ACKNOWLEDGEMENT

I would like to thank my family for their financial support throughout the attachment period. Also I would like to thank the entire Egerton University, especially the department of agricultural economics and agribusiness management for giving me such a chance to experience the working environment in my area of specialization. Also I would like to thank my field attachment supervisors at kakuzi who worked tirelessly and sacrificing their time to ensure my success during my attachment period.

ABSTRACT

The field attachment ensures that student is well trained enough to meet the changing trends in labour market and management where prior acquisition of practical skills and attitudes is necessary. It helps the student to familiarize himself with the working environment in his area of specialization. It also helps him to put into practice all that he has learnt in class thus equipping him with a better understanding. Kakuzi limited is an agricultural company. Currently kakuzi deals with horticulture (Avocados, pineapples and Macademia), rearing of livestock and forestry. It’s the largest exporter of avocado in Kenya. This report focuses on how various activities are carried out in this company, this include how various horticultural crops are grown right from land preparation to harvest and how they reach to the market. Its also includes how various departments operate. Recommendations on the institution and on the attachment programme are also given in this report.

INTRODUCTION

Kakuzi limited is a Kenyan agricultural cultivation and manufacture company. Its products include tea, avocados (of which it has been Kenya’s largest exporter), pineapples and livestock. The company also carries out forestry operations. Its subsidiaries include estates services limited. Kakuzi’s parent company is the British company Camellia plc. The original site of the current kakuzi originates from land acquired by Donald Seth Smith in 1906. With his partner and principal backer, Lord Cranworth, some 10117 hectares were acquired. The central location for this estate was christened Makuyu, the native name for fig tree, which remains at the Head Office to this day. The original crop planted on the estate was sisal then in huge demand for roe manufacture. Kakuzi limited itself is a union of two companies with sisal growing interests; kakuzi fibrelands limited, a public company growing sisal and coffee, and a neighbouring sisal company, sisal limited. Both companies merged in 1966 to form kakuzi limited. In the face of increased competition from synthetic materials: sisal production ceased in 1987. Coffee had been produced on kakuzi since 1919. Around that time sisal limited also started looking further afield and acquired land in Nandi hills which was planted with tea, selling green leaf to neighbouring factories for processing into black tea. This arrangement was not satisfactory and when neighbouring estate, siret tea estate, came on market, kakuzi acquired it complete with a processing factory. During the 1960s a number of additional coffee estates were added to the portfolio. Following a significant drought in 1984, the coffee plantations started to show symptoms of a series fungal disease*, Fusarium*, which had been imported from poorly run neighbouring estates. New planting was an option as this became infected as well and diversification into other crops resulted. Avocados were particularly viable and planted in large areas. Another diversification, on land unsuitable for more valuable crops, is forestry. Planting started in 1992 and by the end of 2010some 1242 hectares had been planted. Cattle were a further diversification during the 1980s when the size of the herd peaked at 7500. As at August 2011 the herd was 4407. A major new water dam initiative undertaken by the company in Ngenya valley in 1990 provided new opportunities. A joint venture initiative with Del Monte, a world leader in growing, canning and marketing of pineapples was entered into in 1991 with 1032 hectares under pineapple cultivation. As at August 2011, 1111 hectares are under joint project pineapple production.

MANAGEMENT

Board of Directors

The kakuzi board consists of the chairman, who has non-executive responsibilities, four other non-executive directors and two executive directors.

The board meets quarterly and is responsible for establishing the corporate governance pillars, setting the strategic direction, reviewing business performance and supervision of management of kakuzi operations.

The directors have the knowledge, experience, autonomy and skills enabling them to carry out their board responsibilities.

ORGANIZATIONAL STRUCTURE

Camellia PLC Board of Directors

Regional Director Africa

Group Managing Director

GM Engineering

Operations Directors

GM field operations

Group Central Workshops

AGM and Group manager

Divisional manager field

Field staffs

Supervisors

Workers

**MISSION OF THE COMPANY**To produce quality products responsibly, ethically and sustainably.

**VISION OF THE COMPANY**

To be the most preferred and supplier of agricultural and horticultural products

**THE CORE VALUES OF THE COMPANY**

Business Integrity, Honesty, Ethics, Respect to Humanity, Environment and Society.

**ACHIEVEMENTS**

KAKUZI LIMITED – STRETCHING THE RAINS

Stretching the rain in kakuzi’s context translates to making maximum use of the rains during wet seasons**,** implementing measures to ensure rainwater is available during the dry seasons, and responsibly using, monitoring and accounting for each drop of rain. kakuzi limited majorly relies on harvested rainwater to run its operations and in return gives more back to nature. The huge effort put by the company to ‘stretch the rains’ in order to sustainably run its operations defines water stewardship and this cannot be overlooked.

Kakuzi employs and houses over 1300 employees directly. Each employee comes with an average of five direct dependents; this quickly increases the number of water users to 7000plus. The business has a Global G.A.P. certified avocado plantation of over 400hectares, a macadamia orchard of over 600hectares, pineapple operations and a staggering 4200heads of cattle. These alone would present a challenging stretch to any water source.

With no river, lake or any other natural water source traversing Kakuzi land, the farm has proactively developed a series of dams to harness rainwater. This rainwater, trapped in a battery of sixteen gaping earth pans, is enough to irrigate the avocado and macadamia orchards, fulfill the pineapples water requirements and quench the livestock’s thirst. All this water use is authorized, document and each raindrop can be accounted for by the company.

