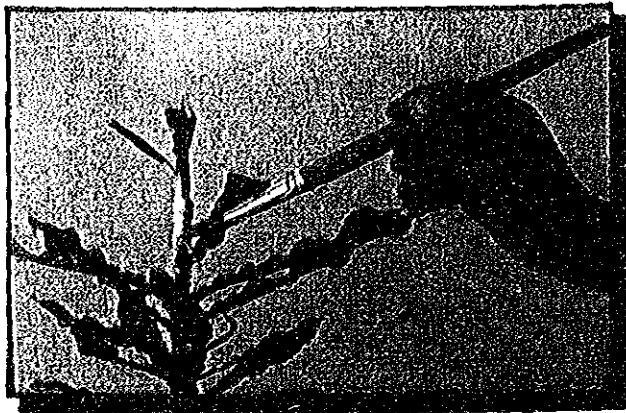
The cleft-grafting is the most popular method for macadamia. The first step of the cleft-grafting is to cut vertically at the centre of rootstock and then insert the wedge-shaped scion.

Upandikizi kwenye mwanya wa kati ndiyo njia inayojulikana sana kwa macadamia. Hatua ya kwanza ya upandikizi kwenye mwanya ni kukata kiwimawima katikati ya shina halafu penyeza chipukizi lililochongwa.

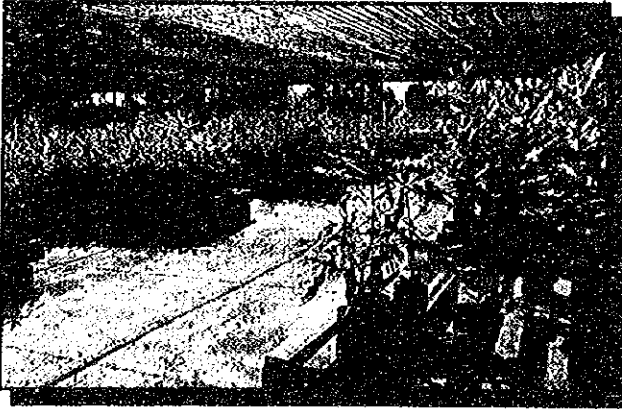
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Then, tie the graft union tightly with the grafting tape and apply grafting wax.

Kisha fungua pandikizi zilizofumaha kabisa kwa utepe wa kupandikiza na utle uta ya kupandikiza.



Graft waxing.



Grafted macadamia seedling ready for transplanting.

When you want grafted seedlings for planting, contact your nearest agricultural Extension Office, N.H.R.S. or K.N.C. - Thika.

Unapohitaji miche iliyopandikizwa, ya kupa-nda ifahamisha ofisi ya kilimo iliyo karibu, National Horticultural Research Station (N.H.R.S.) au Kenya Nut Company (K.N.C.) Thika.

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Renewal of already-planted trees can be done by topworking using bark grafting method. This method is complicated; therefore please get guidance from Extension workers.

Kupandikiza upya kwa miti ambayo tayari imeshapandwa kwaweza kufanywa kwa kutumia njia ya kupandika magome. (Top working) Huchukua muda mfupi kuzaa kokwa kuliko wakati ambapo miche mipya hupandwa. Njia hii inatatiza kwa hivyo tafadhali pata msaada kutoka kwa wafanyakazi wa kilimo.



Top worked tree.



*Transplanting
macadamia.*

Macadamia has two seasons for planting. The long rain (Apr-Jun) season and short rains (Nov-Dec). Planting during the long rains season is suitable.

Macadamia ina misimu miwili ya kupanda msimu wa mvua ya masika (April-Jun) na msimu wa mvua chache vuli (Nov-Dec) kupanda wakati wa masika hufaa zaidi.

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Seedlings should be transplanted to the field 6 to 8 months after grafting.

Miche yastahili kupelekwa shambani miezi (6-8) baada ya kupandikiza.



*Seedling ready
for transplanting.*



Level land.

Level land is preferred to sloping land as harvesting and management of the Orchard is easier.

