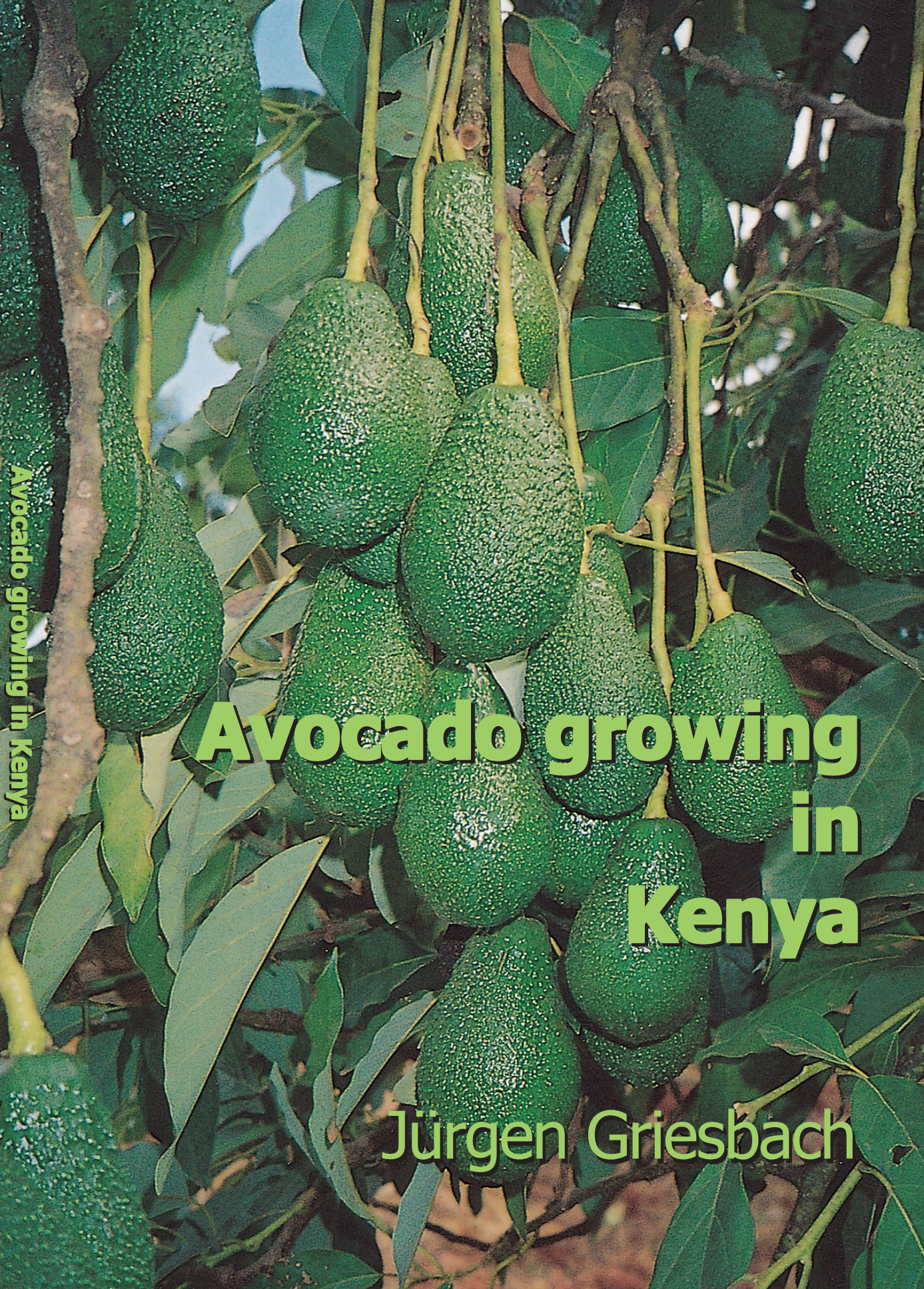


Avocado growing in Kenya

Jürgen Griesbach

Avocado growing in Kenya

AVOCADO GROWING IN KENYA

JÜRGEN GRIESBACH

WORLD AGROFORESTRY CENTRE

ISBN 92 9059 173 0

Cover photo: Pinkerton cultivar, Jürgen Griesbach
Cultivar photos: Jürgen Griesbach
Editing: Mieke Naessens Vlieghe, Jan Beniest and Anthony Simons

World Agroforestry Centre (ICRAF)
P.O. Box 30677
00100 Nairobi, Kenya

Tel: +254 20 722 4000, via USA +1 650 833 6645
Fax: +254 20 722 4001, via USA +1 650 833 6646
E-mail: icraf@cgiar.org
Internet: http://www.worldagroforestrycentre.org

Layout and printing: Kul Graphics Ltd.
Nairobi, Kenya.

CONTENTS

FOREWORD

The World Agroforestry Centre (ICRAF) envisions a large increase in the cultivation of trees in farmland as natural forests decline in area and demand for tree products increases. Smallholder rural households may particularly benefit from increased tree cultivation to help ensure security in food, health and income. To make this agroforestry transformation happen the millions of poor farming households require access to a portfolio of well-adapted and productive trees that can improve their livelihoods. This portfolio will contain both established commercial species and lesser developed indigenous trees. One of the most eligible commercial trees to include in such portfolios around the world is the avocado.

Few tree species can claim such universal appeal as the avocado in terms of bioclimatic suitability and human benefits. The diverse environments in which the avocado developed in Meso-America and the Caribbean have provided a broad range of distinct genotypes that can grow throughout the temperate and tropical zones. In many ways Kenya's diverse climate and topography were made for avocado cultivation with the Mexican highland races and Caribbean coastal races finding corresponding agroclimatic zones here. The high protein, vitamin and anti-oxidant contents of avocado provide a large health benefit to cultivators and urban consumers alike. The world recognition and demand for avocado also offer current and future export opportunities.

On average only 13% of the world's avocado production is traded internationally with the EU and USA being the primary export markets. The avocado is an important commercial fruit in Kenya and in 2003, approximately 30% of its avocado crop was exported. Interestingly, Kenya accounts for only 2% of world production but 5% of world exports. Compared to other important avocado growing countries, Kenya has a unique niche in terms of the production season, shared with South Africa but with the advantage of more competitive shipping costs. Even though the local and export marketing potential is there, this can be expected to become more competitive in the future and will require the avocado production industry to keep abreast of developments affecting the sector, especially when it comes to adhering to consumer needs, preferences, pesticide residue standards and traceability regulations.

Next to this cash value as an export crop, the avocado has many uses and a very high nutritive value. It has an unusually high protein content and a serving of avocado provides almost twice the daily requirement of several minerals and vitamins. It can be eaten raw and also flavours soups, ice cream and milkshakes. There are wide differences in the flavours of individual avocados, ranging from salty, to nutty, to sweet, with shades in between. Avocado oil is easily digestible, largely unsaturated and has a low sugar content. It is also widely used in cosmetics.

Commercial fruit tree species such as mangoes and avocados can open the farm gates to newer and less developed indigenous species. Researchers, development specialists, trainers, teachers and farmers can learn a lot about tree cultivation and domestication from these well established fruits. It is therefore that we decided to publish this book on *Avocado growing in Kenya* as a follow up on the one on *Mango growing in Kenya* (2003).

The aim of this book is to familiarize extension staff, trainers, farmers and marketers with avocado cultivation in Kenya. Even though the content is based on research and development information obtained in Kenya, there is no doubt that other countries in Eastern and Central Africa that have similar ecological conditions can also benefit from the information. Its main focus is on varietal selection for different parts of the country since this is very much needed if producers want to supply local and international markets with a timely and varied supply of good quality fruits.

The author of this book is Jürgen Griesbach, a horticulturist with four decades of experience in fruit production in Kenya. Technical editing of the book was done by Tony Simons, Principal Tree Scientist, and Jan Beniest, Principal Training Officer, both of the World Agroforestry Centre. Its production was made possible through project grants of the Strengthening International Institutions (SII) of the Netherlands' Ministry of Foreign Affairs and the Department for International Development (DFID) of the United Kingdom. Their support to the Centre's activities is greatly appreciated.

Anthony Simons, PhD
Principal Tree Scientist
World Agroforestry Centre

Jan Beniest, Ir
Principal Training Officer
World Agroforestry Centre

INTRODUCTION

With a world production of 3.2 million tonnes in 2004 (data from FAOSTAT - http://faostat.fao.org/faostat), the avocado can be regarded as an international fruit. North and Central America are the main producers (80%) while the rest of the world supplies the remaining 20%.

According to the latest production and export statistics from the United Nations Food and Agriculture Organization (FAO), the following summary emerges:

Estimated world avocado production in tonnes (t)

Major Producer Countries

Country	Production	Export
Australia	40 500	442
Brazil	173 000	
Cameroon	57 000	34 000
Chile	135 000	95 300
Colombia	158 000	5
Costa Rica	25 000	
Democratic Republic of Congo	6 200	
Dominican Republic	140 000	15 163
Ecuador	6 800	
El Salvador	40 000	n.d
Ethiopia	81 000	
Guatemala	27 000	4 680
Haiti	47 000	
Indonesia	270 000	169
Israel	65 000	22 400
Kenya	70 000	20 000
Mexico	1 040 000	124 000
New Zealand	4 000	5 600
Peru	95 000	11 500
South Africa	66 500	38 900
Spain	135 000	34 700
USA	200 200	6 800
Venezuela	52 000	922

Huge expansion in production areas in many countries will definitely increase the production output in the near future, and the estimated figure of 4 million tonnes worldwide sounds very realistic.

When looking at horticulture production in Kenya, one notices that over the last decade there has been a considerable increase in its importance for both the local and export markets as well as for the processing industry. The following statements are quoted from the Annual Report 2003, published by the Ministry of Agriculture, Horticultural Division, Nairobi: "The horticultural sub-sector has continued to grow despite the overall decline in economic growth. It is the second highest foreign exchange earner after tea. The total hectarage under horticulture in 2003 was estimated at about 375 101 ha, out of which 220 000 ha were under vegetables and 151 345 ha under fruits. The total value generated by the sector was KES 28.8 billion in foreign exchange and KES 37.5 billion for the internal trade ($1 = 80 KES). Large-scale growers dominate commercial horticulture, while the majority of horticultural growers are small-scale farmers. The contribution of smallholder growers by volume of exports has declined from about 60% to 50%. A wide range of horticulture crops is grown due to the diverse climatic conditions. These crops are grown under both rainfed and irrigated conditions, but production is inadequate due to seasonality and unreliability of rainfall."

Fruits represent an important horticultural commodity and the ever increasing hectarage of the avocado **(see Appendix 1)** and its respective yield production contributes to export, local consumption and processing. It may be said that the avocado can and should make a steadily increasing contribution towards five important Kenya Government objectives, among others:

1. increased foreign exchange earnings;
2. increased rural employment;
3. higher standard of living for the average family;
4. improved nutrition for people whose diets are inadequate;
5. added support to the 'Green Belt Movement'.

Currently avocados represent about 17% of the total horticultural exports from this country. Nearly 20 000 tonnes, valued at KES 892 million have been exported in 2003 (as compared to 12 890 tonnes valued at KES 682 million in 2002), according to the Horticultural Crop Development Authority (HCDA). At this level of export it represents approximately 39% of total avocados annual production of 70 000 tonnes. The major part of production is recorded from March to September and smaller volumes are available from October to February (**see Appendix 2**). The main export cultivars are Fuerte (80%) and Hass (20%).

Kenya's main competitors on the European market are South Africa, Israel and Spain. (**see Appendices 3 and 4**). These countries have a long-standing tradition and immense experience regarding avocado cultivation. Kenya can only succeed in further establishing itself on the avocado export market if taking into consideration the following:

- For the foreseeable future, the danger will not be an avocado over-supply but rather a limited development of the local and external markets as well as destructive competition among the producers.
- Producers should be guided and assisted by a well-functioning and knowledgeable Extension Service.
- Producers must become more aware of the customers' needs and wishes.
- Expansion of avocado growing in certain ecological zones must only be carried out with superior grafted varieties adapted to given climatical conditions.
- Cultivars, quality, husbandry measures, handling, packaging and presentation are some of the factors that still need to be improved in future.
- Avocado consumption can be promoted by stressing the high nutritive value of the fruit.

This book is primarily intended to be a valuable reference to avocado growing in Kenya. It should also be useful for farmers and extension staff as a practical guide on the main aspects regarding the establishment and maintenance of an avocado orchard. It emphasizes locally available avocado varieties that are suitable for commercial and home garden production.

USES AND FOOD VALUE

The avocado fruit was once a luxury food reserved for the tables of royalty but is today enjoyed around the world by people from all walks of life. Combined with its outstanding productivity in Kenya, the avocado has many uses and its nutritive value is exceptionally high. A serving of avocado provides about twice the amount of the daily requirement of several minerals and vitamins. For a fresh fruit, it has unusually high protein content – comparable to animal sources in quality. The high content of both minerals and proteins makes avocado a highly nutritious food; avocado oil is easily digestible and can have beneficial effects on the digestive system. The oil is largely unsaturated and as the sugar content is low – about three percent – the fruit can be recommended as a high-energy food for diabetics. Avocado cannot be cooked and is generally eaten 'raw' on bread or in salads with lemon juice, salt and pepper. Very often the fruit is simply halved and spiced with salt, pepper, sugar and/or various fillings according to individual tastes.

Other important uses of the fruit are as flavouring in the preparation of ice cream and as a base for milkshakes and soups. Moreover, avocado oil is in great demand for the preparation of a wide range of cosmetics. For anyone wishing to increase their vitality naturally, try the avocado and enjoy!

Calories and Nutrients per 100 g edible portion of Avocado

Nutrients		Minerals		Vitamins	
Calories	50 – 220 kcal	Calcium	11.0 mg	Vitamin A	612.0 I.U.
Protein	0.8 – 4.4 g	Iron	1.18 mg	Vitamin C	7.9 mg
Carbohydrates	1.2 – 10.0 g	Magnesium	41.0 mg	Thiamin	0.11 mg
Fats	5 – 32 g	Phosphorus	42.0 mg	Riboflavin	0.12 mg
		Potassium	634.0 mg	Niacin	1.92 mg
		Sodium	12.0 mg	Vitamin B-6	280.0 µg
		Zinc	0.42 mg	Folacin	65.5 µg
		Copper	0.27 mg		
		Manganese	0.24 mg		

Source: USDA – Nutrient Data Lab (1996)

Minimum daily vitamin and mineral requirements for healthy people

Vitamin A	(IU)	=	2500
Vitamin C	(mg)	=	60
Thiamin	(mg)	=	1.5
Niacin	(mg)	=	19
Iron	(mg)	=	18
Calcium	(mg)	=	1000

Source: 'Vitamins and Minerals', Leonard Mervyn (2000)

HISTORY AND BOTANY

The avocado (*Persea americana*) – also called 'Mwembe mafuta' in Kiswahili – belongs to the family of Lauraceae that also includes the laurel, the camphor and the cinnamon tree. The avocado is native to Southern Mexico, Central America and northwestern South America. As one of the most nourishing tropical fruits, it has been cultivated in tropical America since pre-Columbian times. It was introduced to Florida in 1833 and to California in 1871.

In Kenya, it was most probably the Portuguese who were responsible for the dissemination of avocado during the 16th and 18th centuries. By 1939, such improved cultivars as Puebla, Nabal, Lyon, Lula, Linda and at least two strains of Fuerte – one from California and one from South Africa – had been introduced. They adapted very well to the highlands of Kenya, and especially Fuerte and Puebla have been promoted ever since. Statistics indicate that during 1970 about 23 tonnes of avocado were exported, while in 1984 this figure had climbed to 1400 tonnes. Since 1965, a cultivar introduction programme has been initiated in order to screen more cultivars suitable also for lower altitudes and/or agro-ecological zones.

Three horticultural races of avocado are known that originated in Mexico, Guatemala or the West Indies and each of these has its distinctive characteristics (**see Appendix 5**):

GUATEMALAN RACE (semi-tropical)

Fruits of this race have thick, hard skins that are often pebbled or rough. The mostly large seed is always set tightly in the cavity. The oil content is average and fruits generally keep well both on the tree and under refrigeration. The fruits, for example Hass and Reed, mature late.

MEXICAN RACE (sub-tropical)

The fruits are relatively small, thin-skinned and do not store well; crushed leaves have a typical strong, aniseed-like smell. The seed is usually large and is often used as a rootstock known for its high tolerance to *Phytophthora*. The fruits of cultivars Puebla and Teague, mature early to mid-season.

WEST INDIAN RACE (tropical)

The fruits are normally large and pale green when ripe, sometimes with a reddish blush. The oil content is comparatively low and the skin is tough, leathery and smooth. Fruits are easily bruised but cultivars of this race are well adapted to the hot humid tropics and are also the most tolerant ones with regard to salinity. This race includes the early maturing varieties such as Hardy and Simmonds.

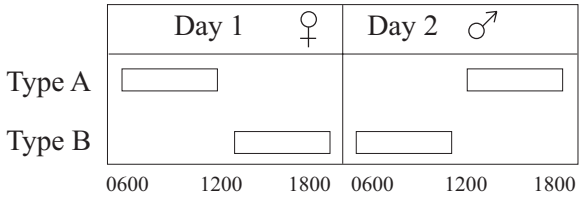
Hybrids of the above-mentioned races have the characteristics of both parents. If one parent is Mexican, for example, the hybrid will retain some of the aniseed scent and the hardiness of that race. Fuerte and Zutano are Mexican x Guatemalan hybrids, among others.

In Kenya where all the three races and their hybrids are grown at more or less the same latitude, the West Indian race is usually found between sea level and 1000 m, the Guatemalan race is best adapted to an altitude between 1000 and 2000 m while the Mexican race flourishes best from 1500 to 2500 m.