The dams are a home to crocodiles, hippo

**PINEAPPLE PRODUCTION**

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**Figure**

**Introduction**

The pineapple is a tropical and subtropical fruit grown in many countries in Africa. In Uganda it is mainly grown south of Lake Kyoga and western Uganda. It is a tradable crop and generates reasonable income. It is used as a fruit as well as for producing juice. It is also used for making jam. In addition it contains a protein digesting enzyme bromelain. Therefore it can be used as a meat tenderizer. Leaves are used for making ropes and coarse cloth. Waste products from the juice canning industry are used as animal feed.

Ecological requirements

Pineapple is fairly drought resistant but for high yields a well distributed annual rainfall of atleast 1000mm is required. A regular supply of soil moisture is essential. Medium altitudes of 1350-1750m above sea level are the best. Below 1350m the fruit has little fibre, leading to a mushy fruit. The fruit also contains too much sugar leading to a bland taste. At high altitudes growth is slow and the fruit contains much acid. Deep sandy loams with a lot of organic matter are ideal. Other soil types can be used as long as they are not water logged and organic matter is added.

Types (cultivars)

**Cultivars**: *smooth cayenne* is by far the most important pineapple cultivar throughout the tropics, the leaves are almost spineless expect at the apices. Queen is still grown in some areas. This cultivar produces smaller but sweeter fruits than smooth cayenne, but the leaves are spiny and difficult to work with. The red Spanish is a semi spineless cultivar grown mainly in west Africa and South Africa. Its fruits are intermediate between those of smooth cayenne and queen but are of better quality than those of smooth cayenne. It has come resistance to mealybug wilt disease.

**Management practices**

**Land preparation**

Where cultivation is to be done for the first time, on forested new lands, the ‘slash and burn’ method of land clearing is applied. This method has the advantage of releasing nutrients to the soil, and destroys or reduces weeds and ants nests in the fields. Following this clearing, certain options are available;

* On the upland sandy soils, little additional preparation is required before planting.
* On the heavier riverain soils, when replanting old pineapples cultivation or using lands previously used for other crops, the area should be ploughed and left to weather for 3-4 weeks. The land is then harrowed and the crop can be planted.
* On riverain and potential acid-sulphate soils where water control is critical, a system of raised beds and drains will be required. The width of the beds will depend on whether single or double rows of plants will be used. If single rows are to used the beds should be made 240cm wide and for double rows the beds should be 390cm wide. Drains on either side of the bed should be made 60cm deep. This will enhance the removal of excess water from the plants’ rooting zone.

**Propagation**

Pineapple is propagated vegetatively. Planting materials are obtained from various parts of the plant and are identified according to the parts of the plant on which they are found. They include;

* **Ratoon suckers** which are shoots produced from ground level and when used, will produce fruit in twelve to 12-14 months after planting.
* **Side suckers** which are produced above ground level and when used bear fruit within 18-20 months after planting.
* **Slips** which are located at the base of a fruit. They produce fruit within 14- 16 months after planting and are the preferred type of planting material.
* **Crowns** are suited at the apex of the fruit. This type of planting material is not commonly used by farmers and even when used they take as long as 20-24 months after planting to produce fruit.

Tissue culture can also be used. The propagules are extremely resistant to desiccation and root readily when planted in the nursery or in the field. By planting various types of propagules the period of harvest can be extended since offshoots fruit in about 17 months, slips in 20 months and crowns in 22-24 months.

Planting takes place at the start of the rainy season or any time in the irrigated areas. The propagule stem should be allowed to air dry for one week prior to planting so that the callus layer is formed over the damaged tissue thereby making them resistant to disease infection after planting. Scay leaves should be removed from the lower portion of the propagule stem to expose the primodia( future roots). If this not done, establishment will take long.

**Preparation of planting materials**

**Treatment**

Remove dried leaflets found at the base of the suckers and trim the ends with a sharp knife. The slips with leaflets pointing upward, should be in a container, layer after layer. When the container is filled, add a solution of Malathion or Diazinon 0.1%-5ml in 4.5L water until the slips are fully covered, in order to ensure all pests are killed. Submerge slips for 20minutes then drain off the solution into another container and store for reuse. Using gloves, remove suckers from the container and pack on ground under shade in an up-right position for 7 days.

This treatment is essential for the control and spread of pineapple mealy bug.

**Planting**

When planting ensure that the ‘heart’ of the plant is above soil level otherwise rotting will occur, particularly if the soil is wet. Either the single or double row system can be used. However, for a more cost effective land use, Kakuzi limited uses double row system which has the largest number of plants per unit area.

Two rows are spaced 70-80cm apart. The suckers should then be planted staggered 45-60cm within the rows. The distance between the double rows or every two rows should be 150cm. this arrangement will give 25000-29000plants/ha. The rows are marked using pegs, string and tape. Holes are dug shallowly(7-10cm deep) using a small hoe or just insert a large stick in the ground and only the pedal part is planted and firmed. The propagules are planted on a level ground and later ridged. Ridge planting helps provide a deep bed for a better root growth and also creates water between the double spaces or draining away excess water in water logged areas.

**Fertilizers**

The fertilizer recommendations are based on a plant density in the double-row system of 25000-29000plants/ha. Soil analysis should also be done to know exactly what should be applied.

Nitrogen is the nutrient most used by pineapples. It can be applied at the rate of 50kg/ha top dressed one month after planting. Additional 41-670kg/ha applied 3-6 months interval is recommended before maturity. An additional 200kg/ha of nitrogen can be applied to each ratoon crop. Where phosphorus is lacking, plants have narrow brittle leaves with a darkred color spreading the entire leaf.