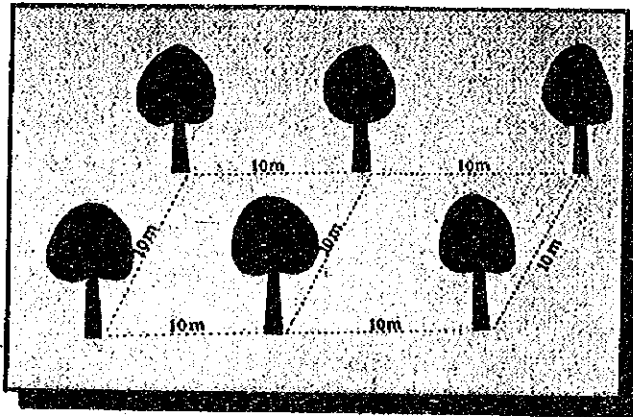
Ardhi iliyo sawa yafaa kuliko ile iliyoinama kwa kuwa uvunaji na utengezaji wa viunga ni rahisi.

Preparation of planting holes should have minimum dimensions of 90 x 90 x 90cm for sufficient root development. Organic manure, fertilizers and lime should be added.

Utayarishaji wa mashimo ya kupandia yastahili kuwa na ukubwa wa 90cm mraba kimo kwenda chini (90cm x 90cm x 90cm) wa kutosha mizizi. Mbolea ya samadi na "Chokaa" (lime) yastahili kuongezwa.



*Transplanting seedling
with fertilizers.*



*Macadamia plants
spaced at 10m. x 10m.*

Spacing should be 10 x 10m. Which gives (100)
to (115) plants per hectare.

Nafasi iliyochwa kati ya mimea yastahili
kuwa 10 x 10m ili kupata mimea mia moja (100)
hadi mia moja na kumi na tano (115) kwa kila
hecta.

Inter-cropping is possible in young macadamia orchards; However, care should be taken not to interfere with the young plants. Beans and vegetables are recommended for Inter-cropping.

Ukuzaji wa mimea mingine miongoni mwa viunga vichanga vya macadamia huwezekana. Wataki uagallifu wastahili ili mimea michanga ya macadamia isiharibiwe. Inapendekezwa maharagwe na mboga zipandwe miongoni mwa laini za macadamia.

*Inter-crossed
Orchard.*





*Macadamia trees
in bloom.*

The main flowering season for smooth-shelled type is usually between June and August, while that of rough type occurs one to two months late.

Uchipuaji wa maua ya macadamia yenye banja (ngozi) laini hutokea katika mwezi wa Juni hadi Agosti hali kwa macadamia yenye banja ngumu hutokea mwezi mmoja au miwili baadaye.

Pruning is very important as the trees grow. The first pruning is done three to six months after transplanting. The branches are pruned to about 60-100cm above the ground.

Upunguzaji (Ukataji) wa matawi ni muhimu sana, miti inapoendelea kukua. Ukataji wa matawi wa kwanza hufanywa miezi 3 hadi 6 baada ya kupandikiza matawi hukatwa kufikia sentimita 60 hadi 100cm juu ya ardhi.



Pruned young trees.



Training young tree.

Some particular varieties e.g. KRG-1 produce many water shoots when young. Therefore it is important to train these branches to promote early fruiting.

Aina zingine kama KRG-1 hutoa chipukizi nyingi zikiwa changa kwa hivyo ni muhimu kuongoza haya matawi kuendeleza utoaji wa matunda mapema.

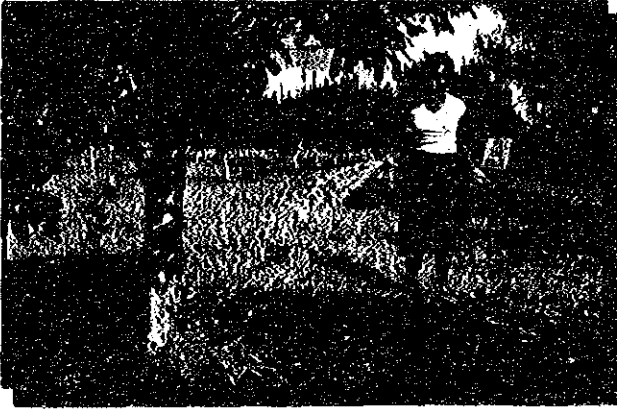
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It is desirable to water once a week during dry season when trees are young.