The medium to large avocado tree is evergreen but some cultivars may be very sparsely foliated for a short period during flowering time. Seedlings generally grow upright and may reach a height of over 25 m whereas grafted trees remain smaller. Depending on race or cultivar, grafted trees may be low and spreading or tall and upright. The development of the root system is greatly influenced by climate, soil and cultural practices. Generally, a high portion of roots is located at a depth of up to 60 cm and may penetrate to 1 m and more, depending on the soil profile. It has been reported that lateral roots spread to a distance of 5 – 6 m. The avocado's leaves are simple, entire and multiform in shape ranging from lanceolate to ovate and grow to a length of 7 to 35 cm. At their juvenile stage, they are light green or reddish and turn dark green, thick and leathery when mature. They are arranged alternately, appearing in flushes and are crowded at the tip of the branchlets.

Vegetatively propagated trees usually start flowering 3 – 4 years after having been planted into the field. Under normal circumstances, inflorescences appear mainly during the months August to September, each carrying up to over a hundred yellowish to greenish flowers. During one bloom period, a well-established tree may produce about a million flowers but will carry only 0.1% of these through to mature fruits. It has also been noted that depending on the location, the same cultivar may flower differently and that off-season flowering – often in March-April – is quite common. The flowers are borne in clusters at the terminals of branches of the current season's growth. The avocado has a unique flower behaviour and cultivars are classified into A and B types.

Flowers of type A first open during the morning when their stigmas are receptive (female stage) and close around noon. They remain closed until noon of day 2, then re-open and release their pollen (male stage). The timing of maturity of different sexual parts of the flower in type B cultivars is exactly opposite.



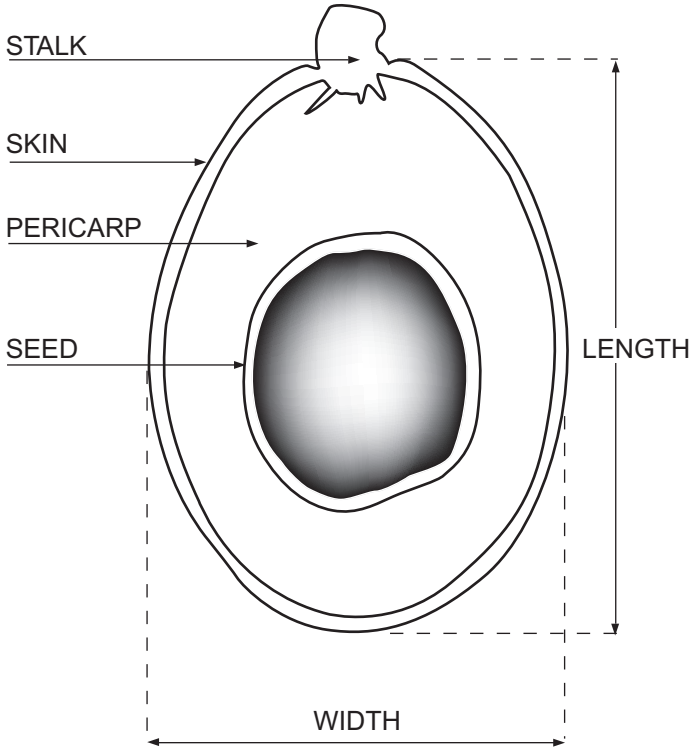
In Kenya, a lot of overlapping within one flower type has been observed and this is one of the reasons why, for example, the Fuerte sets fruits quite reasonably without a pollinator. Nonetheless, in order to ensure proper pollination – which is carried out by bees and other insects – the mixed planting of A and B types is recommended.

Avocado cultivars grouped according to floral type

Type A	**Type B**
Hass	Zutano
Reed	Bacon
Lula	Fuerte
Puebla	Nabal
Simmonds	Linda
Choquette	Booth 7
Waldin	Booth 8
Sama	Tonnage
Pinkerton	Winter Mexican

Fruits of the avocado tree have one single large seed, made up mainly of two cotyledons and surrounded by three concentric layers called the pericarp (**see figure 1**). Fruits of different cultivars vary greatly in size, shape, colour and other characteristics and can weigh up to more than 2 kg. Fruits do not ripen until they drop or are picked from the tree. When mature, the flesh is of a buttery consistency and – depending on race – has an extremely high oil content (up to 30%) which in fruit growing is only surpassed by the olive. Sometimes small sausage-shaped fruits may develop. These are without seeds and are referred to as 'fingerlings' or 'cukes' (see page 44). Mostly Fuerte is susceptible to this.

Figure 1 Avocado fruit diagram



PROPAGATION

It is a well-known fact that avocado trees grown from seed are of uncertain quality because they are not 'true-to-type'. They vary for example in their habit of growth, productivity, fruit quality and the time required before the trees start bearing fruit. Most seedlings are therefore not recommended as commercial planting material although they can be used as a rootstock. Research stations do still carry out propagation by seed however to select and breed new cultivars.

Very little is known about the best choice of rootstock for Kenya. Different rootstocks (clonal or seedling) have not proved to significantly affect fruit quality in the avocado, nor fruit size, apart from indirect influences regarding crop yield or tree health. Previously, and mainly because of their easy availability, Fuerte seeds have often been used as rootstock ignoring their inferior uniformity and only mediocre rootstock performance. Rootstocks of the West Indian race, where they can be used, have significant advantages, including: greater resistance to salinity and chlorosis, greater tolerance towards drought and nutritional deficiencies. As long as *Phytophthora*

cinnamoni (rootrot) does not become a serious problem, the best approach would be to use the seed of cultivars like Lula or Waldin. With respect to *Phytophthora* tolerance, seedlings from the cultivars G 6 and Duke 7 have shown the best performance.

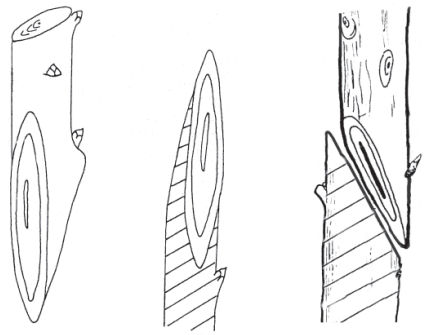
Seed must be collected *only* from healthy and vigorous mother trees and from fruits which are mature and healthy. Seed removed from fruits that have dropped to the ground or even from decayed fruits must not be used as this increases the risk of *Phytophthora* infection. Average to large-sized seeds generally produce vigorous seedlings since the cotyledons contain a large reserve of food supply for the growing plant.

Prior to planting, extracted seeds should be treated in hot water not exceeding 50^{o}C for 30 minutes and then coated or dipped in a broad spectrum fungicide to prevent infection with *Phytophthora cinnamoni*. Seeds are planted with the flat basal end pointing downwards either in nursery beds or directly into perforated black polythene bags, about 20 cm in diameter, and 30 cm deep. During germination shade cover can be up to 80%. Soon after germination, when approximately 20 cm high and having developed two pairs of leaves, the open-seeded seedlings are uprooted, culled and transplanted into containers. Shade may need to be manipulated at approximately 30 – 40% to avoid sun scorching. Whatever potting media is used, it should be of medium texture, sterilized if possible and with good drainage properties. A recommended mixture, for example, could be composed of five parts of topsoil, two parts of coconut fibre, two parts of compost and one part of gravel. For other compost mixtures, a target of 20% air filter porosity and 300 ml/litre water holding capacity would be good. Nurseries should be sited away from areas of pineapple cultivation as this is a source of *Phytophthora cinnamoni* infection.

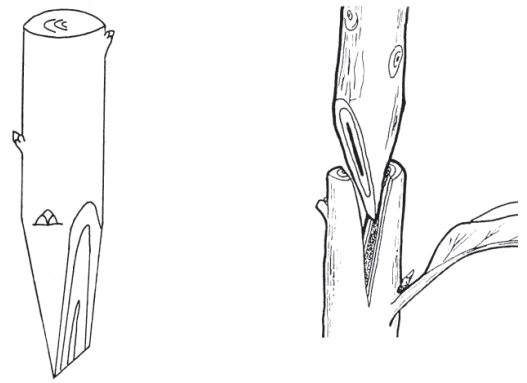
About six months after transplanting, the seedlings will be ready for side grafting, although also wedge or cleft and whip grafts are successful, among other grafting methods (**see figure 2**). Whip grafting with a 2.5 cm cut is useful with small diameter scions (6 – 13 mm diameter). Wedge grafting gives a stronger graft union compared to whip grafting.

Distinct differences in the productivity of different scion sources of the same cultivar have been observed, and the selection of high standard and healthy mother trees is therefore necessary in order to achieve uniform planting materials. A good scion consists of a mature terminal shoot, about 5 cm long, and with (2 – 3) fully developed buds. After the scion has been cut from the tree, all its leaves must be removed at once in order to prevent drying. Three to four months after grafting and at the end of their first growth cycle, the trees are ready to be transplanted into the field.

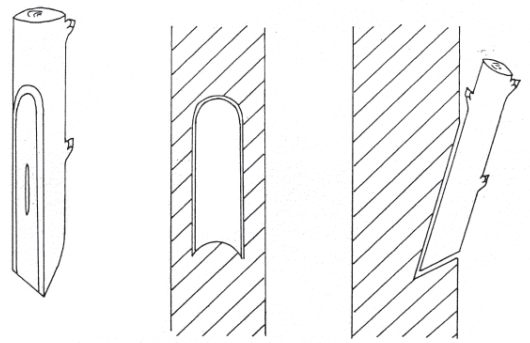
Figure 2 Grafting techniques



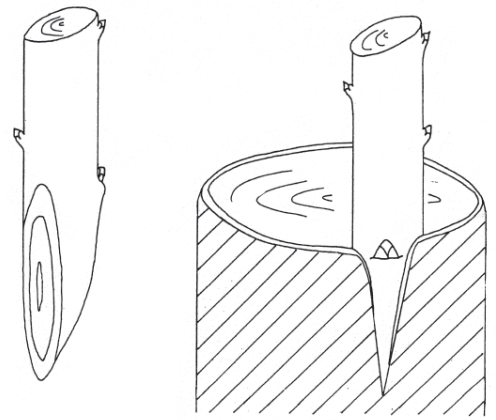
Whip Graft



Wedge Graft



Side Graft



Bark Graft

ESTABLISHMENT

The planting of a new commercial avocado orchard is a long-term investment and requires proper planning and considering several important aspects.

Ecological Requirements

Temperature and Altitude

Various races of avocado have adapted to elevations from sea level up to over 2000 m. This indicates its adaptability to a wide range of environments. The West Indian race prefers warmer/lower altitude conditions below approx. 800 m, while the Mexican race can withstand -5^{o}C for short periods and prefers the higher elevations of up to 2500 m. The Guatemalan race and the hybrids are found between these two as far as temperature is concerned (**see Appendix 6**). For optimum growth and yield, temperatures of 25 to 30^{o}C are believed to be ideal. Prolonged exposure to temperatures above 35 to 40^{o}C combined with low relative humidity will damage fruits and leaves through sunburn, resulting in stress and reduced productivity.

Rainfall

Avocados are moderately drought tolerant. Irrigation will be beneficial to plant growth and crop yields during prolonged dry periods. Critical stages of moisture demand occur during flowering, fruit-set and fruit development. In Kenya, an annual precipitation of 1000 – 1200 mm seems to be sufficient for avocado cultivation, with a minimum of 750 mm being essential for a reasonable crop development. Irregular rainfall distribution sometimes creates problems. Appropriate measures must be taken to preserve moisture and to reduce evaporation, for example by mulching and through weed control. Occasional rain showers during the flowering season will not harm the flowers.

Soil

Avocados will grow successfully in a wide range of soil types but do not tolerate flooding or poorly drained soils. Deep, fertile, well-aerated, particularly sandy or alluvial loams with neutral or slightly acid pH values (pH 5 to 7) are desirable. Heavy soils or those having a high water table are unsuitable and should be avoided. Under these conditions, trees are highly susceptible to root infection by *Phytophthora* as well as nutrient deficiency symptoms, particularly zinc and iron. A good soil structure is necessary since the roots have a high oxygen requirement. Avocado roots are extremely sensitive to high salt concentrations/saline conditions.

Cultivation Requirements

Site Selection

The chosen planting site should be cleared of tree stumps, bushes, big stones and perennial weeds. This will be followed, if necessary, by levelling off to remove unwanted anthills. Land preparation is similar to that for other crops, namely one deep ploughing (30 - 40 cm) and two to three harrowings. To achieve a good tilth of the cleared land, fruit growers are advised to plant an annual crop a year before starting fruit cultivation. If frequent strong winds are expected, the early establishment of a windbreak hedge is necessary. Depending on location, tree species like *Cupressus*, *Casuarina*, *Grevillea*, etc. can be used for this purpose. Unprotected avocado orchards will be affected by stunted growth, increased evaporation and erosion, defoliation, damaged branches, bruised or even blown off fruits. If there is a choice, level or slightly sloping land is advantageous, otherwise contour cultivation or even terracing may be necessary.

Layout

If possible, trees should be planted in straight lines to facilitate crop husbandry measures and harvesting. There are different systems of layout, including the rectangular, hexagonal or square system. In Kenya, the rectangular planting pattern is mainly used. This permits unhindered movement of machinery between the rows for cultivation, spraying, pruning and harvesting. It also allows maximum penetration and utilization of sunlight by the lower parts of the trees. The close square planting system, later followed by a 'tree-thinning' operation is not often practised because crowded and expensive trees may have to be removed before bearing their first economic crop.

The planting distances depend on altitude, soil type/fertility, cultivar and climatic influences. Wider than normal spacing is necessary if the soil fertility is poor, maintenance inputs are limited and plants depend mainly on rainfall. Overcrowding leads to increased infestation with pests and diseases and will consequently reduce yield and income. Depending on the above-mentioned variables, recommended tree spacings are indicated in the cultivar descriptions and vary from 6 m x 7 m to 8 m x 10 m.

Lower returns per ha in the starter years can be compensated by inter- or under-cropping. Annual crops like beans, maize, sunflower, simsim, etc. are suitable, but it must always be kept in mind that a minimum distance of two metres from the young trees needs to be observed.

Preparing planting holes

After the layout and pegging, the digging of planting holes commences. This should be carried out during the dry season and be completed when the rainy season starts. As a rule, the individual holes should be dug sufficiently large and deep to accommodate the baled nursery tree comfortably, leaving enough additional space for the refill of soil on the sides and under the bale. Usually, planting holes measuring 60 cm square and up to 70 cm deep are recommended. If compacted layers of gravel or murram outcrops intervene, it is essential for these hardpans to be broken up to allow free drainage and unhindered development of the root system.

The right time for taking soil samples is when digging the planting hole. For obtaining correct values, care should be taken not to mix topsoil and subsoil and to take separate samples of each for analysis. It is also important to keep topsoil and subsoil separate during planting, as the nutrient content is different, topsoil being more fertile.

To achieve the best analysis results, take 10 to 12 topsoil samples (from 5 to 15 cm depth) from different locations in the field, place in a bucket, mix thoroughly and put approximately 1 kg of this representative mixture into a properly labelled delivery container. Repeat this procedure with soil from a depth of 16 cm downwards (subsoil) and fill a separate container. After delivery for examination to the National Agricultural Laboratories, (P.O. Box 14733, Nairobi), you will receive detailed information about the status of the soil and relevant advice concerning proper fertilization of your tree crop.

As a rule, one should always try to supplement the topsoil taken from the planting hole with an application of manure, phosphate and, if necessary, a soil insecticide. Two buckets of well rotten farmyard manure and 250 g of double superphosphate, well mixed with the topsoil, will significantly improve the structure and fertility of the filling medium.

Planting

To utilize the full benefit of the seasonal rainfall, trees should be planted as soon as the rain has deeply penetrated the ground. Trees planted at this time of the year have a full growing period ahead to establish themselves before the next dry season approaches. Potted plants, usually in plastic sleeves, must be removed from their containers in the field right at the planting hole in such a way that the soil around the roots is not disturbed. After the plastic is cut and removed, the plant is placed into the planting hole. Again, great care must be taken not to damage any roots while filling the hole. Tamp the soil as you fill, but never plant an avocado tree deeper than the soil level it was in while in the plastic bag. After planting, the leftover soil is used to build a basin around each tree in order to collect water from rain or irrigation.

Newly planted trees should be irrigated immediately with enough water (15 – 20 litres) to settle the soil around the bale and to wet the roots thoroughly.

To ensure ample moisture, this watering may have to be continued – depending on rainfall – until the first young shoots appear. In order to minimize moisture loss and sun-scorch growers are advised to whitewash the stems of their young trees with a 10% solution of agriculture lime. Furthermore, each tree must be mulched which helps to reduce water loss through evaporation and controls weeds. Keep the mulch at least 10 cm from the trunk to deprive harmful pests of a hiding place next to the tree.

Finally, the young orchard must be protected against livestock and wild animals. These cause damage to the leaves, shoots, flowers and fruits, thus preventing the trees to develop properly.

ORCHARD MAINTENANCE

Pruning

Formative pruning during the first years is desirable to encourage lateral growth and multiple framework branching. In order to reinforce this shaping of the tree, sucker growth must be continuously stopped by removing all shoots originating from below the grafting joint. These shoots grow from the rootstock and are not part of the grafted cultivar. Training a tree means creating a strong central shoot from which extend spaced side branches at the desired height and the creation of a bare main trunk about 50 – 70 cm in height. Keep in mind that excessive pruning of a young tree in its juvenile stage will definitely delay the productive phase.

In later years, pruning is mainly undertaken to influence the size, quality and quantity of the fruit. It includes the removal of undesired shoots inside the canopy, the pruning of broken or diseased branches and the shortening of those touching the ground. The best time to prune is during the dormant season. This is also the best moment for the frequently required rejuvenation pruning aimed at bringing declining/neglected trees back to full productivity. To avoid fungus infestation, wounds created during pruning have to be treated with a suitable sealing compound. Furthermore, exposed trunks and branches need to be whitewashed to protect against sunburn.