Potassium deficiency produces a poor quality fruit; few suckers and slips will be formed. The best method of application is pre-plant broadcast mixed with the top 15cm of soil. Iron deficiency is identified by a general chlorosis (pale yellow or yellow-white color) similar to that typical of nitrogen deficiency. Zinc deficiency causes a mottled yellowing of leaves.

**Weed control**

Weeds can be controlled in 3 ways notably by: hand, use of mulch and use of herbicides. To obtain maximum production, perennial weeds should be dug out prior to planting and all newly germinating weeds should be controlled while in seedling stage. If a crop is planted with pineapples, weeding should be done in the early stages. It is advisable that after harvesting the intercrop hand weeding should not be continued. The pineapple has shallow root system which should not be disturbed.

Different materials can be used for mulch but Kakuzi uses poly-mulch. It restrict weed growth, decreases erosion and it conserves moisture.

**Pest control**

Two insects pose a serious threat to pineapple cultivation. These are the ant and the mealy bug. The combination is the ant mealy bug complex. Mealy bug colonies are tended by ants, which protect them by making shelters of soil around the meal bug. Initial control should be directed against the ants to ensure success. When the ants are controlled the shelters collapse and control measures can then be directed towards the meal bug. Ants can be controlled either by drenching their nests with insecticide or by applying baits.

Mealy bug can be controlled by spraying the plants in the field after the ants have been eliminated. Insecticide application is recommended throughout the plant growing cycle to keep the pest under control. When spraying, ensure that the nozzle is directed torwards the lower parts of the plant where the mealybugs are found.

**Disease control**

Wilt disease is the most common disease in pineapples. It is caused by a virus associated with the mealybug. This disease occurs throughout the world. The most visible symptom is a bright bronze to red coloration of the leaves of the young plants or a pinkish and/or yellowish coloration of the older plants. If the plants continue to grow, the leaves lose turgidity and curl outwards. Any fruit produced by these plants is usually small and /or distorted. Control is effected by taking the measures to control the mealybug previously described, starting with the selection and treatment of healthy suckers for planting. This is followed by the eradication of the ants associated with the mealybug and the routine treatment of the plants to control the pest.

Also all infected plants should be removed from the plants site and destroyed by burning as these plants are a source of infection.

**Artificial flower- induction**

It is a procedure that utilizes synthetic hormones to induce plants to flower. It permits better scheduling of the harvest as it takes 5 months from time of induction to full maturity of the fruits. The process works best when the following criteria are fulfilled;

* The plants in the block to be treated should be homogeneous in size and less than 12 months old or posses less than 25 leaves. Young and unhealthy plants should not be induced to flower since they will produce small fruits, (unless small frits are specifically required for a particular for a particular market). Treatment should take place in the cool of the day, early morning or late evening, with preference for the latter. The main products used to induce flowering are Naphthalene, Acetic acid and Ethrel.

**Harvesting and post harvest handling**

The time of harvesting the pineapple depends on whether the fruits are for the domestic or overseas market. Fully ripe fruits are suited for local markets while unripe but mature fruits can shipped overseas.

**Assessing maturity**

Fruit maturity is evaluated on the extent of fruit eye flatness and skin yellowing.

The pineapple is hand harvested with pickers being directed as to the stage or stages of ripeness required. It is harvested by breaking or cutting the stalk a few cm below the fruit. The harvested fruit is packed either in the field or at central packing shed. While in the field it should be placed in shaded conditions. The fruit should be placed in the field crates for transport to the packing shed. In the field, a preliminary grading exercise can be conducted. Undersize, oversize, overripe, underripe, damaged, bruised, insect and fruits should be rejected.

**Transport**

Fruit should be transported in such a way as to avoid unnecessary damage. The transporting vehicle should allow for good air circulation and protection of the produce from sunlight. Transport of fruit should be done in the cool periods of the day and on roads/dams that allow for smooth traveling.

**Pack house operation**

At the pack house the fruit is prepared for the market.the fruits stalk should be trimmed to about 1-3cm in length. It should then be sorted by removing all those that are defected. it should then be washed in clean water to initiate cleaning and as a from of pre-cooling exercise.

Size grading and separation according to stage of ripeness should be carried out. Large is considered to be greater than 1.2 to 1.6kg and small less than 1.2kg. the fruit is then packed in special cartons with good ventilation. The preferred method of packing is by placing the fruit vertically or in a standing position in the carton. Dividers or spactators are placed between fruits in the carton to prevent the fruit from rubbing together and minimize abrasion and damage.

Fruits are normally packed to a net weight of 10-15kg but this depends ,however, on the carton and market. Fruits in individual cartons should be the same size which would determine the counts that can be accommodated. Accepted counts are as follows;

* **6count-over 1.6kg**
* **8count-1.2kg**
* **12count-1.0kg**
* **20count-0.75kg**

**Grading standards**

Pineapple should have the following minimum quality standard is stimulate consumers appeal and increase profits.

* Fruit needs to be mature, firm and well formed.
* Fruit should be free of surface debris and stains.
* Fruit should have no wounds, scratches, punctures or bruises.
* Fruit should have no scares or residues from insects or spray chemicals.
* Fruit should be free of soft rots or surface moulds.
* The size of the crown and ratio of crown to fruit length should be guided by market requirement

FLOW DIAGRAM OF A POST HARVEST HANDLING SYSTEM OF PINEAPPLES

Harvesting

Field Containers

Transport to packing house

Trimming fruit stalk

Washing/ cleaning/ pre- cooling

Sorting to remove defects

Waxing ( applied alone or with fungicide)

Size grading

Packing in containers(use of dividers)

Storage(low temperature)

Load in transit vehicles

**RECORD KEEPING**

Record keeping is of vital importance at all stages in the production of pineapples.