Inafaa kunyunyizia maji mara moja kila wiki katika msimu wa kiangazi, miti ikiwa michanga.



*Watering
young trees.*



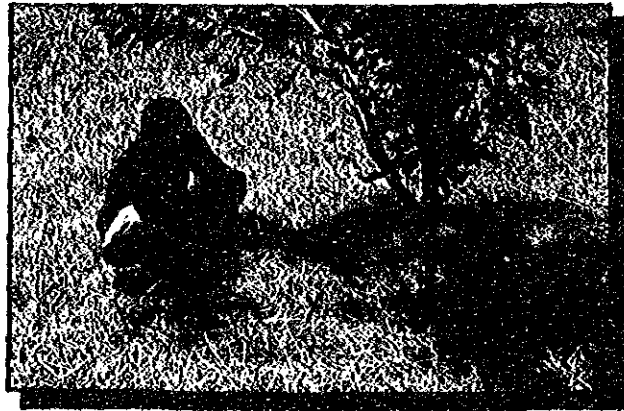
Watering mature trees during drought.

Watering mature trees during dry seasons is important as well as for increased yields. This is particularly important in marginal coffee zones of low altitudes and distinct drought periods.

Kuinyunyizia maji miti iliyopevuka katika msimu wa klangazi ni muhimu pia kwa kuzidisha mazao. Hili huwa muhimu zaidi hasa katika sehemu zilizo kandokando ya mahali kahawa inapokuzwa ambapo kuna klangazi dhahiri na penye kimo cha chini kutoka usawa wa bahari.

Mulching is important for moisture conservation and weed control. Dry grass can be used for mulching and should be kept away from the trunk to prevent white ants attack.

Kutia majani yanayooza chini ya miti husaidia kuhifadhi na kuzuia magugu. Nyasi zilizokauka zaweza kutumiwa hapa lakini ziwekwe mbali na mashina ya macadamia. Ili kuzuia mchwa usiishambulie.



Dry grass mulching.



*Effect of soil
moisture deficiency.*

Lack of soil moisture affects flowering and fruit setting often causing thick shelled nuts

Ukosefu wa maji katika udongo huzorotesha uchipuaji wa maua na matunda, na hivyo kusa-babisha ukuaji wa matunda yenye banja nzito.

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For the control of white ants, white paint or waste oil is applied at the base of the stem.

Ili kuzua mchwa rangi nyeupe au mafuta (yaliyotumika kwa injini ya gari) yapakwe sehemu ya chini ya shina.



Waste oil applied on the base of the stem.



Mulched orchard.

Mulching the whole orchard conserves soil moisture, controls weeds and soil erosion especially on sloping land.

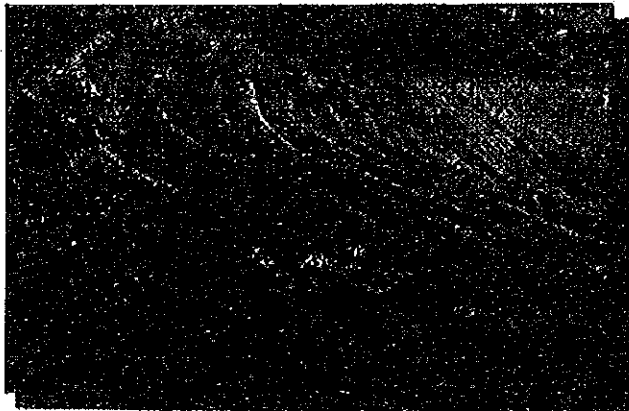
Utiaji wa majani yanayooza kwa kiunga kizima huhifadhi rutuba ya udongo hasa katika ardhi yenye miteremko.