Weed control

Timely weed control and soil management are necessary to prevent competition from weeds for sunlight, water and nutrients. There are two main objectives of orchard tillage: cultivation for moisture infiltration during the rainy season(s) and cultivation for moisture retention during the dry season.

There are five basic approaches to weed control:

1. Mechanical cultivation

This method will be used when establishing the orchard but any further weed control in an existing orchard using heavy machinery should be avoided in favour of other methods, or at least be carried out very carefully.

Possible problems related to the use of heavy machinery can be: damage to the shallow, most valuable root system; increased risk of *Phytophthora* root rot infestation, injury to branches and fruits; harm to the soil structure and promotion of erosion.

2. Manual cultivation (hoeing/pulling)

To avoid injury to the shallow roots around newly planted trees, pulling weeds by hand is the preferred method. Especially in orchards where the area to be weeded is small, shallow hand hoeing should be practised. Deep hoeing must be avoided as it not only severs avocado roots but also turns up new weed seeds to germinate. Using a fork-jembe has numerous advantages and is highly recommended.

3 Intercropping / cover crops

Intercropping with annual crops, preferably legumes, at a sufficient distance from the trees and implemented during the rainy seasons is often practised. Among other benefits, this also creates some additional income for the farmer during the first few years before the young orchard starts producing profitably.

If the farmer does not depend on the extra income from the cash crop, he/she ought to allow the natural growth of weeds between the rows. However, it is most important to keep them under control; they must be slashed several times to keep them short. Under no circumstances should there be any competition with the young trees. Towards the end of the rainy season, the whole plantation has to be cultivated as many times as necessary in order to eliminate all existing weeds. This will supply the soil with humus, reduce evaporation and increase moisture retention.

4. Mulching

Mulching has proved to be a very effective measure for improving the performance of many crops. Its main advantages are:

- marked reduction of weed growth;
- control of wind and water erosion;
- increased moisture holding capacity;
- improved water infiltration rate;
- improved soil structure;
- increased activity of beneficial soil micro-organisms;

- regulation of surface soil temperatures;
- better feeder-root development near the surface.

Many materials, such as leaf litter, grass, straw, compost and manure can be used as mulch. If straw mulch is used, a light pre-application of nitrogen is advisable. The mulching material should have no contact with the tree trunk, but it is important to cover the ground area which is exposed to sunshine and not protected by the shade of the growing canopy.

Since most of the organic cover material decomposes very rapidly, re-mulching should be carried out whenever additional mulch is available.

5. Herbicides

Weed control using herbicides is not very common in Kenya's avocado industry. Herbicides are expensive and – if not properly handled— may burn the avocado foliage through direct contact. However, they can be used as a control measure where labour force is costly. A well-known systemic product for the elimination of broad-leaf weeds and annual/perennial grasses is available under the trade name 'Roundup' and is mainly used for ring or strip application.

Irrigation

Irrigation becomes important when rainfall does not fully meet the requirements of a certain species of tree. Immediate and harmful effects such as reduced fruit-set, dropping of fruits, smaller fruits, poorer fruit quality, reduced yields and stunted trees usually follow lack of soil moisture.

Irrigation programmes vary, depending on orchard location, climate, soil type and kind of fruit to be grown. The most crucial period of water deficit is during the two months after fruit set. Before costly investments in irrigation equipment are made, hydrological, economic and financial aspects have to be considered.

In Kenya, most established avocado trees are rainfed and receive their water needs without additional irrigation. In a normal year, the most crucial period when additional irrigation water may be required, is around mid-January until the beginning of the long rains, usually in April. As soon as a prolonged wilting of leaves, or even in some cases dropping or shrinking of fruits is observed, it is obvious that irrigation is due. During this time approximately 40 - 50m^3/ha/day are needed.

For younger orchards, it is a common practice to use basin irrigation, i.e. approximately from planting up to the sixth year. The basins are constructed at the time of planting, around the base of each tree and then gradually enlarged annually to cover the expanding

root system which is usually 50 cm beyond the drip line of the canopy. These basins are flooded by means of buckets, hoses, pipes, etc. As soon as the trees become fully productive and the water demand is increasing, the basin irrigation may be replaced by other methods like channel, flood, sprinkler or drip irrigation.

No standard recommendation regarding the quantity of irrigation water can be given, and each grower must learn from experience the requirements of his own orchard. Under average high potential highland conditions in Kenya, irrigation is rarely necessary as taproots are able to penetrate into deep, well-structured soils in search of moisture.

Fertilization

Generally, fertilization is essential for plant development, health and productivity. Avocados can take up and utilize adequate amounts of essential elements without much fertilization, provided a suitable fertile plot has been chosen for planting. Many productive orchards in the country never receive a chemical fertilizer. However, manure applications of 5 – 30 kg per tree per year and according to the age of the trees are common. As a point of reference, the yield figures mentioned in **Appendix 7** were recorded from an unfertilized plantation.

However, it is always advisable to have soil samples analysed prior to planting for pH, nutrients and organic matter. Most Kenyan soils are slightly acid and very often deficient in nitrogen and phosphorus. A safe rule is to apply a total of 30 g of actual nitrogen per un-irrigated tree in the first year, continue to double the amount each year until 480 g are reached in the fifth year, which should be adequate thereafter. Since avocados are extremely sensitive to high salt concentrations, it would be safer to keep splitting the total quantity into two or even three separate applications. As nitrogen will penetrate with moisture, nitrogen containing fertilizers are spread around the trees – and only given under moist soil conditions – in such a way that they will cover mainly the so-called drip line area.

Phosphate containing fertilizers will not be absorbed if the soil is too acidic. These fertilizers have also to be worked into the soil to reach the root zone as they will otherwise not penetrate sufficiently. Often, first the pH of the soil has to be adjusted by adding calcium (lime). Since the soil in Kenya often has a tendency to be acidic, calcium-based fertilizers are the safest for most Kenyan avocado growing areas. Phosphorus is an important nutrient, especially for the development and stimulation of root growth of young trees. Since P-fertilizers move relatively slowly in the soil, a pre-plant application is essential if there is an identified deficiency.

Potassium nutrition is more important for yield and fruit quality of mature avocado trees than for young trees that do not yet bear fruit.

There are considerable differences between countries with regard to the amount of fertilizers applied. As long as there are no local soil/leaf sample results available, it would be a big mistake to adopt rates used elsewhere under different agro-ecological conditions. The practice of some growers of applying complete (N-P-K) fertilizers annually may be a waste of money since phosphate and potassium may not be needed. Nitrogen is the most important nutrient but has not to be applied excessively because it will promote vegetative growth rather than flowering. Under certain circumstances zinc, iron, magnesium and boron deficiencies may occur but can be controlled by using foliar sprays containing the required element.

To determine the ideal fertilization programme, not only the soil but also the leaves of the established crop have to be analyzed. In order to obtain an accurate diagnosis, leaf samples of a specific age and position from stress-free trees have to be collected, preferably during morning hours. The leaves are placed into perforated plastic bags, kept under cool conditions and dispatched to the laboratory within 48 hours after sampling. The Horticultural Extension Officer should be consulted in case of doubt. Standard figures have been tentatively defined for those elements that are important to the nutrition of the avocado crop (**see figure 3**). The result of the analysis of the leaf samples will be compared with these from the table and the proper fertilizer application rates can then be calculated.

Tentative leaf analysis guide for diagnosing nutrient status in avocado leaves two months prior to flowering

Element	Unit	Adequate	Deficient less than:
Nitrogen	%	1.6 - 2.0	1.6
Phosphorus	%	0.08 - 0.25	0.05
Potassium	%	0.75 - 2.0	0.35
Calcium	%	1.0 - 3.0	0.50
Magnesium	%	0.25 - 0.80	0.15
Sulphur	%	0.20 - 0.60	0.05
Boron	ppm	50 - 100	10 - 20
Iron	ppm	50 - 200	20 - 40
Manganese	ppm	30 - 500	10 - 15
Zinc	ppm	30 - 150	10 - 20
Copper	ppm	5 - 15	2 - 3

Source: Horticulture Publications
State University, New Jersey, USA (1966)

PESTS AND DISEASES

It is necessary to protect a cultivated plant in the field against attack and injury from pests and diseases. Preventive measures are essential to reduce expensive inputs for controlling losses caused by pests, diseases and weeds, and include management decisions such as: selection of proper orchard site, appropriate plant density, choice of cultivars which are resistant or tolerant to insect infestation or disease, controlled fertilizer application, orchard sanitation and weed control.

Although all the above-mentioned measures contribute to a healthy plant development, the application of pesticides/fungicides may become necessary. The drawbacks of improperly used farm chemicals include risks such as pollution, toxicity, phytotoxic residues, drift damage and resistance. Therefore, apply only recommended chemicals and carefully follow the directions given on the container labels. In particular, adhere to described and very important safety periods – also called 'pre-harvest intervals' – which indicate the length of time between the final application of a pesticide/fungicide and harvesting. A list of some common chemicals can be found in **Appendices 8, 9** and **10**. Where specific insecticides/fungicides have been mentioned in the following text, these are given as examples and should not be regarded to exclude others. Trade names have been avoided as an active ingredient could have several trade names by different manufacturers.

Pests

Fortunately, pests are not a significant constraint to avocado production in Kenya at present and seldom require chemical control measures.

False Codling Moth (*Cryptophlebia leucotreta*)
The adult is a small brownish, night-flying moth. The female lives for about two weeks and may lay 100 – 400 eggs which are deposited singly, mostly on the fruit. After emerging from the egg, the young larva tunnels into the fruit, and the fruit sap thus liberated through the injury forms a typical white crystalline excretion on the surface of the fruit. For some unknown reasons, the larva seems to die when it attacks fruits at an early stage of development but is able to develop fully if fruits are approaching maturity when infested.

Spray application with insecticides such as Dichlorvos, Parathion, Mevinphos, Phosphamidon or Fenthion are effective but should only be used if really necessary.

Thrips

These are small, slender insects, 1 – 2 mm long, with two pairs of fringed wings. Using their piercing/sucking mouthparts they can be a troublesome pest. The characteristic symptom of attack is a silvering of the infested plant tissue which will then turn brown and dry up, if the damage is very severe. Further indications of attack are small black/shining spots of excreta on the infested parts of the plants. If chemical control is considered, products: Fenthion, Carbaryl, Decamethion, Malathion, Omethoate, Diazinon lead to satisfactory control.

Scale Insects

Two main groups of scale insects include the Soft Scales (*Coccus* sp.) and the Armoured Scales. Members of these groups occasionally occur but are not generally a serious problem in avocado orchards. Both are protected by a shell. Damage is caused by toxic saliva, extraction of plant sap and honeydew in association with sooty mould. A severe infestation forms a continuous crust over the underside of leaves. The symptoms of scale attacks on plants are discoloration, malformation, leaf and fruit drop and retarded growth.

Control recommendations are the application of systemic or contact insecticides like: Malathion, Dimethoate, Triazophos, Diazinon, Bifenthrin, Fenitrothion and Omethoate. These sprays are usually more effective if mixed with white oil.

Minor pests to be mentioned are:

- tip wilters (*Anoplocnemis curvipes*)
- avocado bug (*Taylorilygus* spp.)
- fruit fly (*Ceratitis* spp.)
- leaf roller (*Tortrix* spp.)
- mites and aphids.

Fungal diseases

Of much greater importance is the control of some fungal diseases which cause more damage than any pest. Successful/prophylactic spraying programmes depend on:

- the use of the right amount of a recommended fungicide;
- a timely application before infection is most likely to occur;
- permanent thorough fungicide coverage of susceptible plant parts.

Avocado root rot (*Phytophthora cinnamomi*)

This is the most serious disease in nearly all avocado producing areas of the world and in Kenya some outbreaks have also been reported. Every effort has been made to rectify the situation by uprooting or treatment of affected trees. Hot water and fungicide treatment of seeds for propagation purposes is highly recommended and grafting on *Phytophthora*-tolerant and/or resistant rootstocks have been included. In areas subject

to flooding and in poorly drained soils, trees of any size and age are likely to be infected by this fungus. Trees affected by the disease lose vitality, become sparsely foliated and do not produce a good crop. Leaves are pale-green and wilted, branches usually become sunburnt and die back in advanced stages. Feeder roots get darkened and decayed and trees will eventually die prematurely. The fungus can be spread or introduced to new areas by infested planting material, soil and irrigation water.

Two chemicals are registered for the treatment of a *Phytophthora*-affected avocado tree and new ones are being tested continuously:

- Ridomil, active ingredient Metalaxyl, is a soil-applied granular formulation, that works by killing the pathogen;
- Aliette is sprayed onto the leaves and works partly by direct action on the fungus and partly by increasing the natural defence mechanisms of the plant; trees are injected twice annually with a weak solution of fosetyl-aluminium.

Anthracnose (*Colletotrichum gloeosporioides*)
Anthracnose infection is important only on fruits, where it is the most serious disease affecting the avocado. Dry spots, dark brown in colour, form on the skin, leading to abnormal development. In severe attacks the young fruits soon drop. On fruits at a later point of their development, the fungal spores germinate and then enter a dormant stage. The infection remains hidden for a long period until the fruit ripens. It is mostly a post-harvest disease as the fruits are more susceptible when mature. Besides orchard sanitation measures, copper based fungicides are normally used to control the disease but also spray applications with chemicals such as: Benomyl, Mancozeb, Metiram, Propineb, Thiabendazole or Triforine are very successful.

Cercospora fruit spot (*Pseudocercospora purpurea*)
This is another important fruit disease impairing the quality of the avocado. The severity of infection varies from season to season and can cause losses of up to 60%. Small, light-yellow spots later changing to brownish appear on fruits and leaves which eventually become hard and crack, thus creating entry points for other decay organisms. Treatments are the same as those for anthracnose.

Scab
Scab is caused by *Sphaceloma perseae* is usually common in humid areas. The fungus readily infects young, succulent tissues of leaves, twigs and fruits. Lesions appear as small dark spots slightly raised, oval to elongated. These coalesce, giving a corky appearance to the surface of the fruits – impairing the appearance but not the internal quality of the fruit. Recommended treatments are again the same as for anthracnose.

The following are some problems affecting avocado trees that are not diseases:

Carapaces
These develop when the tender surface of very small fruits rubs against the edge of a leaf or twig. Therefore, a thin dry, smooth, superficial layer of light-brown colour is formed which expands less rapidly than the normal surface and leads to the deformation and cracking of fruits.

Algae and lichens
They commonly occur on leaves and branches of trees growing in damp, shady locations. Symptoms appear first on upper leaf surfaces as green, yellowish-green or rust coloured, roughly circular spots. They cause very little, if any, damage to the tree.

Cukes
Pickle shaped, see photo page 44, size of a finger, small sausage-shaped fruits without seeds, referred to as 'fingerlings' or 'cukes'. Fuerte is a susceptible variety.

Fruit drop
Since it reduces the quantity of saleable crop and often markedly so, this is a natural concern to growers. Such fruit drop occurs under the best of care, as a tree gets rid of excess fruits beyond its capacity to mature. For all avocado cultivars, there are two periods in the year when a percentage of the fruit that has set will drop. This is particularly evident during years when there is a very heavy fruit-set.

The first abortion occurs when the fruits have reached pea-size. After the avocados have grown to egg-size, there is another period when a lesser amount of fruit will drop.

When these fruits are opened it can be seen that the seed is black and dead. The reasons for these two types of fruit drops are not well understood but it is assumed that they are due to faulty pollination, other internal physiological malfunctions or unfavourable weather conditions, especially hot/dry winds, sudden chilling or moisture stress.

HARVESTING

Since avocados do not soften on the trees when they mature, it is not easy to identify the right harvesting time. It is good to remember that the fruit **matures** on the tree but **ripens** off the tree. Assessment of the correct harvesting time is important because it directly affects fruit quality, the storage and shelf life. If the consumer buys immature, watery, tasteless and often wrinkled fruits of poor quality that have been picked too early he/she is not likely to buy again. Every individual cultivar will vary in its precise time of maturity from year to year in one particular district.

As an approximate measure, the number of months from bloom, which is mainly in August/September, to maturity is given below:

West Indian cultivars:	5 – 8 months
Mexican cultivars:	6 – 8 months
Guatemalan cultivars:	10 – 15 months

Locally harvested avocado fruits are available throughout the year with the main production of known cultivars occurring from March to October. Fruits for the remaining months, i.e. from November to February, come from seedling trees or West Indian cultivars. Depending on their location and altitude, provinces differ in their picking seasons (**see Appendix 11**) which could be further influenced by planting potential newly introduced cultivars as well as off-season flowering.

A list of available local cultivars and their general season of maturity is as follows:

Early:	Hardy, Ruehle, Teague, Waldin, Tambarina, Simmonds
Early to mid-season:	Winter Mexican, Kyoyl, Zutano, Bacon, Tonnage, Danish W.I. Bank
Mid-season:	TX 531, Booth 7, Booth 8, Choquette, Fuerte, Ettinger, Lula, Puebla
Mid-season to late:	Hass, Pinkerton, Sama, Linda
Late:	Nabal, Reed

Note: The above cannot be generalized to be valid for the whole of Kenya, as – for climatic reasons – not all cultivars can be grown in Nyanza, Western and Coast provinces, for example.

As the harvest season draws near, and depending on the variety, there are some fruit symptoms which are indicators of approaching maturity:

- Dark coloured fruits change from a green colour to black or purple.
- Green fruits develop a yellowish skin tint appearing duller and less shiny.
- On Fuerte and other cultivars, but mainly Mexican types, a whitish 'bloom' starts developing.
- Fruit stems turn yellow on the green cultivars.
- Green fruits develop corkiness near the blossom-end resembling rust.
- Seed coats become dark-brown and tissue-thin and do not adhere to the flesh.
- Some people use the floating test: immature avocados sink or float below the water surface, mature ones float on top of the water.
- Another common method of determining whether a crop is ready for harvesting is to pick a few fruits when they are apparently mature and then leave them to ripen in a warm place. If these soften without shrivelling within a week at about 27^{o}C, then the crop is ready for picking.