Whether it is an estimate of the market demands, the average number of slips needed to plant a bed, the amount and date of the fertilizer application, the number and weight of fruits obtained, a system of records is necessary.

Various recording systems could be developed and maintained. However, if record keeping is considered a burden, just a record of daily operations would be extremely helpful.

**AVOCADO PRODUCTION**

**INTRODUCTION**

The avocado (*Persea americana*) is a native of Central America and the West Indies. Accounts of the fruit date back to the early 1500s when the Spanish conquistadors overran the Aztec and Inca empires and found the avocado being extensively cultivated. It was introduced into Florida, California and Hawaii in the early 1800s and is now found worldwide where growing conditions are suitable. The world production of avocados is approximately 2.3 million tonnes, with a production area of 340 000 hectares. Australian production is small compared with leading avocado producing countries, at 29 834 tonnes (ABS 2001). Exports represent only 0.5% of total production at 160 tonnes. Imported fruit is restricted due to quarantine barriers aimed at keeping Australia free from exotic pests and diseases. Australia has 960 100 trees and of these 47% are less than six years old. The NSW plantings—19% of the national total—are shown in Figure 1. The avocado belongs to the family Lauraceae. Camphor, sassafras, cinnamon and laurels are related species. The tree is evergreen, though heavy leaf fall may occur during profuse blossoming and when the tree is affected by root rot. The growth habit varies from tall and upright to well-shaped and spreading. Fruit of the cultivated species vary greatly in size, shape, colour, texture and flavour. The edible part of the fruit—the flesh between the seed and the skin— varies in colour from cream to yellowish-green. When ripe the flesh should have the consistency of soft butter. The fruit has one seed. The fruit is unique in that it will not ripen until harvested and may be left on the tree for some time (depending on variety) after reaching maturity. Avocados contain from 5 to 40% oil, the percentage varying with the variety, growing area and seasonal conditions. Only ripe olives have a higher oil content. The therapeutic value of avocado oil is related to its fatty acid composition. Hass fruit contain up to 83% mono and poly unsaturated fatty acids. Avocados contain many vitamins, particularly the B complex and vitamins A and E, as well as folic acid and iron. They contain no cholesterol. There are many ways to eat avocados. Most people have probably tasted avocado in a guacamole dip. They can be served halved with vinaigrette dressing as part of a salad, with seafood or an acid fruit such as citrus, in sandwiches, soups, salad dressings, ice creams and milk shakes. Avocados are also used in high-quality cooking oils and in the manufacture of cosmetics.

Avocado nursery operations

Seed selection and harvest

Seeds are selected from healthy trees with the desired qualities for example disease resistance, high yields etc. Fuerte seeds are preferred in this catchment. The fruit must be mature and free from disease.

**Soil preparation**

Nursery should be located in a site that has good drainage. Top soil is mixed with river sand at the ratio of 3:2. This means 3 wheelbarrow loads of top soil and 2 wheelbarrow loads of sand. Half kilo of agricultural lime is added to this mixture to neutralize acidity. Planting pot are then filled with this soil and stacked in beds.

**Seed Sowing and establishment**

The ripe fruit is cut and the seed removed. The skin on the seed is removed and the seeds kept in a cool, dry environment ready for sowing.

**Grafting**

At 5months from the sowing date, the seedling will have hardened properly and attained pencil thickness. This is this is the best time to graft. The following basic items are needed to carry out grafting:

* Sectateurs.
* Grafting knife
* Grafting tape
* Grafting tube
* Jik-for sterilizing the tools.

Wedge grafting procedure

Cut the rootstock off at a right angle to the upright shoot at the grafting level. Make a vertical cut to a depth of 30mm at the center of the rootstock. Cut the scion to a wedge shade on the opposite sides, so that the sharp edge is about 30mm long. Use the grafting knife to force open the vertical cut in the rootstock and insert the wedge scion carefully, as far as it will go in. Use a PVC tape to tie the graft union. Use a grafting tube to cover the scion as shown on the photo.

Maintenance

Fertilizers both granular and foliar are applied to boost the growth. Fungicides and insecticides are applied based on the observations made.

Planting young trees

Be sure to buy trees from a reputable source—poorly raised trees can lead to disaster. It is recommended that you buy trees from an accredited ANVAS (Avocado Nursery Voluntary Accreditation Scheme) supplier. Use trees that have been grafted to a recommended variety. Seedling avocado trees have irregular cropping habits with unpredictable fruit quality and tree size. Take care when planting. Dig holes large enough to take the root system comfortably; very large holes are unnecessary. If post-hole borers are used ensure that the glazed side of the hole is broken in so that roots do not spiral in the tree hole. Potted trees can usually be planted without disturbing their root systems. Where a tree has become rootbound, gently loosen and straighten the roots before planting. Some light root pruning may be necessary. Do not place fertilisers in the planting hole, as burning of sensitive roots can occur. Place the tree in the hole so that the potting mix mark is slightly higher than ground level. This allows for some sinkage. Half fill the hole with soil and press it gently towards the root ball. Fill the hole with water and allow to drain before completing filling the hole with soil. Make a basin around the tree so hand watering can be done if irrigation is not installed.