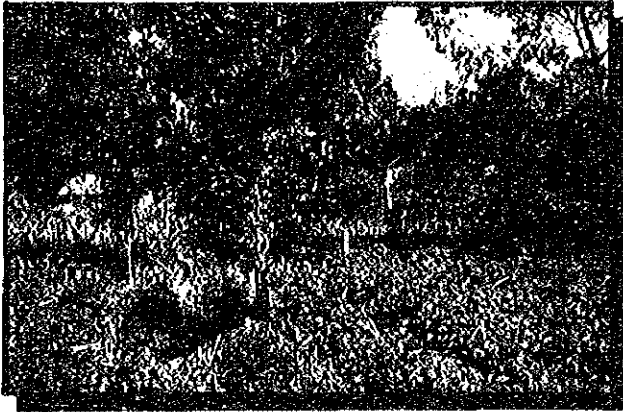
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Bench terraces should be dug on steep slopes and napier grass or leguminous plants on the edges.

Kuchimba na kusawazisha ardhi kwenye mitere-
mko na kupanda nyasi au kupanda mimea kama
maharagwe na kunde kingoni, ni muhimu sana.

*Bench terraces
on stopy land.*





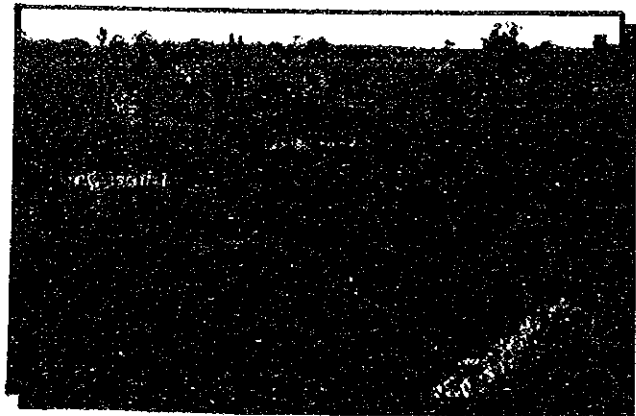
*Orchard intercropped
with beans.*

Beans and other leguminous plants are useful inter-crops for covering the surface of orchards to conserve soils.

Maharagwe na mimea mingine aina hiyo ni muhimu kupandwa miongoni mwa miti ya macadamia kwa vile hufunika ardhi kwenye kiunga na kuhifadhi udongo.

For prevention of water logging on flat land during rainy season ditches about 1m deep should be dug between trees.

Ili kuzulia kujaa kwa maji katika ardhi iliyo sawa wakati wa mvua nyingi mashimo yenye kimo cha mita moja yafaa kuchimbwa kati ya miti.



*Ditch dug on
a flat land.*



Fertilizer application.

Fertilizer application should be done twice a year for increased yields. Application should be done just before rainy season.

Yafaa kuwekea miti mbolea (fertilizer) mara mbili kwa mwaka ili kuzidisha mazao. Uwekaji mbolea wafaa ufanywe munda kabla ya msimu wa mvua.

The amount of fertilizers depends on the age of the tree. Thus increasing with age of the tree.

Kipimo cha mbolea hutegemea umri wa mti. Kwa hivyo, huongezeka vile mti unavyozidi kwa umri.

Fertilizer application chart.

Age of plant (years)	TYPE OF FERTILIZER			TOTAL
	N	P	K	
1	120	120	120	360
2	150	150	150	450
3	250	250	250	750
4	350	350	350	1050
5	500	500	500	1500
6	700	700	700	2100
7	1000	1000	1000	3000
8	1500	1500	1500	4500
9	2000	2000	2000	6000
10	2500	2500	2500	7500



*Mature Nuts
on the tree.*

The macadamia nuts mature after 7-8 months from flowering.

Kokwa za macadamia huwa tayari baada ya miezi 7 hadi 8 kutoka uchimpuaji wa maua.

The mature macadamia nuts naturally drop on the ground and harvesting is done by collecting them.

Kokwa mbivu za macadamia hujianguka chini na uvunaji hufanywa kuziokota.



Nut collection.



Clean ground.

Refrain from picking the nuts from the trees as they are immature. Keep the ground clean for ease of nuts gathering.