It is known that a large fruit size is not necessarily a sure indication of greater maturity but with a little experience and care, the farmer will be able to select fruits that are sufficiently mature to meet the established standards. Fruits from commercial orchards are tested in laboratories for their oil content to determine proper picking dates of certain cultivars. For example, in California the law requires that all fruits test at least 8% oil.

Retailers should expect avocados to arrive in a firm, slightly backward-ripeness condition, graded, free from any disease, bruising or other damage. European markets have very strict requirements regarding quality. Being a luxury fruit avocados sell relatively slowly and it is therefore obvious that a long shelf life is expected. Thus, successful marketing of avocados – especially for export – depends largely upon strict adherence to good handling and packing practices.

All previously implemented crop husbandry measures aimed at achieving a high standard of fruit quality will be a waste of time and money if avocado fruits are treated like potatoes during harvesting and post-harvest handling. Always remember that fruits are easily bruised or scratched and that careful harvesting will already influence the price you will be paid for your produce.

In view of the above, the following recommendations apply:

- Avocado fruits must never be pulled off the tree as this may damage the skin and allow decay diseases to enter.
- Fruits have to be clipped from the trees with secateurs in such a way that a short stem portion of about 0.5 cm is left on the fruit.
- It is recommended that cotton gloves be used during picking, grading and packing.
- Never drop the fruits and never place them on the ground without some protection underneath.
- For picking fruits growing high on a tree, use ladders of suitable length and/or a specially designed picking tool. The latter consists of light wooden or bamboo poles with a cloth catching bag about 20 cm in diameter fixed to the end of it. The bag is held open by a metal rim with a cutting blade attached.
- Generally, a two-person picking team is preferable. The picker in the tree – instead of having to climb up and down the ladder – can lower his/her fruit-filled canvas bucket with a rope to his colleague on the ground for careful emptying into field boxes.
- The sides and bottoms of these should be smooth and free from anything that may injure the fruits.
- Do not fill the field boxes above the top. Fruits in a properly filled field box should never have contact with another box placed on top of it.

- Store the field boxes in the shade in order to minimize sunburn, loss of moisture and dust accumulation. Field storage should be as brief as possible.
- After the produce has been cleaned, graded and repacked in a sheltered place it has to reach the market outlet immediately.
- If a grower intends to join the sophisticated export market, his produce will require additional special treatment after harvesting and prior to marketing. To ensure uniform quality and continuous supply, only experienced registered exporters should be involved in meeting the required export regulations for trimming, washing, disinfecting, drying, waxing, grading, labelling, packaging, transportation, phytosanitation and storage.
- Finally, it has to be mentioned that it is imperative to finalize arrangements for marketing before harvesting the crop. Once harvested, horticultural produce is highly perishable and will not last long in storage. It has to be sold regardless of prevailing market conditions, and the farmer has little bargaining power and will most likely be the loser.

YIELD

The number of fruits that set and mature is small in relation to the number of flowers produced. The quantity of annual avocado production depends on such factors as alternate bearing, location, spacing, poor pollination, crop husbandry measures and source of planting material.

In order to achieve good yields, the following pre-conditions should be applied:

- introduction of bee-hives;
- planting of mixed A and B floral types;
- purchase of planting material from recognized tree nurseries only;
- planting of cultivars adapted for a specific region only;
- considering the essential establishment requirements of an orchard;
- proper maintenance of the orchard.

The first yield may be expected in the third or fourth year after planting and commercial production usually starts in the fifth or sixth year. Yields given in the literature vary from country to country but average about 10 t/ha. The yield performance table found under **Appendix 7** reflects the productivity of some of the cultivars planted in the Central Province of Kenya. Considering that high yields may be expected from the tenth year onwards, the seventh-year Kenya figures are already very impressive. If one converts tonnage figures into numbers of fruits, then Fuerte, in its 8th year, has produced an average of 49 500 fruits and Hass 87 780 fruits per ha.

Some characteristics of Kenya-grown avocado cultivars

Cultivar	Bacon	Booth 7	Choquette	Danish W.I. Bank	Ettinger
Race *	M x G	G x W	G x W	W	M x G
Floral type	B	B	A	B	B
Maturity season	early to mid-season	early	mid-season	early	mid-season
Fruit size	medium-large	medium	very large	small-medium	medium
Fruit weight (g)	175 - 420	250 - 380	450 - 1100	170 - 300	250 - 350
Fruit shape	oval	round - oval	oblong/oblique	oblong/oblique	pear shaped
Average fruit dimensions					
length (cm)	10.1	8.3	12.1	8.8	10.5
width (cm)	6.6	7.5	8.4	6.8	5.7
Fruit colour	green	dark green	deep green	light green	green-light green
Seed % (average)	16.2	27.6	14.6	23	18
Eating quality	good-fair	good	good-fair	poor-fair	good
Bearing habit	regular	tendency towards alternate bearing	alternate	alternate	regular
Yield	medium-good	good, high	high	good	light-medium
Tree growth	medium, erect tall, upright	vigorous, spreading	wide and spreading	upright with downward hanging branches	vigorous and upright
Spacing (m)	7 x 8	7 x 8	7 x 7	7 x 8	7 x 8
Oil %	16 - 18	10 - 14	6 - 12	3 - 6	18 - 22

*** G = Guatemalan**
M = Mexican
W = West Indian
x = Hybrids

Some characteristics of Kenya-grown avocado cultivars

Cultivar	Fuerte	Hass	Hardy	Kyoyl	Linda
Race *	M x G	G	W	W	G
Floral type	B	A	B	B	B
Maturity season	mid-season	late	early	early to mid-season	mid-season
Fruit size	medium	small-medium	medium	large	medium-large
Fruit weight (g)	290 - 380	140 - 340	160 - 310	250 - 545	250 - 800
Fruit shape	pear shaped	oval-pear shaped	oblong/oblique	oblong	elliptical
Average fruit dimensions					
length (cm)	11.3	8.5	10.7	13,3	10.4
width (cm)	7.5	6.4	6.4	7.6	7.1
Fruit colour	green	brownish-black	light green/reddish	deep green	purple
Seed % (average)	13	22.5	23.1	13.6	12.6
Eating quality	excellent	excellent	fair	poor-fair	excellent
Bearing habit	tendency towards alternate bearing	regular	regular	alternate	regular
Yield	light-medium	heavy	good	medium	good
Tree growth	large and spreading	large and spreading	wide and spreading	large and upright	medium, upright
Spacing (m)	8 x 10	7 x 8	8 x 8	8 x 8	7 x 7
Oil %	16 - 25	18 - 23	6 - 8	7 - 9	10 - 15

*** G = Guatemalan**
M = Mexican
W = West Indian
x = Hybrids

Some characteristics of Kenya-grown avocado cultivars

Cultivar	Lula	Nabal	Pinkerton	Puebla	Reed
Race *	G x W	G	G x M	M	G
Floral type	A	B	A	A	A
Maturity season	mid-season	late	mid-season	mid-season	very late
Fruit size	medium-large	large	medium-large	medium	medium-large
Fruit weight (g)	230 - 415	350 - 720	250 - 410	180 - 380	220 - 510
Fruit shape	oblong-pear shaped	nearly round	pear shaped	roundish	ovate-round
Average fruit dimensions					
length (cm)	9.6	10.3	10.8	8.7	8.3
width (cm)	7	9.4	8.2	7.6	7.3
Fruit colour	green	dark green	green	maroon-purple	green
Seed % (average)	39.2	24.9	11.1	23.5	13.7
Eating quality	good	excellent-good	excellent	good-excellent	good
Bearing habit	regular	tendency towards alternate bearing	regular	alternate	regular
Yield	heavy	heavy	heavy	good	good-heavy
Tree growth	large and upright	vigorous and upright	medium, spreading	medium, spreading	medium and upright
Spacing (m)	6 x 7	8 x 8	6 x 7	7 x 8	7 x 7
Oil %	8 - 15	9 - 16	18 - 20	15 - 20	18 - 20

*** G = Guatemalan**
M = Mexican
W = West Indian
x = Hybrids

Some characteristics of Kenya-grown avocado cultivars

Cultivar	Ruehle	Sama	Simmonds	Tambarina	Teague
Race *	W	G	W	W	M
Floral type	A	A	A	A	B
Maturity season	early	late	early	early	early
Fruit size	medium	medium	small-medium	small-medium	small-medium
Fruit weight (g)	200 - 320	210 - 355	150 - 310	160 -300	125 - 280
Fruit shape	pear shaped	pear shaped	pear shaped	elongated	oval
Average fruit dimensions					
length (cm)	10.8	10.5	8.5	10.8	7
width (cm)	7.1	7.4	6.2	5.8	5.7
Fruit colour	light green	black	light green	light green	light green
Seed % (average)	14.7	12.5	23.1	20.1	16.4
Eating quality	fair - good	excellent	fair-good	fair	good
Bearing habit	regular	regular	alternate	alternate	tendency towards biennial bearing
Yield	high	good	good	medium-good	medium-good
Tree growth	wide and spreading	vigorous and upright	large and upright	wide and spreading	wide and spreading
Spacing (m)	7 x 7	8 x 8	7 x 7	7 x 7	8 x 9
Oil %	2 - 5	18 - 25	3 - 6	6 - 9	16 - 21

*** G = Guatemalan**
M = Mexican
W = West Indian
x = Hybrids

Some characteristics of Kenya-grown avocado cultivars

Cultivar	Tonnage	TX 531	Waldin	Winter Mexican	Zutano
Race *	G	G	W	M x W	M x G
Floral type	B	A	A	B	B
Maturity season	mid-season	mid-season	early	mid-season	early
Fruit size	medium-large	medium-large	medium	medium	medium
Fruit weight (g)	275 - 550	310 - 540	145 - 315	215 - 350	150 - 397
Fruit shape	pear shaped	oblong/oblique	ovate/oblique	pear shaped	pear shaped
Average fruit dimensions					
length (cm)	10.6	8.4	7.6	7.56	10.7
width (cm)	7	5.6	6.1	5.9	6.9
Fruit colour	green	dark green	light green	dark green	green
Seed % (average)	24	12	25.8	25.4	23
Eating quality	fair-good	good	fair	good	fair
Bearing habit	regular	regular	alternate	regular	regular
Yield	good	high	moderate	moderate	good
Tree growth	tall and upright	large and upright	vigorous and upright	large and upright	tall and upright
Spacing (m)	6 x 7	7 x 8	7 x 8	7 x 7	7 x 8
Oil %	10 - 12	15 - 20	6 - 8	15 - 20	15 - 18

*** G = Guatemalan**
M = Mexican
W = West Indian
x = Hybrids

DESCRIPTION OF AVOCADO CULTIVARS

Bacon

This variety originated from a chance seedling planted in Bueno Park, California and was introduced to the trade in 1951. Its parentage is unknown but it is thought to be a Mexican x Guatemalan hybrid, and it produces type B flowers.

The medium-sized green fruit is of oval shape and has a thin, smooth and glossy skin. Fruits normally weigh 175 – 420 g. The flesh is of fair-good quality, melting, almost free from fibre and has an unusually pale yellow/green colour. The oval seed is tightly set and the average oil content ranges from 16 – 18%. Fruits mature during mid-season.

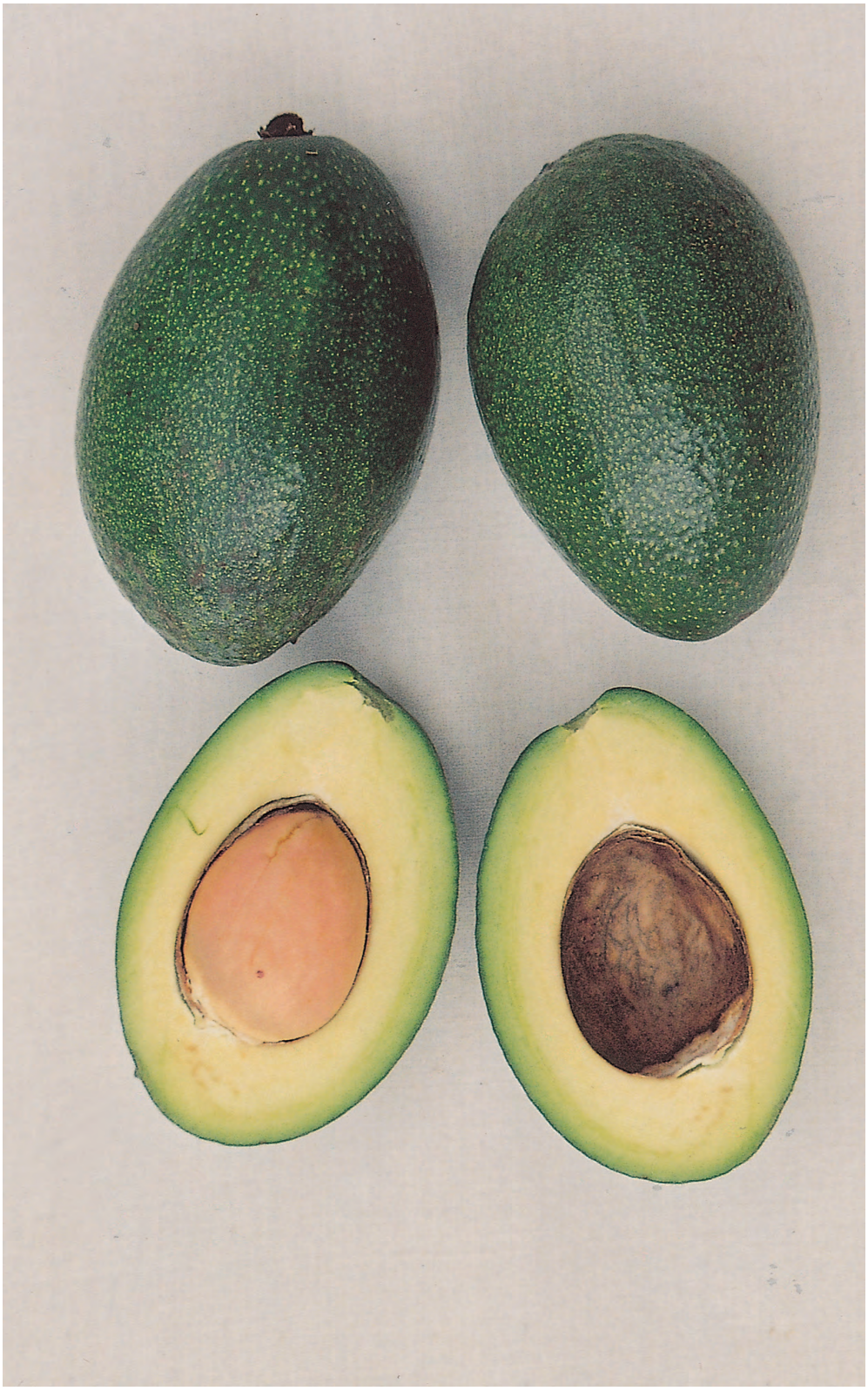
The tree is an upright grower and is very cold tolerant. It is a consistent good producer, and cropping commences at an early age. The recommended tree spacing is 7 m x 8 m.

Advantages:

- early and consistent cropper
- excellent frost tolerance
- good shelf life – stores well

Disadvantages:

- tends to be affected by serious end spot problems
- harvesting is expensive because it requires a high labour input due to tall, upright-growing trees



Booth 7

This variety originated from a chance seedling which was planted in Florida in 1920. From 1935 onwards, it has been propagated commercially. Its parentage is unknown but it is assumed to be a Guatemalan x West Indian hybrid, and it produces type B flowers.

The medium-sized dark-green fruit is round or ovate in shape and has a slightly rough/grainy, thick and brittle skin. The yellow flesh is of good quality, melting, almost free of fibre, and the average oil content ranges between 10 – 14%. The rather big ovate seed separates cleanly from the flesh at maturity. Fruits normally weigh 250 – 380 g and mature at mid-season.

The vigorous, spreading tree is a good cropper but shows a tendency towards alternate bearing. Recommended spacing is 7 m x 8 m.

Advantages:

- spreading tree-growth and consequently easy harvesting
- firm, leathery fruit-skin prevents damage during handling
- flesh peels readily from the skin

Disadvantages:

- alternate bearing
- susceptible to infestation by False codling moth
- large seed cavity

Booth 8

Like Booth 7, this variety also originates from a chance seedling of unknown parentage, which was planted in Florida in 1920. It is assumed to be a Guatemalan x West Indian hybrid and produces type B flowers.

This is one of the most widely grown cultivars in Florida. The medium – large, oblong-ovate fruit weighs around 350 – 600 g. The green skin is slightly rough, fairly thick and brittle. The light-green/yellow fruit flesh is of good quality and contains 8 – 15% oil. The medium large seed is tightly set, and the fruit ripens at late mid-season.

Booth 8 is a wide and spreading tree but not as vigorous as Booth 7. It is a good producer but shows a tendency to biennial bearing. Recommended spacing is 7 m x 7 m.

Advantages:

- suitable also for lower altitudes
- easy picking
- good fruit quality
- transports very well

Disadvantages:

- tendency to alternate bearing
- susceptible to infestation by False codling moth

Choquette

This variety originated in Miami (Florida) from seed planted in 1929. Commercial propagation started in 1939. Its parentage is unknown but it is thought to be a Guatemalan x West Indian hybrid producing flowers of type A.