Mulching

Avocados have a shallow rooting system so it is desirable to maintain a depth of mulch around trees. This should be loose, 10 to 15cm deep and extend beyond the tree’s drip line. It should not accumulate against the trunk. Slightly ‘hayed off’ and coarsely cut crops such as oats, sorghum, setaria or mixtures of these with a legume such as lablab, soybean or lupins provides an open mulch that decomposes gradually. Coarsely cut barner grass is excellent. Finely cut softer material, for example sawdust and bagasse, is undesirable as it may pack down and become soggy, inducing root rot. Mulch provides organic matter, a valuable source of tree nutrients and food for beneficial soil microorganisms, as well as improving the physical characteristics of maintaining soil moisture and temperature levels and checking weed growth. Hot sun beating directly onto bare ground can damage the shallow root system of avocados. Mulch crops can be grown in the interrow and, with a side throw slasher, directed onto the tree row when mowed. Chipping of avocado limbs and leaves following heavy pruning is practised by many growers. Since woody prunings have a carbon to nitrogen ratio of around 100:1, extra nitrogen should be applied to trees to avoid nitrogen draw-down.

Tree training and pruning

Little pruning is required after planting as avocado trees generally shape themselves. For the first two years pinch out the strong growing tips to promote side shoots and a bushier, more compact tree. Limbs causing overcrowding and shoots arising from below the graft union should be removed. It is important to avoid a weak crotch or a divided trunk. Since the avocado is a rainforest tree its growth is rapid if left unpruned. Furthermore, they have terminal flowering and in some areas a long cropping cycle. These factors present a problem in managing the canopy once trees settle into regular cropping. However, there are some options available to growers to regulate tree canopy size, including tree removal, selective limb removal, staghorning and mechanical hedging.

Tree removal is a difficult decision for growers, as a yield decline immediately follows the removal of productive trees. Replanting of removed trees on a new site can be a viable option. Selective limb removal is practised by many growers. Limbs that are low, overlapping or growing up the centre of the tree or impair tractor movement through the orchard need to be removed. Remember, avocados are very sensitive to sunburn, so after pruning paint exposed limbs with white plastic paint. Staghorning is the practice of pruning a tree back to a stump, above the graft. It is recommended to staghorn all trees in a block at the same time. This allows even light infiltration for regrowth and better control of irrigation, fertiliser rates and timings. With this pruning fruit production is lost for a couple of years. Mechanical pruning allows trees to be shaped into a hedgerow. Tree height and the slope of the pruning cut can be predetermined. Hedging to a Christmas tree shape is the preferred style. A plant growth regulator to control vegetative regrowth is currently being evaluated.

Fertilising Young trees require small amounts of fertilisers regularly. This is particularly applicable on sandy soils. Spread fertilisers by hand evenly around the tree extending beyond the canopy drip line. Every 8 weeks apply a nitrogenous fertiliser, for example urea, at 20g per tree, to encourage vegetative growth. Organic fertilisers are ideal, applied on top of the mulch layer. Use 10 litres of matured poultry manure per tree. From the third year apply an NPK mixture. This should be based on soil and leaf analysis, coupled with

nutrient removal based on crop replacement. That is the amount of nutrient taken from soil by the fruit crop, root and shoot growth and losses from leaching, soil erosion and nutrient fixation. For every one tonne per hectare of fruit yield, the total replacement figure under normal growing conditions approximates: nitrogen 7kg, phosphorus 1.5kg, potassium 8kg, calcium 3.5kg and magnesium 1.5kg. Apply nitrogen and potassium fertilisers following the summer fruit drop through to the end of autumn and phosphorus four times per year. Lime or dolomite in the autumn/winter may be required to keep the soil within the desired pH range of 5.0 to 5.5. Since fertigation is a more efficient way of applying nitrogen and potassium fertilisers, the total quantities of these nutrients can be reduced by around 25%. Boron and zinc are two essential trace elements that are required on a regular basis for tree and fruit development. Apply boron in October and again in April where leaf levels are less than 40mg/kg. Use either Solubor (22% boron at 4g per square metre of ground area canopy) or Borax (11% at 8g). A foliar spray at flowering with Solubor ( 1g per litre) is recommended. Boron levels must be monitored to avoid either deficient or toxic symptoms developing. Take leaf samples from mid-April through to late May. In later maturing districts leaf samples can be taken in June. Zinc is applied as zinc sulphate heptahydrate and is often banded around the drip line of the tree at the end of flowering. Rates vary from 10g in sandy soils to 25g in clay soils per square metre of ground area of canopy. Zinc foliar sprays are not recommended.

Irrigation In all growing areas in NSW supplementary irrigation is required. Even on the far north coast with an 1800 mm per year rainfall, irrigation is required in the spring. Avocados are very sensitive to moisture stress, especially during flowering, fruit set and fruit development. During these critical periods the soil profile should not be allowed to dry out and tree requirements should be monitored, for example using tensiometers. Using weekly evapotranspiration figures is another useful method.

Irrigation systems should be designed to apply peak water requirements when the trees are mature. This amount depends on the number of trees per hectare, soil texture and depth, prevailing weather conditions and the trees’ growth cycle. It is recommended that growers on the north coast have 3 to 5ML per hectare per year available for irrigation, increasing to 12 to 15ML in Sunraysia. Water stress can cause symptoms including; fruit drop during hot and dry weather, ring-necking of fruit, skin cracking, salt burn on leaves and drying out of the feeder roots. In young trees, vegetative growth is reduced.