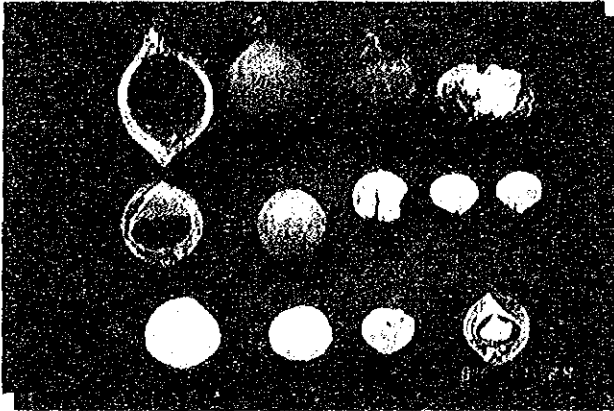
Usichume kokwa kutoka kwa miti kwa vile hazijaiva. Yafaa pahali hapo pawe safi ili kurahisisha uokotaji wa kokwa.

Macadamia stink bug is one of the most serious pests in low altitude areas. Sometimes more than 70% of the nuts are attacked by the bug in this project orchard.

Mdudu wa macadamia (anayenuka) ni moja-wapo wa wadudu wabaya zaidi katika sehemu zenye kimo cha chini kutoka usawa wa bahari. Mara nyingine zaidi ya asilimia 70 ya kokwa hushambuliwa na mdudu huyu (katika mradi wa kiunga hiki).



*Macadamia
stink bug on the tree.*



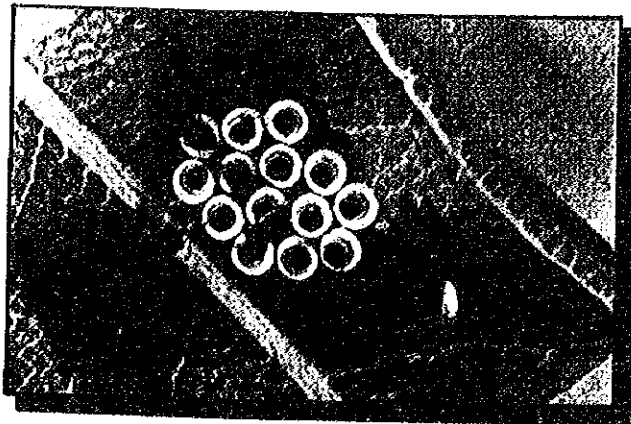
*Mould on Nuts
infected by stink bug.*

The bug attacks all stages of developing nuts. When developing nuts are attacked mould grows in the kernel as secondary infection. This affects the commercial value of the nuts.

Mdudu huyu hushambulia hatua zote katika ukuaji wa kokwa. Kokwa zinazokua zinaposhambuliwa kutu hukua ndani yake kama maambukizo ya baadaye. Hali hii huzorotesha thamani ya kokwa zinapochukuliwa sokoni.

There are few parasitic wasps which lay their eggs in the eggs of the bug. More than 70% of the eggs collected in this project orchard are parasitised.

Kuna manyigu wachache "Vimelea" ambao hutaga mayai yao ndani ya mdudu wa macadamia (stink bug), Zaidi ya asilimia 70 ya mayai yaliyookotwa katika mradi wa kiunga hiki yalikuwa katika hali hii.



Parasitic wasps hatching in the eggs of stink bug.



Minor stink bug.

There are other stink bugs which attack the nuts. However, their damage is not as serious as that of the macadamia stink bug.

Kuna aina nyingine za wadudu wanukao wanaoshambulia kokwa za macadamia. Walakini uharibifu wao si mbaya kama ule wa mdudu wa macadamia (stink bug).

The nut-borer is a larva of a tiny moth which feeds on the nut mainly on the husk and may sometimes be found feeding on the other kernel. There are several species of the nut-borer which include some storage pests.

Mdudu anayetoboa kokwa ni mtoto wa nondo mdogo ambaye hula ganda la kokwa na mara ngingine hupatikana akila sehemu ya nje ya kiini cha kokwa Kuna aina nyingi wa mdudu wanaotoboa kokwa pamoja na wadudu wapatikanao ghalani.



Nut borer and the damage it causes in the nut.