The large to very large, oblong/oblique green fruit is characterized by its glossy, smooth and slightly leathery skin. Fruits normally weigh 450 – 1100 g, and the smooth yellow flesh is of good quality with an oil content of up to 12% and a mild, nutty flavour. The medium, oval seed is tightly set.

The wide and spreading tree bears heavily in alternate years. The recommended planting distance should be 7 m x 7 m.

Advantages:

- large fruits that are sought after locally
- few fibres and good quality
- resists scab disease
- transports well

Disadvantages:

- not favoured on export markets
- alternate bearing
- unfavourable fruit-shape

Danish W.I. Bank

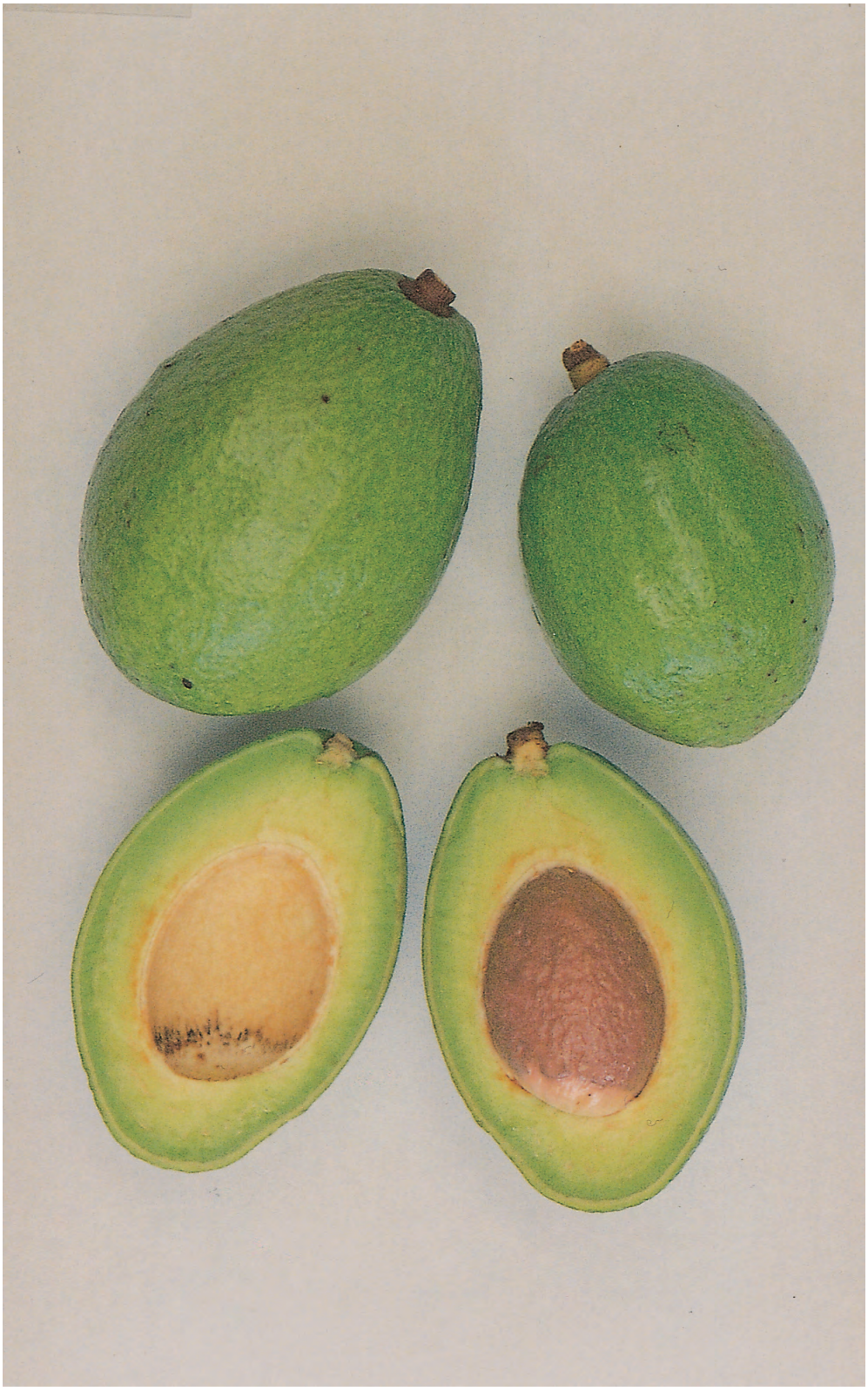
This early season chance seedling originated in Miami (Florida) and the fruits resemble closely those of the Simmonds/Waldin cultivars. Its parentage is unknown but typical characteristics indicate that this must be a West Indian hybrid producing flowers of type B.

The small to medium sized light-green fruit is oblong/oblique in shape and has a thin, smooth and waxy skin. Fruits normally weigh 170 – 300 g. The green/yellowish flesh is of a fair quality, melting, almost free of fibre, and the average oil content ranges between 3 – 6%. The rather big ovate seed is tightly set and separates cleanly from the flesh.

The tree's growth is vigorous with downward hanging branches. It produces a good crop but only every other year. Recommended spacing is 7 m x 8 m.

Remarks:

- Further evaluation of this cultivar is needed before more detailed information can be given.



Ettinger

This variety originated in Kefar Malal, Israel and has been introduced commercially in 1947. Its parentage is unknown but since it is very much related to Fuerte it is thought to be a Mexican x Guatemalan hybrid and produces type B flowers. It is being cultivated mainly in Israel.

The light green, medium-sized fruit is elongated/pear-shaped and weighs around 250 – 400 g. The thin, polished skin is tough/leathery – one of the requirements to be a good shipper. The flesh is light yellow, almost free of fibre, soft-melting and ripens uniformly. The cone-shaped seed is of average – large size and often set loosely in its cavity. Due to an oil content of 18 – 22%, the eating quality can be graded as good. The Ettinger ripens at mid-season, slightly before and/or together with Fuerte.

This variety grows vigorously and upright. It is a light to medium but regular producer. The recommended planting spacing is 7 m x 8 m.

Advantages:

- little fibre
- no distinct biennial bearing
- good quality and shelf life
- transports well

Disadvantages:

- in Kenya, this variety cannot compete with the well adapted Fuerte cultivar.

Fuerte

This variety – found as a backyard seedling in Atlixo/Mexico in 1911 – is thought to be a hybrid between a Mexican and a Guatemalan type and produces flowers of group B. Fuerte has all the qualities local and overseas markets desire; in fact it is the world's best known commercial cultivar up to the present day.

The green pear-shaped fruit is of average size, weighs from 290 – 380 g and has a comparatively small seed, which lies tightly in its cavity. The skin is thin, leathery and slightly rough, and the pale yellow flesh – almost free of fibre – has an outstanding flavour. The oil content ranges between 16 – 25% and the seed separates cleanly from the flesh.

Because Fuerte has a long period of bloom, there may be more than one set of fruits on the trees simultaneously. In contrast with most other varieties, Fuerte has a spreading habit of growth, and therefore the recommended spacing should not be less than 8 m x 10 m.

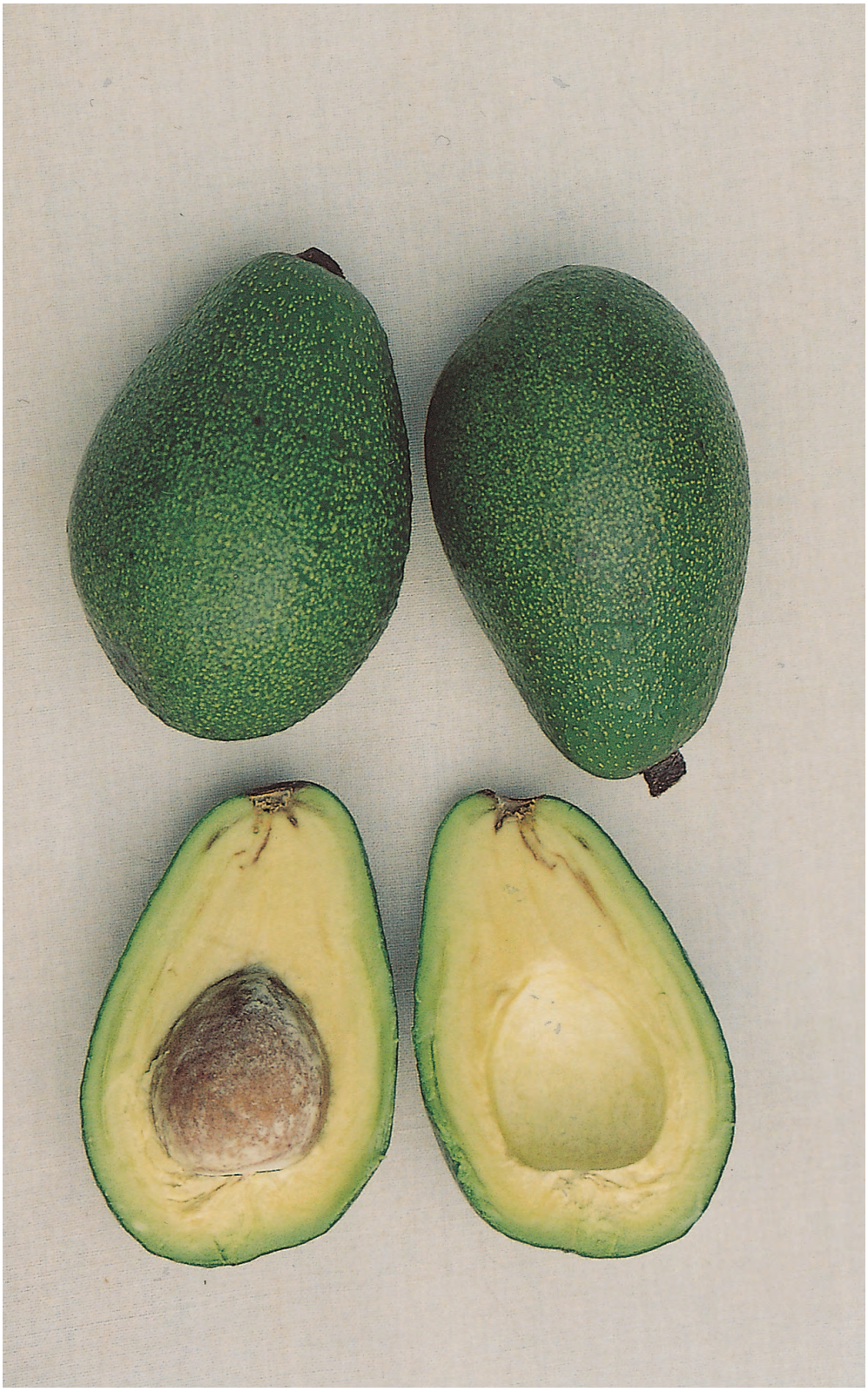
Advantages:

- extended picking season and good shelf life
- green pear-shaped fruit of excellent quality
- one of the most cold-tolerant varieties

Disadvantages:

- tendency to alternate bearing
- performs best at higher altitudes
- susceptible to cercospora and anthracnose
- sometimes produces 'cukes'

'cukes' and in the middle a normal shaped fruit



Hardy

This cultivar is a West Indian race selection that matures very early and originates from a chance seedling planted in Miami, Florida. Hardy produces type B flowers, but it is not recommended for commercial plantings.

The medium-sized, oblong/oblique fruit is only of fair eating quality. Its weight ranges between 160 – 310 g, and the skin is smooth and glossy, light green in colour changing to reddish/brown at maturity. Since the oil content is only 6 – 8%, the pale yellow flesh is not very tasty. The oblong seed is rather big and firmly attached to the flesh.

The tree is wide and spreading, and yields are good and regular. A tree spacing of 8 m x 8 m is recommended.

Advantages:

- good and regular cropper
- early cultivar, unusual fruit colour

Disadvantages:

- only fair eating quality
- very large seed
- does not store well on the tree

Hass

The original tree – a chance seedling – was selected at La Glabra Heights, California, in 1920. Owing to its excellent adaptability to different climatical regions, this Guatemalan cultivar has assumed an important rank in new plantings all over the world. Its flower type is A, and the picking season is later than that of Fuerte.

The mature fruits are of excellent quality with creamy yellow flesh, which is completely free of fibre. The fruits are green at first, but change to dark blue when almost ripe. They are relatively small, weighing up to 340 g, ovoid to pear-shaped with a tough, pebbly skin. Hass fruits ship well, have a good shelf life and have been enjoying wide consumer acceptance ever since the early 1970s. The round seed is small and separates readily from the flesh which has a fat content of 18 – 23% resulting in an excellent nutty flavour.

The variety is a vigorous, moderately spreading tree. It comes into cropping at an early age and usually bears regularly and heavily. Recommended spacing is about 7 m x 8 m.

Advantages:

- excellent, high-quality fruit
- outstanding shelf life and shipping characteristics
- one of the longest harvesting seasons
- early and heavy cropper

Disadvantages:

- when bearing a heavy crop, tendency to produce small fruits
- sunburn on exposed fruits
- large upright trees make harvesting expensive

Kyoyl

This mid-season variety originated in Florida from a West Indian seedling of unknown parentage and produces type B flowers.

The large, oblong to slightly oblique fruits mature at mid-season. Their weight ranges from 250 – 545 g, but the eating quality is rather poor. The skin is dark green, tough and polished. The yellow flesh is juicy and sweet, but the oil content is only about 7 – 9%. The seed is relatively small, approximately 13.6% of the fruit weight, and the flesh is nearly free of fibre.

The tree is a large and upright grower. Yields are light to good, but only in alternate years. Recommended planting distance should be 8 m x 8 m.

Remarks:

- Before further recommendations can be given, more research in Kenya is required.

Linda

This is a Guatemalan variety, which was introduced to California in 1914 and produces type B flowers.

This mid-season, large variety, varying in shape from oval to elliptical, is purple when ripe and weighs from 250 – 800 g. The thick/rough skin is tough and the seed small and tight. The melting flesh is yellowish, with a very pleasant flavour and has an oil content of 10 –15%; there are no fibres.

The tree is not a vigorous grower, has a slightly spreading habit and regularly bears a good crop. It starts producing fruit at an early age, and the recommended spacing should be 7 m x 7 m.

Advantages:

- outstanding quality
- late maturity
- transports well
- small seed size

Disadvantages:

- sometimes too large fruit size for easy export
- upright tree, difficult to harvest

Lula

This variety is a chance seedling, which was planted in Miami, Florida in 1915. It is a hybrid of Guatemalan x West Indian parentage and produces type A flowers.

The mid-season, pear-shaped, light green fruit has a waxy and almost smooth skin. It weighs 230 – 415 g and has, at one time, been one of the leading commercial cultivars. The pale to greenish yellow flesh is delicious and the oil content ranges from 8 – 15%. It is sweet, melting, and free of fibre. The seed is quite large and is tightly set.

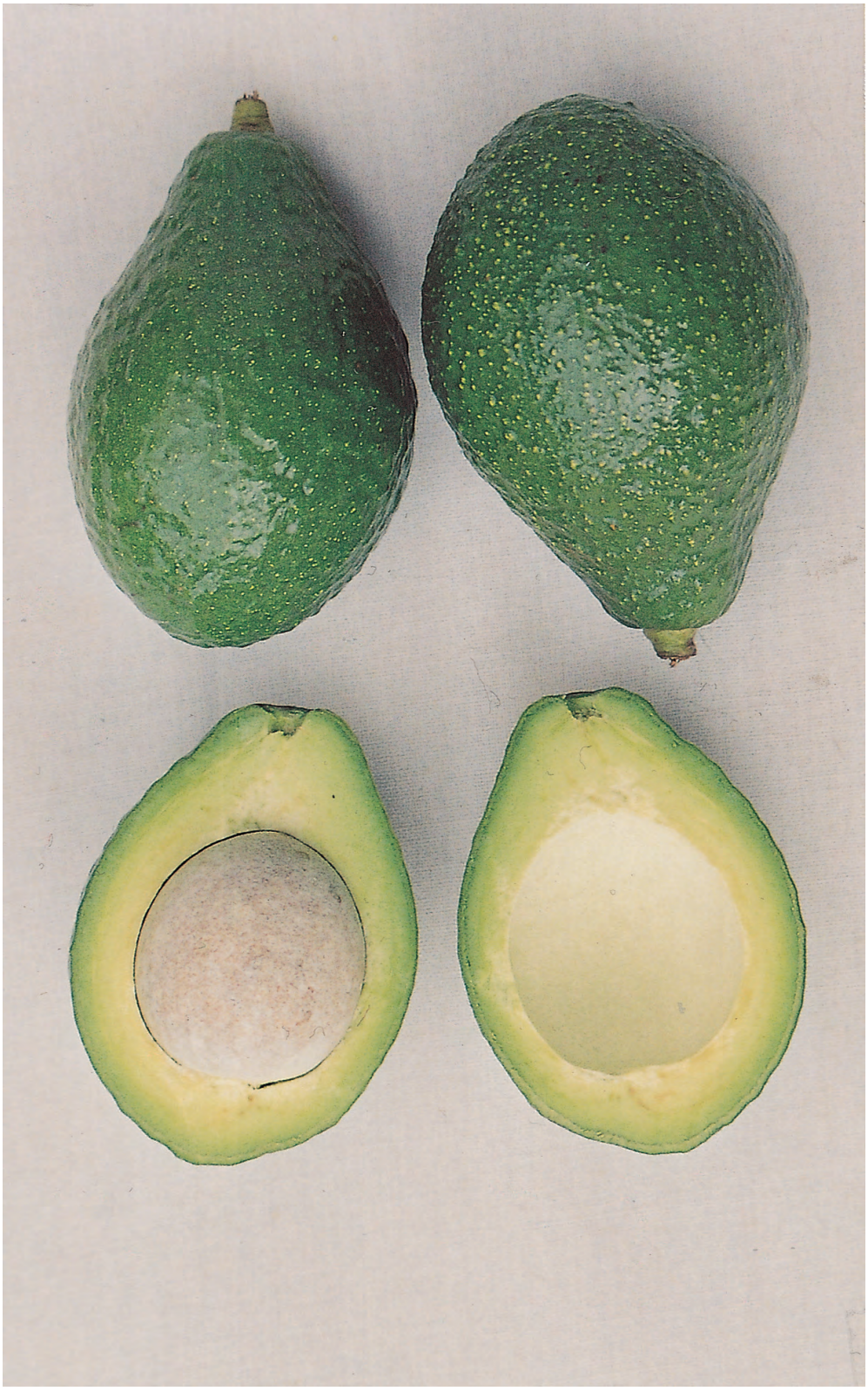
The tree grows tall and upright, bears early, regularly and heavily. The recommended tree spacing is 6 m x 7 m.