**Flowering**

Avocado flowers carry both male and female reproductive organs. Each flower opens twice over a two-day period, the first day as a female and the second day as a male. This enables the classification of varieties as either an A or a B type flower. Air temperature regulates the opening and closing of flowers. In summary, there are three requirements for a successful fruit set: 1. An overlapping of the flowering stages 2. Significant insect activity, including bees 3. Temperatures above 10oC during flowering and for the three days following. Flowering normally lasts for three to four weeks, longer in cooler growing areas. In adverse weather conditions fruits can form without pollination. Such fruits are small and cigar-shaped and are known as ‘cukes’ or ‘cocktails’. In some growing areas the application of a plant growth regulator at flowering has produced less ‘necky’ and larger sized fruit.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Flower type | Day 1 | | Day 2 | |
|  | Am | Pm | am | pm |
| A | female |  |  | male |
| B |  | Female | male |  |

Figure1. Flowering schedule for Type A and B varieties

|  |  |
| --- | --- |
| Type A | Type B |
| Gwen | Fuerte |
| Hass | Sharwil |
| Pinkerton | Shepard |
| Reed |  |
| Wurtz |  |

Figure2. Flower types of main varieties

Pests and diseases

Rats and squirrels will strip the fruit. Protect with tin trunk wraps. Leafrolling caterpillars (Tortrix and Amorbia) may destroy branch terminals. Avocado brown mite can be controlled by powdered sulphur. Six-spotted mite is very harmful; even a small population can cause large-scale leaf shedding. A miticide may be required if natural predators are absent. Two fungi and one virus cause more damage than any other pests. Dothiorella (Botryosphaeria ribis) canker infects the trunk, causing dead patches that spread to maturing fruit, causing darkened, rancid smelling spots in the flesh. Flesh damage begins after harvest and is impossible to detect on the outside. Mexican types are immune to trunk cankers but the fruit is not. The disease is rampant near the coast and has no economical control method.

Sunburn

Sunburn sometimes called sunscald, typically occurs in the case of defoliation of trees, exposing fruit or previously shaded bark. Newly planted trees that grew with the bark shaded in the nursery, and trees that are unable to take up enough water because of unhealthy roots or inappropriate irrigation, are highly susceptible to sunburn. Prevent sunburn by providing trees with good growing conditions and proper cultural care, especially suitable volume and frequency of irrigation. Where feasible, prevent conditions that cause the foliage to drop prematurely, including Phytophthora root rot and high Persea mite populations. If trees are defoliated, do not irrigate until soil in the root zone approaches dryness. Defoliation reduces the trees’ use of water, so the soil will remain wet longer than with unaffected trees. Examine the soil carefully and frequently and modify irrigation to prevent excess moisture in the root zone.

Meditterranean fruit flies

Meditterranean fruit flies become a problem in avocado orchards when the fruit is mature (during the earlier stages 10 of fruit development the skin of the fruit is too tough for the flies to penetrate and lay eggs). In most cases the fruit is picked before it reaches the stage of maturity where the skin is soft enough to be stung.

Mealybugs

Male mealybugs resemble tiny flies, the females are wingless and covered with a powdery wax. They damage plants by sucking their sap and spreading disease. Ants spread mealybugs among the plants and protect them from many natural enemies. Out of doors, mealybugs constitute a greater problem in the south, because most species are tropical or greenhouse insects. They primary affect fruit trees. Commercially available beneficial insects are the best control method for mealybug.

Adult coconut bug

The nymphs and adults of the coconut bug feed on young and mature avocado fruit. A lesion which is slightly darker than the rest of the fruit skin can be distinguished from about the second day after feeding takes place. With age the area becomes sunken and dark brown to black, much like a hail mark. Internally the lesion forms a typical hard clot. Damage by the coconut bug has mainly occurred on avocados planted next to macadamia and especially if the latter had been sprayed for the control of other stinkbugs. Root rot (Phytophthora cinnamomi) is a soil-borne fungus that infects many plants, including avocados. It attacks host plants, especially under moderate to warm, moist conditions. It infects the feeder root system, causing stunted growth, dieback of branches and eventual dying off of the plant. This can be controlled or eliminated by placing bait in or near the holes. A selection of a disease-free, certified plants and avoiding planting where avocados previously grew or where soil drainage is poor can also be effective. The disease is easily transported by equipment, tools and shoes from infected soils. Once a tree is infected (signs include yellowing 11 and dropping leaves), there is little that can be done other than to reduce watering.

Sun blotch

Sun blotch is a viral disease that causes yellowed streaking of young stems, mottling and crinkling of new leaves and occasional deformation of the fruit. It also causes rectangular cracking and checking of the trunk, as if sunburned. It has no insect vector but is spread by the use of infected scions, contaminated tools and roots grafted with adjacent trees. It is important to use virus-free propagating wood.



Figure 3. Fruit affect by sunblotch.

MACADAMIA PRODUCTION

Macadamia can be produced successfully in areas where avocados, mangoes and bananas do well. The trees flower during spring from august to September. The further development of the fruit lasts 31 weeks.

Select high-quality nursery trees by inspecting the;

* Plant container and roots
* Soil moisture
* Leaves
* Internodes
* Graft union
* Shape of the tree

Plant container and roots- the size of the container is very important. If the container is too small, the tree becomes pot-bound and the taproot might be distorted. The tree may appear healthy in the nursery, but has little chance of reaching its full pontential in the orchard. The weakened root system cannot provide the growing tree with sufficient water and nutrients.

Climatic and soil requirements

Soil

Most soil types are suitable for the production of macadamias, provided they are well drained and have no restrictive layers in the 1m of the soil, poorly-drained day soils are not suitable.