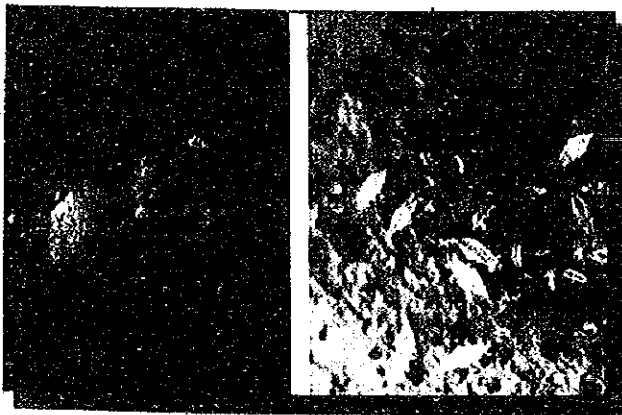
Weevils feeding on macadamia leaves.

Some weevils are known to attack the edges of macadamia leaves. These are most serious in young orchards and in the nursery.

Funza wengine (weevils) wamejulikana ambao hushambulia ncha za majani ya macadamia. Hawa wadudu ni wabaya zaidi katika viunga vichanga na chumba cha kukuzia miche.

Scales and thrips attack the surface of the husk. So far these pests are minor.

Magamba (scales) huota juu ya maganda ya kokwa. Hadi kiwango hiki wadudu hawa wanao-sababisha hali hii, ni harifu.



Scales, strips and the damage they cause.



*Emperor Moth feeding
on macadamia leaves.*

Sometimes naked branches in the macadamia trees can be observed. This is damage due to Emperor moth caterpillar.

Wakati mwingine matawi huonekana uchi bila maganda. Uharibivu huu hutokana na kiwavi--nondo aitwaye "Emperor Moth".

Clusters of rot occur as nuts approach maturity. Affected husks die and become brown and dry. Affected nuts do not fall and nuts of these clusters hang on the tree for several years.

Vishada (vikundi) vya uvundo hutokea kokwa zinapoelekea kupevuka. Maganda ya kokwa hufa na kugeuka rangi na kuwa kahawia na kukauka. Kokwa hizi hazianguki bali hubaki zikininginia mitini kwa miaka kadhaa.



Cluster of rot.



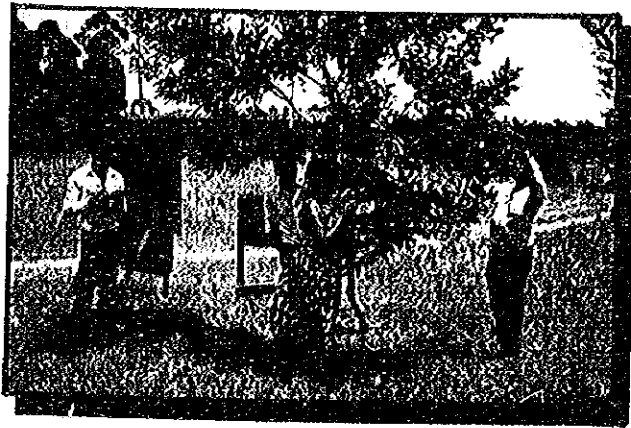
Dried tree due to damping off.

The nursery trees and newly planted trees suddenly dry up due to damping off. *Phytophthora* spp have always been isolated from affected trunks. High soil moisture and unfavourable growth conditions such as draught and injuries contribute to increasing the susceptibility of the host to infection.

Miti iliyoko katika chumba cha kukuzia miche na miti iliyopandikizwa majuzi hukauka ghafla kwa ajili ya uloaji wa maji. "*Phytophthora* spp" hutenganishwa na mashina yaliyoshambuliwa. Kuwepo kwa maji mengi katika udongo na hali isiyofaa ukuzaji kama vile ukame na madhara husababisha kuongezeka kwa wepesi wa kuambukizwa.

The above is an outline of growing macadamia. If you want to know more about it consult the Agricultural Extension workers in your area.

Maelezo yaliotolewa hapa ni dokezo juu ya ukuzaji wa macadamia iwapo unataka kujua zaidi juu yake, tafuta msaada kutoka kwa wafanyikazi wa kilimo (Agricultural Extension workers) katika eneo lako.



*Data collection
in the orchard.*



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