Advantages:

- produces early and consistent crops
- has no fibres
- gives heavy yields
- ships well

Disadvantages:

- susceptible to scab
- large seed
- not a well-known cultivar



Nabal

This is a typical Guatemalan variety from where it was imported to Florida in 1937. It produces type B flowers.

The almost round, medium to large fruit matures at late season and weighs between 350 and 720 g. The dark green skin is nearly smooth, thick and granular.

The green/yellowish flesh is of high quality, nutty and melting. Its oil content is about 9 – 16%. The seed is of average size, round and firmly attached to the flesh.

The tree grows vigorously and upright, bears heavily but has a tendency towards alternate bearing. Recommended spacing is 8 m x 8 m.

Advantages:

- ships well
- stores well
- has good quality

Disadvantages:

- tall, upright trees making fruit picking difficult
- alternate bearing
- sometimes the fruit size is too large to export

Pinkerton

This rather new variety originated probably as a seedling of Rincon on the Pinkerton Ranch in Ventura County, California in 1970. It is thought to be a Mexican x Guatemalan hybrid and produces type A flowers.

This mid- to late-season, long, pear-shaped cultivar is of dark green colour and normally weighs between 250 – 410 g. The skin is medium-thick, leathery and pebbled; the high-quality pale green flesh has high oil content (18 –20%) and is of smooth, creamy texture. The small seed separates readily from the flesh with the coat adhering to the seed. The fruit ships well and has a good shelf life.

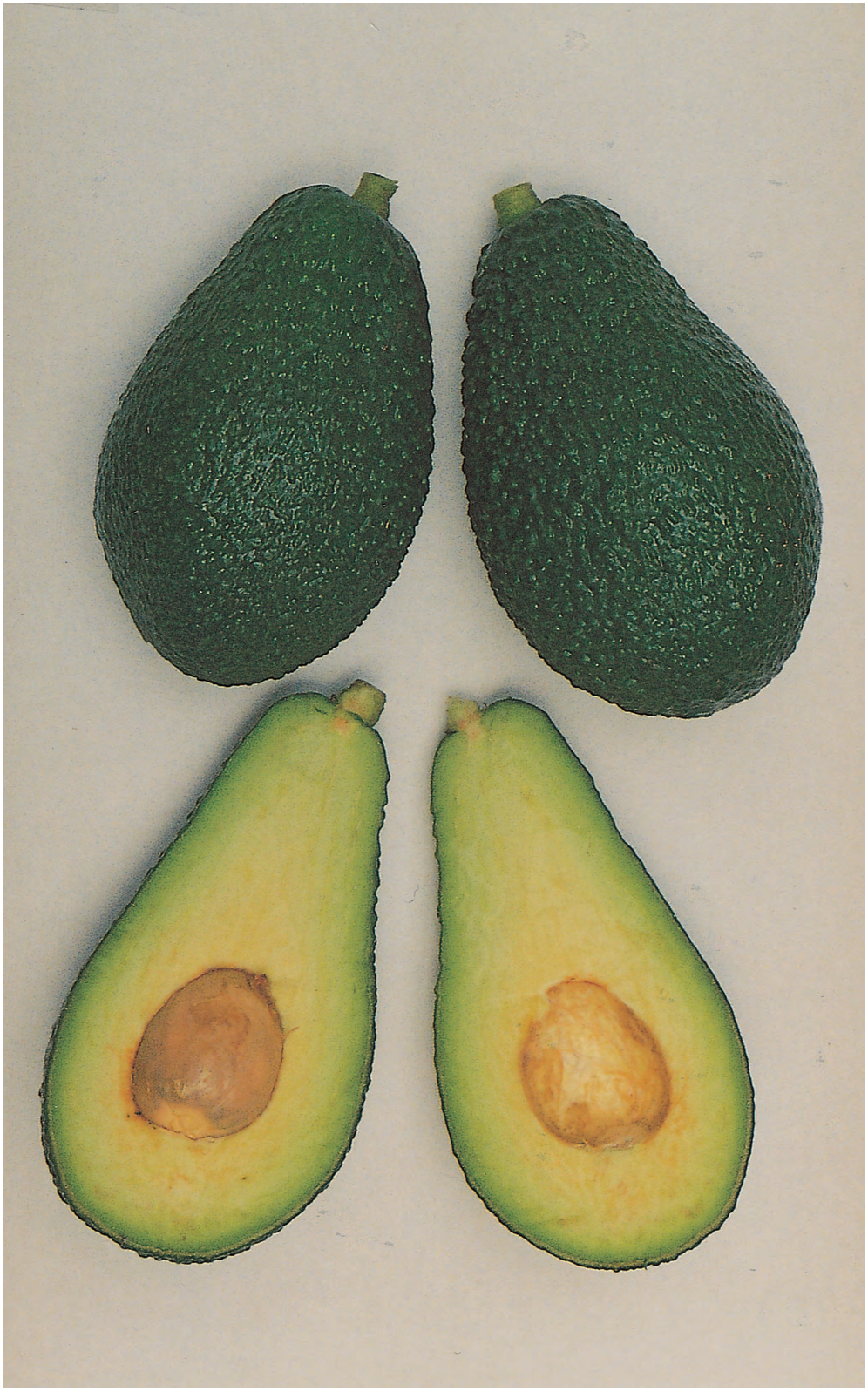
The tree is of medium size, but more spreading than Hass, bears early, regularly and heavily. The recommended planting distance should be 6 m x 6 m.

Advantages:

- good shelf life
- stores and ships well
- late variety
- small seed
- excellent peeling and flesh characteristics
- medium-sized tree
- regular good cropper
- tolerates low temperatures
- resistant to cercospora

Disadvantages:

- has long-necked fruits, which seem to be a peculiarity of juvenile trees. They do not match well with the packers' standardized equipment.



Puebla

This variety originated from a chance seedling, which was found at Atlixco, Mexico in 1911. It is considered as pure Mexican, but some suggest it may be a Mexican x Guatemalan hybrid belonging to the flower type A.

The medium-sized, mid-season cultivar is of ovate shape. Its thin skin is smooth, glossy and purplish-red at maturity. The light green flesh is juicy, melting and of good flavour with an oil content of nearly 20%. The ovate seed is medium to large and tightly fixed in its cavity.

The tree is a very rapid grower, erect with drooping branches but does not set fruits regularly. In Kenya, Puebla was mainly planted as a pollinator for Fuerte. The recommended tree spacing is 7 m x 8 m.

Advantages:

- spreading tree growth and thus easy harvesting
- flesh peels readily from the skin
- few fibres
- good eating quality

Disadvantages:

- does not ship well
- alternate bearing
- large seed cavity

Reed

This Guatemalan variety originated around 1948 from Carlsbad, California, as a seedling, possibly of an Anaheim x Nabal hybrid. Its flower type is A, and it flowers later than most other varieties.

The green, medium to large, nearly round fruit weighs from 220 – 510 g but the seed is relatively small. The flesh is free of fibre and has an excellent nutty flavour. The skin is slightly rough, tough, medium-thick and difficult to peel. The average oil content ranges from 18 – 20%.

The tree is an upright grower with downward hanging branches, bears early and regularly. The recommended tree spacing is about 7 m x 7 m.

Advantages:

- fruit has good shipping and shelf life qualities
- very late maturity
- excellent fruit quality
- small seed size
- early and consistent cropper

Disadvantages:

- fruit size is sometimes too large
- thick skin making it difficult to detect softening of the flesh

Ruehle

A West Indian variety possibly from a seed of Waldin selected at Homestead, Florida in 1923 and first propagated in 1946. Ruehle produces type A flowers.

The pear-shaped, early variety is of medium size and weighs about 200 – 320 g. The fruits are borne in clusters, are light green and have a very low oil content of about 2 – 5% only. The flesh is juicy, firm and of light green colour and without fibres. The skin is smooth, glossy, thin and leathery. The fruit production is good and regular but plantings are only advisable for local consumption.

The tree is a large, spreading tree and fruits are somehow difficult to harvest. Recommended planting distance is 7 m x 7 m.

Advantages:

- heavy and regular bearer
- firm, leathery fruit skin
- juicy, firm and sweet flesh

Disadvantages:

- susceptible to False codling moth
- only fair fruit quality
- not favoured on the export market

Sama

In 1970, the author found this chance seedling on the Wanguhu farm in Trans Nzoia District, Kenya. It is thought to be a Guatemalan hybrid and produces type A flowers.

The medium-sized, late maturing, pear-shaped, dark-blue/black fruits are of excellent quality. Fruits normally weigh 210 – 355 g and have a thick, pebbly skin. The flesh is yellow, juicy, melting, of nutty flavour and free of fibre. The seed is relatively small and separates readily together with the seed coats from the mature fruit. The oil content is 18 – 25%.

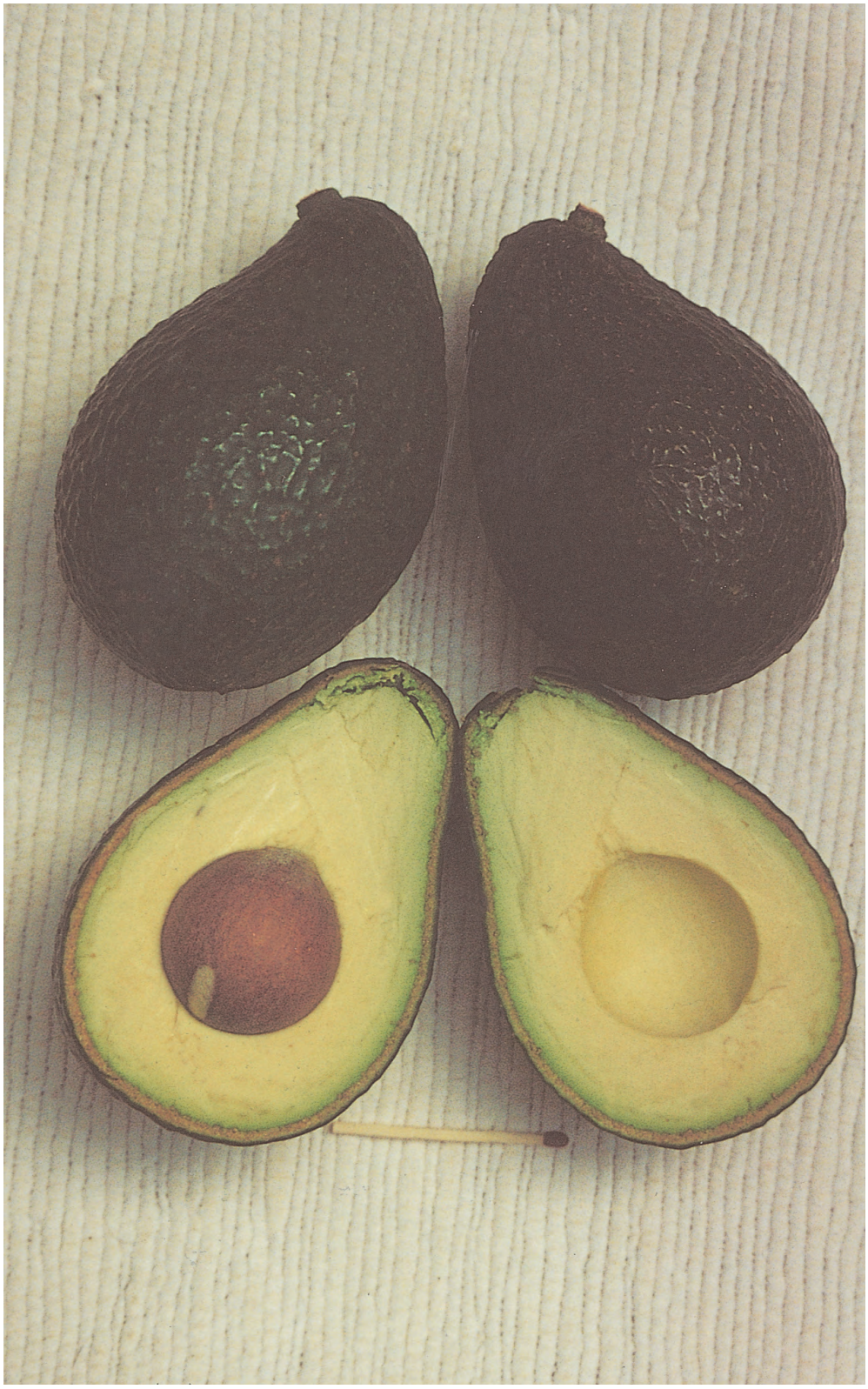
The tree is large and upright. It comes into bearing at an early age, and crops are regular and good to heavy. The recommended spacing is about 8 m x 8 m.

Advantages:

- excellent fruit quality
- small seed
- tough skin
- transports well
- good and regular yielder

Disadvantage:

- relatively unknown, needs more publicity



Simmonds

This West Indian variety first fruited in Miami in 1913 and is possibly a seedling of Pollock. From 1921 onwards, it has been propagated commercially and produces type A flowers.

The medium-sized light green to yellow, pear-shaped fruit matures during early mid-season. The skin is very thin, smooth and polished but easily bruised. The light-green, juicy, melting flesh is of fair flavour, almost free of fibre and has an oil content of 3 – 6%. The seed is medium to large, oval-oblique in shape and usually is tightly attached to the flesh.

The tree is a large and upright grower and has a tendency to biennial bearing. The recommended tree spacing should be 7 m x 7 m.

Advantages:

- widely grown in the humid tropics
- seed used for rootstock propagation
- sweet-tasting flesh

Disadvantages:

- large seed and cavity
- susceptible to fruit fly and False codling moth infestation
- not for export, but only of interest for domestic markets

Tambarina

Details about the provenance of this West Indian variety, which was imported from Florida into Kenya in 1981 are not available. After about four years in the field, the grafted trees started fruiting. They belong to the flower type A.

The medium sized, light green, elongated/slightly oblique fruit has a thin, waxy skin, which is covered by a lot of corky lenticels that are first yellow and later change to brownish. The seed is of medium size and separates readily from the mature fruit together with its seed coat. The flesh is of fair quality, almost free of fibre and is of pale yellow/green colour. The elongated, pointed seed is tightly set and the oil content ranges from 6 – 9%.

The tree is wide and spreading and produces a fair to good yield but only every second year. The recommended spacing should be 7 m x 7 m.

Remark:

- Further screening of this cultivar is required before more detailed information can be given.

Teague

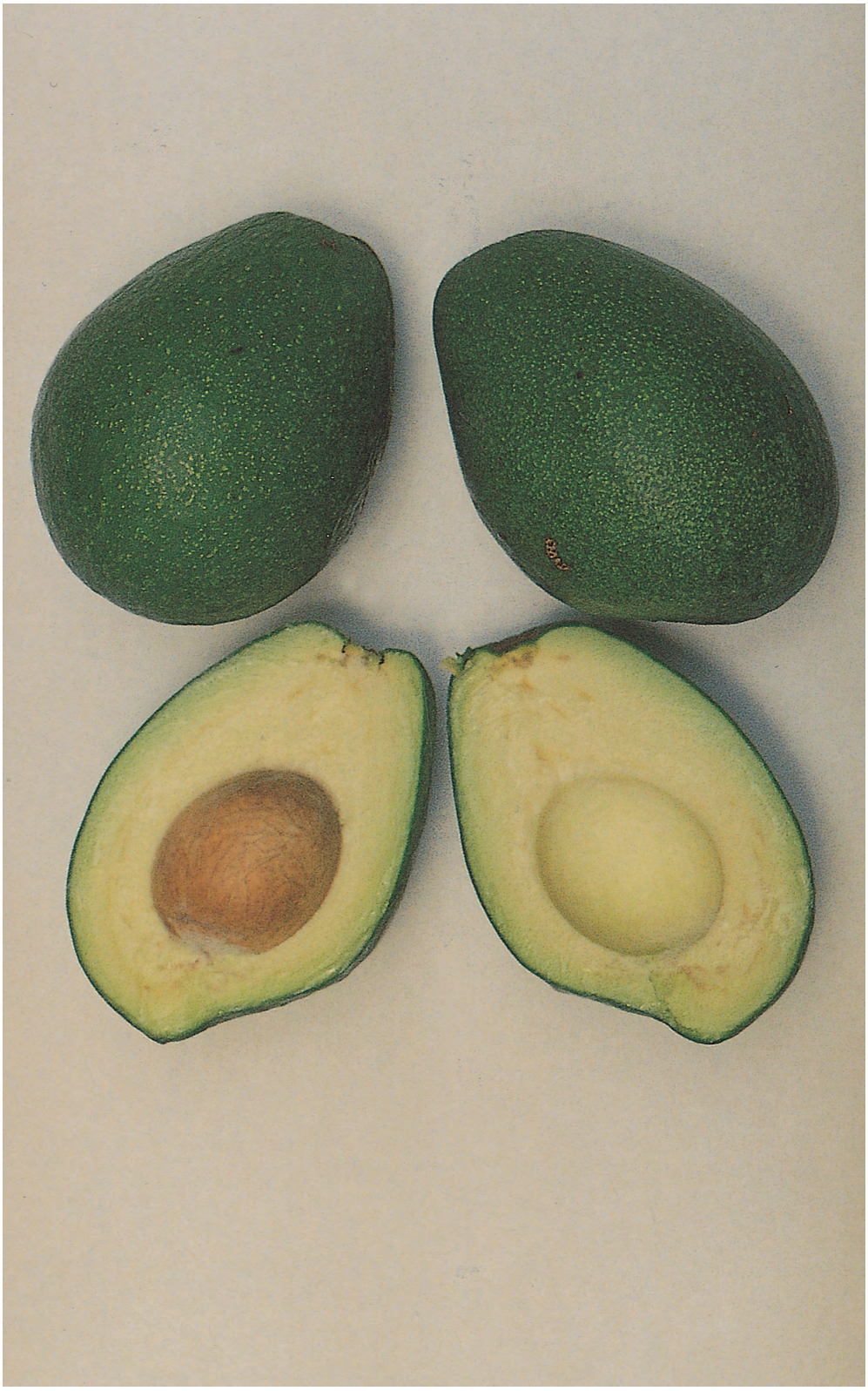
Around 1981, this earliest maturing Mexican variety was imported to Kenya from California and was later released from the local quarantine station for further commercial propagation. It is probably a hybrid of Duke and Fuerte and produces type B flowers.