Temperature

The ideal temperature for macadamia is between 16 and 25c. Although the trees can survive when temperatures drop below 3c, hey should not be regard as frost resistant.

Height above sea level

It influences nut quality and production. Production declines dramatically above 600m. above 640m growth is slower and trees take longer to produce.

Cultivars found in Kakuzi

Embu

Kiringaga

Murang’a

Soil preparation

If the physical properties of the soil, namely properties of the soil, namely depth (0,81,0m), drainage, etc are suitable for growing macadamias, the soil must be prepared carefully and well in advance. The soil must be loosened as deeply as possible. It should then not be necessary to make large planting holes, if compacted the roots could become rootbound. An investigation should be done after the planting of macadamia trees to ensure that root growth is not restricted. Do not fertilize recently planted trees. They must first become well established and grow vigorously. It is wise to wait one year before applying fertilizer.

Planting distances

Macadamia cultivars have different growth patterns. They are usually either spreading or upright growers. The size of each cultivar's drip area (surface area below leaf canopy) depends on the altitude, soil type, rootstock, rainfall, temperature and relative humidity. The planting distance for each cultivar will therefore differ from place to place. Various guidelines can be followed with respect to spreading and upright growers. As soon as the competition for light becomes too great, production will decrease. To allow for tractors to move between the trees, the hedgerow planting system is used. With this system:

* Upright growers are planted 3,5 m apart within the row with 7 m between rows.
* Spreading cultivars are planted 10 m apart within the row with 6 m between the rows.

Intercropping

Other crops are sometimes cultivated between young macadamia trees. There are 3 main aspects to be considered before planting an intercrop. Cultivation of the intercrop could damage or adversely affect the growth of the tree or injure roots and should be avoided. Tall-growing plants could crowd out or overshadow the young macadamia trees and should not be planted. No other crops should be planted between bearing macadamia trees. Once this stage has been reached, the macadamia trees should receive the attention and treatment necessary to ensure maximum growth and production.

Leaf analysis

Macadamia leaf samples must be taken during October and November. The time of sampling is critical. The correct leaf must be sampled. When submitting a leaf sample from a particular orchard for the first time, it must be accompanied by a soil sample. Thereafter it is advisable to send in soil samples annually. It is essential to consider the results of both soil and leave samples when making fertilisation adjustments. Only leaves from healthy plants must be sampled. They must be free from sunburn, insect damage or any deficiency symptoms or signs of disease.

Method of sampling

Select approximately 20 healthy trees, well distributed throughout the orchard, homogeneous in appearance, and representative of the orchard as a whole.

The selected trees must be clearly marked with, for instance, paint. In this way it is possible to take soil samples at the same places and leaf samples from the same tree every year. Four leaves are taken from alternate sides of the trees giving a sample of 80 leaves.

Fertilisation

Do not fertilise young, transplanted trees too soon. They must first become well established and start growing vigorously before any applications are made, preferably after at least 1 year. Never apply fertilisers against the stem of young trees. Fertiliser must be broadcast evenly from about 0,2 m from the stem to about 0,5 m outside the drip area of the tree. Macadamia trees are very sensitive to root damage, therefore each fertiliser application must be followed by a light, controlled irrigation. Fertilisers must not be worked into the soil.

Zinc and boron sprays

Because most soils are naturally low in zinc, or the zinc is not available, this element must be applied every year. The following concentrations are recommended:

* Zinc oxide at 200 g/100 l water, or
* NZn at 150 ml/100 l water.

Many macadamia orchards are also low in boron and it is desirable to spray the trees every 2 years with 100 g borax or 75 g Solubor/100 l water right from the start.

Irrigation

Water stress often limits tree growth, as well as the set, growth and quality of macadamia nuts. It is important to know how much water to apply and when to apply it if it does not rain.

Diseases and pests

Phytophthora root rot

This disease usually occurs as a result of mechanical damage causing injury. These areas usually become infected. Trees suffering some kind of stress such as drought conditions may also get the disease.

Nut borer

Nut borer is the common name for the larvae of 4 types of moths that can either burrow into the green husks of macadamia nuts or feed on the kernels. The damage can easily be recognised, but the moths are small and inconspicuous and seldom seen in an orchard. Adult larvae are about 10 mm long and pale red or grey. An infested nut can be recognised by a small hole in the husk which is surrounded by excreta. Affected nuts, especially young developing nuts, usually drop as a result of damage to the husks. Susceptibility to attack by moth larvae differs among cultivars because of hardness and thickness of the shell. No insecticide is at present registered against nut borer. It can, however, be limited by planting fairly resistant cultivars such as Nelmak 1, Nelmak 2 and the Hawaiian cultivars. A natural enemy that plays a role in the control of false codling moth is the parasite Trichogrammatoidea lutea, which parasitises the eggs of the moth.

Stinkbugs

Stinkbugs are the most important pest on macadamias in South Africa. Damage is caused by a stinkbug complex comprising at least 20 different types. The most important types are: two-spotted stinkbug, green vegetable stinkbug, coconut stinkbug, small green stinkbug, spotted stinkbug, yellow-edged stinkbug and yellow-spotted stinkbug. Stinkbugs can cause crop losses of up to 80 %.

Damage

Most stinkbugs have 4 generations per year and each generation causes a different type of damage to the nuts. The first generation is the spring generation (August to September), and occurs during or after flowering. This generation can cause extensive flower and/or fruit drop of small macadamia fruit. The second generation is the summer generation (December). Damage occurs during fruit development or just before the fruit reaches mature size. Once the fruit has reached mature size, it remains on the tree even after stinkbugs have fed on it. When harvesting, these nuts will have large, sunken lesions on the kernels. The third generation, the autumn generation (February to March), is normally the largest. This generation feeds on the nuts before and during harvest. Although it causes lesions on the nut kernel, no fruit drop occurs. The size of the lesions depends on the type of stinkbug. The coconut, two-spotted, yellow-spotted, and spotted stinkbugs are capable of inflicting damage late in the season because of their longer mouthparts. Less trouble is experienced from other stinkbugs during autumn. The fourth generation stinkbugs (winter) do not normally cause problems because most nuts have been harvested and stinkbugs are not very active during this season. The damage evident at the end of the season (stung nut kernels) is inflicted from December to harvest. The hardness of the shell does not limit stinkbug feeding. Nuts must therefore be protected against stinkbugs throughout the year from flowering until harvest.

Control

Stinkbugs can be controlled chemically. The shaking method is used to monitor the number of stinkbugs, especially the winter and spring generations when morning temperatures are low. Ten trees must be chosen weekly at random per control unit/block (a unit is not larger than 5 ha). All the lower branches which can be reached on each tree must be shaken and the stinkbugs counted. Trees must be shaken before the temperature exceeds 18 °C, otherwise the stinkbugs will fly away when the branches are shaken. The economic threshold value (in other words the level at which economic damage to harvest occurs) for this method is an average of 0,7 stinkbugs per tree. There are also other signs which may indicate the presence of stinkbugs:

An excessive number of fruit on the ground during spring and summer.

Feeding marks (small brown or black sting marks) on the inside of the green shell.

Egg masses on tree stems. Unparasitised eggs should be destroyed while those that have been parasitised should be left on the tree so that the parasites can hatch. Whenever chemical control is necessary pesticides should be applied judiciously. At present cypermethrin and endosulfan are the only active ingredients registered for use against stinkbugs. Cypermethrin is applied as a full cover spray at 20 ml/100 l water. Endosulfan can be applied at 120 ml/100 l water when the shaking method of monitoring shows 0,7 stinkbugs per tree. It has a residual effect of a few days compared to cypermethrin which has relatively long residual effects. Endosulfan can therefore be used until the end of the production season for the control of stinkbugs.

Recommended guidelines

* Monitor for stinkbugs before applying any pesticide.
* Spray cypermethrin after flowering to reduce the original population size.
* Follow up with an endosulfan treatment if the number of stinkbugs in the orchard warrants it.

Harvesting, storage and processing

Macadamia nuts drop from trees when they are mature and are then collected from the ground. The main crop is usually collected from March to July. The area underneath the trees must be clear. Grass, old leaves, branches and other debris must be removed. The nuts must be collected regularly, at least once a week. Nuts remaining under the trees for too long lose quality and are susceptible to damage by mould, rats and other rodents. During the main harvesting period the branches may be shaken to loosen the nuts. Never pick immature nuts.

Removal of husks

The green husks around the nuts must be removed as soon as possible after harvesting.

Drying

Freshly harvested, dehusked nuts contain 25 % moisture and must be dried before they are stored in bulk. Wire frames containing 3 layers of nuts are used for drying. Air must circulate freely between the frames to prevent mould. A fan may be used. The nuts could also be sundried, but if the freshly harvested nuts are exposed to the sun immediately, the shells may crack. These cracks provide access to insects when the nuts are stored. If the nuts are not dried, but immediately stored in bags or other containers, fungal growth could occur.

Storage

The hard, undamaged shells offer adequate protection against insects during storage. The kernels of shelled nuts are, however, susceptible to infestation. Because insects can infest stored nuts, the necessary preventive precautions should be taken. A reasonable degree of insect control is possible if packhouses and storage areas are kept absolutely clean. The shell offers total protection against insect damage and if nuts are to be stored for any length of time, it would be best to store them unshelled. Before they are stored, any cracked or broken nuts should be removed because cracks in the shell will provide access to insects. Because shelled nuts are susceptible to insect damage, they can only be successfully kept in cold storage. The nuts should be packed into cartons as soon as possible after shelling. They can then immediately be placed in a cold store at 0 to ­4 °C. Cold storage prevents fungal growth and rancidity. This method is also recommended for the long-term storage of unshelled nuts.

Shelling

For successful shelling, the nuts should be dried to a moisture content of about 1,5 % to ensure that kernels shrink away from the shells. Therefore, nuts should be dried before shelling. The final drying takes place in large containers through which hot air is circulated. The macadamia nut has a very hard shell, but is easily cracked mechanically between rotating steel rollers. A nutcracker or shelling machine works on the principle that nuts are cracked between a rotating steel roller and a fixed plate. The distance between the roller and the plate is adjustable according to the grading size of the nuts. The kernels of the nuts that have been properly dried, drop from the shells when the nuts are cracked.

Packaging

The fried or roasted nuts are packed in airtight bottles, tins or plastic containers for consignment and marketing.

CONCLUSION

Kakuzi limited is a Kenyan agricultural cultivation and manufacture company. Its products include tea, avocados (of which it has been Kenya’s largest exporter), pineapples and livestock. The company also carries out forestry operations. Its subsidiaries include Estates services limited. Kakuzi’s parent company is British company Camellia Plc. Horticulture East being one of the estates where I was attached deals the production of pineapples, avocados and macademia (only planting material of macamedia are prepared in this estate). They have several sections one of them being nursery bed and the main field.