The small to medium sized, light green, ovate fruits normally weigh 125 – 280 g. The thin skin is brittle and smooth/glossy. The pale-yellow, juicy and aromatic flesh contains 16 – 21% oil and is almost free of fibre. The ovate, rather small seed is tightly set.

The tree's growth is vigorous and spreading but some trees yield only poor to fair crops. The recommended tree spacing should be 8 m x 9 m.

Remarks:

- At the moment, there are no indications that Teague will become an important future cultivar in Kenya. Its main weakness, among others, is that not all its trees bear equally well, and fruits have the tendency to drop from the tree prematurely.



Tonnage

This cultivar belongs to the Guatemalan race and is thought to be a seedling of Taylor. In Florida, its commercial propagation started 1930. Tonnage produces type B flowers.

The mid-season, pear-shaped, medium to large fruit weighs normally 275 – 550 g. The green, thick and rough skin is light green and polished. The light green, melting flesh is of mild flavour, contains 10 – 12% oil and is almost free of fibre. The rather big, ovate seed is fairly tight and the average seed/flesh ratio stands at 24%.

The tree is tall and upright and bears regularly a good to heavy crop. The recommended planting distance should be 6 m x 7 m.

Advantages:

- good and consistent cropper
- maturing earlier than Lula
- fruit appearance good
- peels readily

Disadvantages:

- rather large seed and cavity
- tendency of sprouting seed inside mature fruits

TX 531

Also one of the more recently (1979) introduced cultivars from Florida, it is thought to be a derivation of Hass x Nabal which means that it is a member of the Guatemalan race and produces type A flowers. The first released trees were planted in November 1980 and started bearing after three years in the field.

The medium to large-sized oblong/oblique fruits mature at mid-season and are of dark green colour. The glossy, tough skin is covered with many light green lenticels, and the yellow, juicy flesh is of very good eating quality and almost fibreless. Fruits normally weigh 310 – 540 g and their oil content ranges between 15 – 20%. The small oblong seed reaches only 12% of the total fruit weight.

The tree is large and upright and a heavy and regular bearer. The recommended planting distance should be 7 m x 8 m.

Remarks:

- This is a very promising cultivar of good quality, shelf life, cropping and shipping properties.

Waldin

Like Simmonds, this is one of the better-known West Indian cultivars. Seed was first planted in Florida in 1909 and later propagated commercially in 1917. It has been a leading commercial cultivar in Central and Southern Florida but never a success on the export market. The seed is recommended for use as a rootstock.

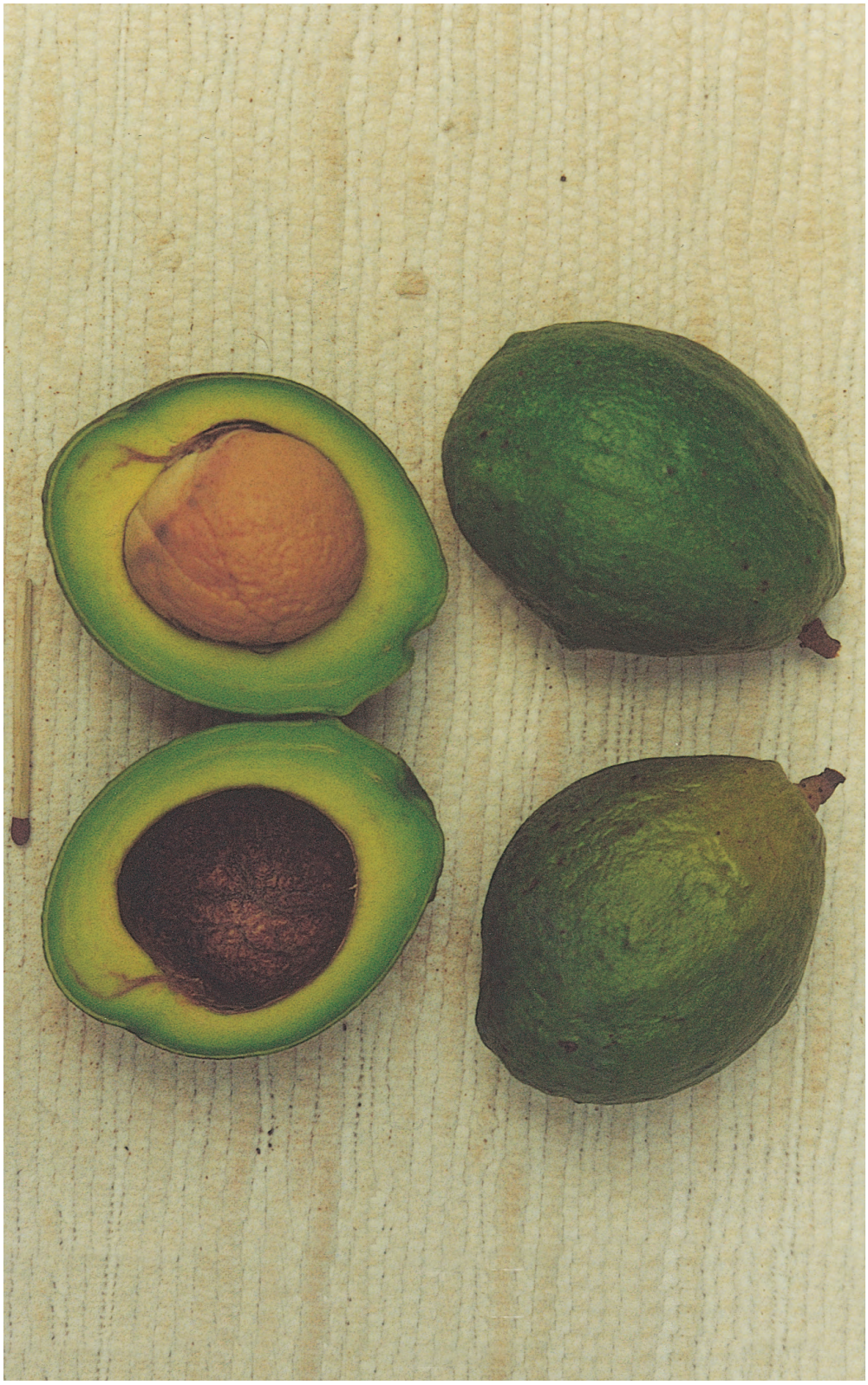
The medium-sized, early cultivar is of ovate/oblique shape and produces type A flowers. Fruits normally weigh 145 – 315 g and their thin, leathery skin is smooth, pale green and glossy.

The greenish-yellow flesh is sweet, juicy and melting but only of average quality. The oil content is 6 – 8%. The seed is rather large and not very tightly fitted.

The trees grow vigorously and upright and tend to overbear and dieback. The tree spacing recommended is 7 m x 8 m.

Remarks:

- Like Simmonds, this cultivar is also very much affected by infestation with False codling moth and fruit fly and therefore its rating for commercial planting is only fair.



Winter Mexican

Mexican x West Indian hybrids are rarely cultivated, but for experimental purposes, this cultivar was introduced to Kenya in 1979 and planted into the field in November 1980. The first yield of 0.345 t/ha was recorded in 1983 and increased to 2.226 t/ha in 1984.

The medium-sized, mid-season, dark green and pear-shaped fruit has a glossy but rough skin that clings to the firm, tasty flesh. It is light green in colour, melting, sweet and almost free of fibre and has a high oil content of up to 20%. Fruits normally weigh 215 – 350 g. The rather large oval seed is tightly set and consists up to 25.4% of the total fruit weight.

The tree is a large and upright grower; yields are moderate but regular. The recommended tree spacing is 7 m x 8 m.

Remarks:

- Additional field research is needed before recommendations that are more detailed can be given.
- Moderate yields and the unfavourably large seed cavity may negatively influence the chances of this becoming a favoured cultivar.

Zutano

This cultivar is believed to have originated in Fallbrook, California. It was introduced in 1941 from a selection made in 1926. Its parentage is unknown but it is probably a hybrid between a Mexican and a Guatemalan type, producing flowers of type B.

The medium pear-shaped fruit matures in the early mid-season slightly earlier than Bacon. Fruits normally weigh 150 – 397 g and have a moderate shelf life. The skin is light green, smooth, glossy and very thin and leathery. The light green/yellow and melting flesh has an oil content of 15 – 18% and is free of fibre. The oblong seed is relatively large (up to 23% of the fruit weight), tight and separates cleanly from the flesh.

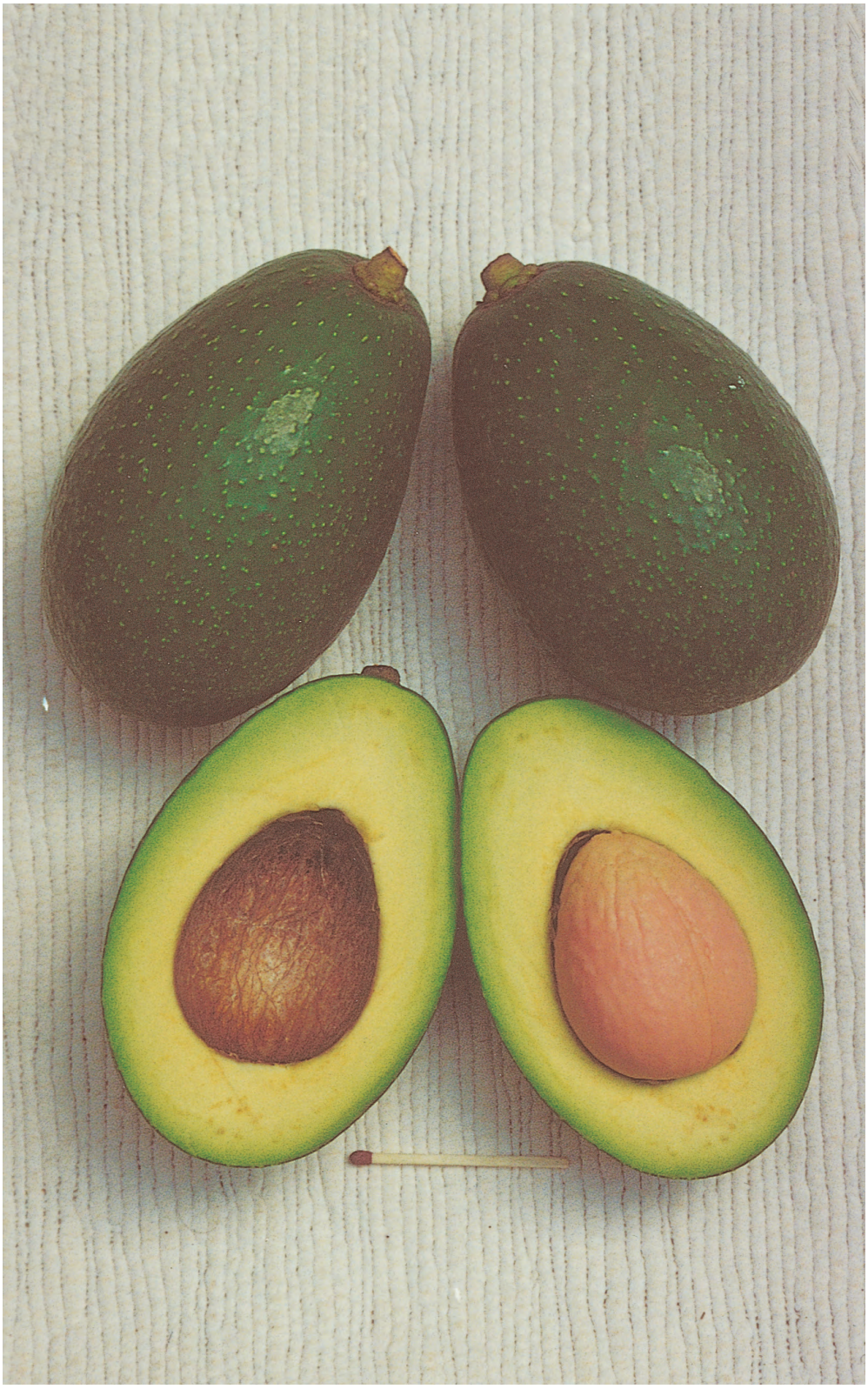
The tree is a tall and upright grower; yields are good and consistent. The recommended tree spacing is about 7 m x 8 m.

Advantages:

- produces good and regular crops
- matures earlier than Fuerte
- is fairly tolerant to cold and wind

Disadvantages:

- moderate shelf life
- tendency towards splitting on the fruit bottom when over-mature
- tree topping will be beneficial to reduce picking costs



FURTHER READING

Agro-Progress. 1988. *Transport Study Tropical Fruits*. Nairobi: GTZ.

Adelhelm R, Griesbach J, Ulrich W. 1972. *Feasibility Study, Economic Appraisal and Development Programme for a Horticultural Production Centre in the Trans Nzoia District / Kenya*. Hamburg: Africa-Verein.

Bohlen E. 1978. *Crop Pests in Tanzania and their Control.* KATRIN/ Federal Agency for German Economic Cooperation. Hamburg/Berlin: Paul Parey.

Cooper J, Dobson H, Orchard J. 2003. *Avocado Production Protocol.* UK: University of Greenwich.

Gaillard JP, Godesfroy J. 1995. *Avocado.* The Tropical Agriculturist Wageningen / Netherlands: Technical Centre for Agriculture and Rural Cooperation.

Griesbach J. 1992. *A Guide to Propagation and Cultivation of Fruit-Trees in Kenya.* Schriftenreihe No. 230, Eschborn / Germany: GTZ.

Griesbach J. 1978. *Der Avocado-Anbau in Kenia.* Schriftenreihe: Entwicklung und ländlicher Raum, Heft 6.

Griesbach J. 1980. *Growing Avocado in Kenya.*, Vol. II. Tübingen/Germany: Institute for Scientific Co-operation.

Griesbach J. 1980. *Avocado, a most promising Fruit for National Nutrition and Export.* Kenya Farmer. Nairobi: Agricultural Society of Kenya.

Griesbach J. 1986. *The Avocado Industry in Kenya.* Dairy and Livestock Farmer. Kenya. Nairobi: News Publishers Ltd.

GTZ. 1993. A market-oriented Development Concept for Tropical Fruit Cultivation in Kenya. Nairobi: GTZ.

Hill DS. 1974. *Agricultural Insect Pests of the Tropics and their Control.* London, UK: Cambridge University Press.

Hörmann DM, Will M. 1986. *The Market for selected fresh Tropical Fruits from Kenya in Western European Countries.*University of Hannover / Germany: Institute for Horticulture Economics.

Horticultural Crops Development Authority, Nairobi, 2003. Avocado Export Statististics.

Jaetzold R, Schmidt H.1983. *Farm Management Handbook of Kenya.* Nairobi: Ministry of Agriculture / GTZ.

Koch FD. 1983. *Avocado Growers Handbook.* California: Bonsall Publications.

Ministry of Agriculture, Nairobi. Horticulture Annual Reports, Horticulture Division 2003.

Page PE. 1984. *Tropical Tree Fruits for Australia.* Brisbane / Australia: Queensland Department of Primary Industries, Horticulture Branch.

Samson JA. 1980. *Tropical Fruits.* Wageningen / Netherlands: Tropical Agriculture Services,Agricultural University.

Strübi P. 1988. Report on Results of second and third Avocado Storage Trial. University of Nairobi.

Toerien J. 1999. Overview of the World Avocado Production., IV World Avocado Congress, October 1999.

GLOSSARY

active ingredient	toxic component of a formulated pesticide
bud	a condensed shoot containing immature leaves and/or flowers
canopy	crown of plant
chlorosis	yellowing of leaves, often caused by mineral deficiency
compost	decomposed plant remains
cultivar	a cultivated variety
die-back	progressive death of a shoot or stem backwards from the tip
elongated	longer than it is broad
evergreen	describes a plant that retains leaves at all seasons, shedding a few more or less continually
fruit	botanically, the whole seed-bearing organ whatever its form
fungicide	a chemical that kills fungi, particularly those responsible for various plant diseases
germination	the first stage in the development of a seed into a plant
habit	the overall shape or form of a plant, such as upright, rounded, spreading, etc.
herbicide	a chemical that kills plants, a weed killer
hybrid	a plant resulting from crossing two distinctly different parents, different varieties, species or genera
inflorescence	flower; the term is generally used for a compound inflorescence made up of a number of flowers arranged on a single stem
insecticide	a chemical that kills insects

lateral	describes a shoot, bud, etc. at the side of a stem of the main shoot
lenticel	a pore-like, slightly raised, spot on a fruit skin
maturity	stage of final fruit development (ripened)
perennial	a plant that lives for a number of years
pesticide	a chemical that kills garden pests; the term is also used loosely to include fungicides
pH	a measurement of acidity or alkalinity
phytotoxic	a chemical liable to damage or kill plants
pollen	the dust-like particles produced by male flower parts
pollination	the transfer of pollen from male anthers to female stigma of a flower, the first stage in the sexual reproduction of plants
propagation	increasing one's stock of plants by means by sexual or vegetative multiplication
provenance	germplasm from a single place of origin
residue	amount of pesticide remaining in or on plant tissues after a given time
rootstock	plants propagated for further grafting/budding
scion	the plant part grafted onto the stock
species	one or more species make up a genus
stigma	the female part of a flower; part of the pistil
susceptible	succumbing to disease, infection i.e. not resistant
tap-root	a strong vertical root
trunk	the main stem of a tree

Appendix 1

Provincial avocado production statistics

Province	Hectarage (ha)								Production (tonnes)							
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Eastern	1 106	1 127	1 173	1 111	1 241	1 295	1 334	1 355	10 493	16 173	17 401	15 206	15 232	17 030	17 909	18 162
Western	319	427	470	475	593	609	633	648	3 293	4 567	4 519	5 672	5 872	6 041	6 078	6 420
Central	559	572	1 441	1 466	1 232	1 463	2 031	1 980	7 043	8 037	17 688	20 546	18 090	21 615	16 540	25 198
Rift Valley	419	408	474	402	451	414	483	638	8 665	6 744	7 603	6 939	4 792	5 004	6 709	8 480
Nyanza	144	149	217	458	493	543	282	327	1 560	1 266	1 477	4 812	7 357	3 826	4 265	11 619
Coast	35	62	73	74	74	80	82	97	276	496	450	496	544	640	650	649
Nairobi	3				35	30	35	54	21				140	240	280	420
Total	**2 585**	**2 745**	**3 848**	**3 986**	**4 119**	**4 464**	**4 880**	**5 099**	**31 351**	**37 283**	**49 138**	**53 671**	**52 027**	**54 396**	**52 431**	**70 948**

Source: Horticulture annual reports, Ministry of Agriculture 1996 - 2003, Nairobi / Kenya

Appendix 2

Export market statistics figures for avocado from Kenya by sea and air

Year	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec	Total (kg)	Tonnes (t)
1996													10 429 448	10 429
1997	262 313	142 256	914 399	2 069 359	3 100 231	2 269 851	1 857 878	1 873 164	440 930	162 532	93 340	103 472	13 289 725	13 290
1998	189 288	961 576	1 195 343	648 714	843 375	1 223 381	378 178	395 488	402 508	46 959	45 847	36 120	6 366 777	6 367
1999	58 318	483 312	2 748 944	2 699 065	1 525 123	1 134 627	329 590	98 385	30 486	52 872	42 424	29 839	9 232 984	9 233
2000	186 538	1 601 511	2 292 762	1 353 219	1 392 313	990 508	844 725	1 448 452	460 454	62 529	48 788	34 315	10 716 113	10 716
2001	36 645	482 747	3 069 604	2 588 134	1 909 145	2 313 498	2 440 829	1 279 944	790 140	258 548	73 632	129 808	15 372 674	15 373
2002	489 341	575 803	2 209 906	1 369 403	1 406 494	1 363 612	2 366 974	1 629 923	899 129	272 520	191 065	115 637	12 889 807	12 890
2003	766 408	2 026 054	4 038 382	2 927 438	1 664 589	2 679 001	2 147 725	1 368 231	514 197	522 106	236 200	129 696	19 020 028	19 020
2004	997 045	2 015 520	2 852 227	1 816 375	2 811 171	1 041 113	1 792 367	1 116 744	981 261	102 571	288 700	145 420	15 960 150	15 960

Source: Horticulture Crops Development Authority, Nairobi - 1996/2003

Appendix 3

Main avocado suppliers to the European markets in tonnes ...

Country	1994	1995	1996	1997	1998	1999	2000	2001
Israel	20 082	30 749	42 517	39 542	27 086	30 635	42 913	37 641
South Africa	33 569	29 502	26 692	23 307	48 928	31 513	41 659	31 196
Mexico	19 479	33 077	29 611	19 181	14 215	13 997	12 632	13 172
Kenya	6 991	8 862	7 687	12 988	6 956	9 738	11 420	15 639

Appendix 4

... and their main months of supply

Country	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec
Israel	■	■	■	■						■	■	■
South Africa				■	■	■	■	■	■	■	■	■
Mexico	■	■	■					■	■	■	■	■
Kenya			■	■	■	■	■	■	■			
Spain	■	■	■	■						■	■	■

Source: EUROSTAT - elaboration: COLEACP, CSIF

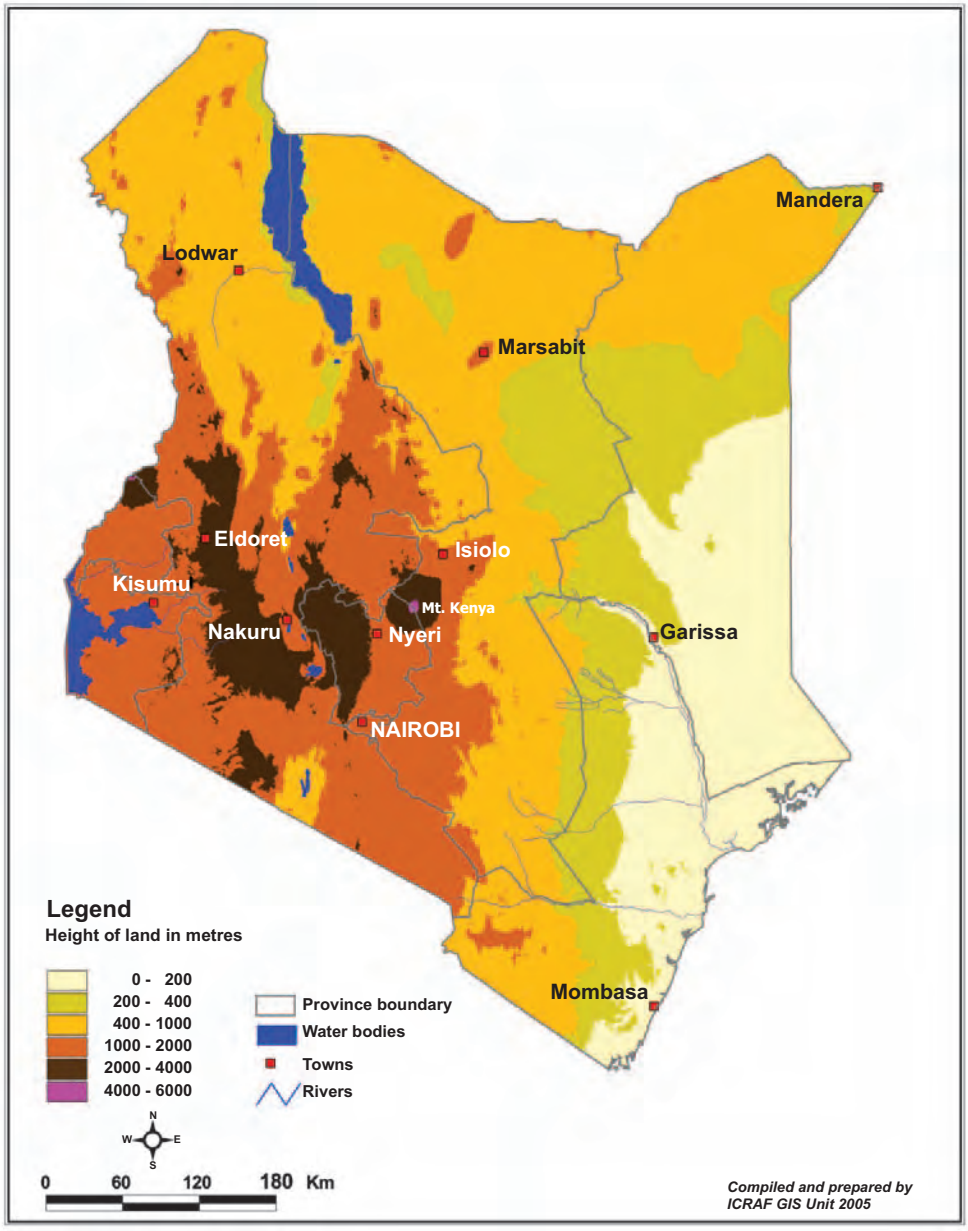
Appendix 5

Some characteristics of the three avocado races

Characteristics	Race		
	West Indian	Guatemalan	Mexican
Fruit:			
Shape:	elongated	round	elongated
Size:	medium - large	variable	small
Skin:	thin, leathery	thick, warty	thin, waxy
Oil content:	low	medium - high	high
Seed:	large, rough	small, smooth	large, smooth
Flowering to harvest:	5 - 8 months	10 - 15 months	6 - 9 months
Tree:			
Origin:	tropical lowlands	tropical highlands	tropical highlands
Cold tolerance:	vulnerable	moderately tolerant	most tolerant
Size of leaves:	large	medium - large	small
Smell:	no odor	no odor	anise scented
Cultivars:	Hardly Ruehle Simmonds Waldin	Linda Nabal Reed Hass Tonnage	Puebla Teague

Appendix 6

Altitude map of Kenya



Appendix 7

Yield performance figures of some avocado cultivars
(Location: GK Prison, Kamiti, elevation: 1650 m)

Cultivar:	Planting year: Planting distance Trees/ha	1979 Average kg/tree t/ha	1980	1981	1982	1983	1984	1985	1986	1987	1988
Fuerte	25.04.75	10.560	29.740	56.940	52.940	87.320	27.480	70.880	24.660	101.870	
ex Kitale	10 m x 8 m	1.320	3.718	7.118	6.618	10.915	3.435	8.860	3.083	12.713	
	125										
Fuerte	03.09.76		7.950	17.220	25.780	32.080	35.060	45.260	29.280	67.350	
ex Muguga	10 m x 8 m		0.994	2.153	3.223	4.010	4.383	5.658	3.660	8.419	
	125										
Puebla	25.04.75	12.320	13.450	16.920	17.820	47.500	34.660	59.140	16.740	59.360	
	6 m x 8 m	2.563	2.798	3.519	3.707	9.880	7.209	12.301	3.482	12.347	
	208										
Hass	03.09.76	2.310	15.025	26.950	27.825	60.525	16.425	45.370	13.250	96.050	
	6 m x 8 m	0.480	3.125	5.606	5.788	12.589	3.416	9.437	2.756	19.978	
	208										
Sama	03.09.76	4.560	8.240	20.550	30.380	38.900	19.950	42.800	45.150	53.900	
	6 m x 8 m	0.948	1.714	4.274	6.319	8.091	4.150	8.902	9.391	11.211	
	208										
Bacon	03.09.76	1.850	17.611	18.911	14.256	27.544	53.356	16.770	34.188	73.913	
	6 m x 8 m	0.385	3.663	3.933	2.965	5.729	11.098	3.488	7.111	15.374	
	208										
Zutano	03.09.76	0.780	13.950	40.410	61.155	38.775	84.500	105.000	54.600	126.360	
	6 m x 8 m	0.162	2.901	8.405	12.720	8.065	17.576	21.840	11.357	26.283	
	208										
Reed	03.09.76	1.250	12.000	15.600	57.000	88.100	68.600	138.000	118.000	106.100	
	6 m x 8 m	0.260	2.496	3.245	11.856	18.325	14.269	28.704	24.544	22.069	
	208										
Waldin	11.11.80					16.100	9.340	32.665	37.440	55.840	64.800
	6 m x 8 m					3.349	1.943	6.794	7.780	11.615	13.478
	208										
Simmonds	11.11.80					11.200	37.415	35.650	50.715	102.900	41.200
	6 m x 8 m					2.300	7.782	7.415	10.549	21.403	18.970
	208										

Appendix 7 cont.

Booth7	11.11.80	0.800	13.500	8.200	47.100	12.900	50.500
	6 m x 8 m	0.166	2.808	1.706	9.776	2.683	10.504
	208						
Booth 8	11.11.80	0.400	11.475	15.200	52.267	27.600	31.590
	6 m x 8 m	0.083	2.387	3.162	10.872	5.741	6.570
	208						
Choquette	11.11.80		1.400	3.100	38.100	3.700	31.360
	6 m x 8 m		0.201	0.645	7.925	0.770	6.522
	208						
Lula	11.11.80	2.850	16.100	35.700	72.700	16.000	41.183
	6 m x 8 m	0.593	3.349	7.426	15.122	3.328	8.566
	208						
Ruehle	11.11.80	9.700	43.200	21.800	56.900	49.000	56.619
	6 m x 8 m	2.018	8.986	4.543	11.835	10.192	11.776
	208						
Tonnage	11.11.80	16.100	13.700	29.400	91.900	50.000	27.778
	6 m x 8 m	3.349	2.850	6.115	19.115	10.400	5.779
	208						
Winter	11.11.80	1.660	10.700	12.300	19.700	12.800	15.172
Mexican	6 m x 8 m	0.345	2.226	2.558	4.098	2.662	3.156
	208						
Tx 531	11.11.80	1.820	17.250	27.120	9.320	24.000	10.270
	6 m x 8 m	0.379	3.588	5.640	1.439	4.992	2.137
	208						
Trapp	11.11.80	1.230	13.220	2.950	17.450	25.540	96.153
	6 m x 8 m	0.256	2.750	0.614	3.630	5.312	19.999
	208						
D.W.I. Bank	11.11.80	2.680	24.100		61.130	15.140	52.418
	6 m x 8 m	0.557	4.992		12.715	3.149	10.903
	208						
Hardy	25.06.81		5.810	3.120	48.750	33.250	51.750
	6 m x 8 m		1.208	0.649	10.140	6.916	10.764
	208						
Tambarina	October 82				1.516	17.820	6.255
	6 m x 8 m				0.315	3.706	1.301
	208						
Kyoyl	October 82			5.890	13.730	27.580	19.184
	6 m x 8 m			1.225	2.856	5.737	3.990
	208						
Pinkerton	October 82			4.990	16.200	36.990	18.765
	6 m x 8 m			1.038	3.369	7.694	3.903
	208						

Source: Author's own records and calculations

Appendix 8

Some common and fully or provisionally (*) registered insecticides

(Those under temporary registration are not included)

Trade name	Active ingredient	Range of effectiveness
Actellic 25 EC	Perimiphos-Methyl	Fast acting; for the control of storage pests, but it also controls a wide range of insect pests in horticultural crops
Agropyrifos 48 EC *	Chlorpyrifos	Controls caterpillars and sucking insects on horticultural crops
Agrozinon 60 EC *	Diazinon	Broad spectrum contact poison, effective against many sucking and biting insects
Applaud 40 % SC	Buprofezin	Controls i.e. white flies in citrus and mealy bugs in passion fruit
Basudin 600 EW	Diazinon	Contact poison; kills biting and sucking insects
Brigade 25 EC	Bifenthrin	Broad spectrum insecticide/miticide
Buminal *	Protein	Bait for fruit fly
Chenothion 50 EC	Fenitrothion	Contact and stomach poison; kills biting and sucking insects
Danadim	Dimethoate	Contact/systemic insecticide/miticide against a broad range of insects
Decis 2.5 EC	Deltamethrin	Broad spectrum contact poison
Diazol 60 EC	Diazinon	Poison for the control of a wide range of pests in fruit/vegetable crops
Dipterex 95 SP	Trichlorfon	Mainly a stomach poison, particularly effective against flies and caterpillars
Ethion 4 EC	Ethion	Controls i.e. root mealy bug, scales, leaf miner etc.
Evisect-S	Thiocyclam	Insecticide for the control of leaf miners, aphids, thrips on horticultural crops

Appendix 8 cont.

Trade name	Active ingredient	Range of effectiveness
Folimat 500 SL	Omethoate	Systemic insecticide/acaricide
Furadan 5 G.	Carbofuran	Systemic granular insecticide/ nematicide mainly for the control of soil pests
Gusathion - M * 200 EC	Azinphosmethyl	Contact and stomach poison. Very effective against a broad spectrum of sucking/biting insects
Hostathion 40 EC	Triazophos	Insecticide/acaricide for the control of insect pests and mites
Karate 17,5 EC	Lambdacyhalothrin	Synthetic pyrethroid with broad spectrum rapid knock-down action
Kelthane 18,5 EC	Kelthane	Non-systemic acaricide
Lebaycid 500 EC	Fenthion	Contact and stomach poison against sucking/biting insects
Malathion 50 EC *	Malathion	Contact and stomach poison against many sucking/biting insects
Marshal 250 EC	Carbosulfan	Broad spectrum contact insecticide/miticide
Mesurol 500 SC	Methiocarb	Broad spectrum insecticide for the control of sucking and biting insect pests
Metasystox *	Oxydemeton-methyl	Systemic insecticide/acaricide with rapid action
Metigan 18,5 EC	Dicofol	A specific miticide for the control on a wide range of crops
Methomex 90 *	Methomyl	Insecticide to control mainly sucking pests on horticultural crops
Nemacur 050 *	Fenamiphos	Granular insecticide/nematicide
Perimor 50 DG	Pirimicarb	Specific poison for the control of aphids on a wide variety of crops

Appendix 8 cont.

Trade name	Active ingredient	Range of effectiveness
Sevin 85 S	Carbaryl	Broad-spectrum insecticide for use on horticultural crops
Tafgor 40 EC *	Dimethoate	Systemic insecticide/acaricide mainly effective against sucking insects
Thiodan 35 EC	Endosulfan	Contact and stomach poison. Wide range insecticide with effectiveness against chewing/ biting insects
Thuricide H.P.	*Bacillus thuringiensis*	Biological insecticide for the control of Lepidopterian larvae on coffee and other crops

Source: List of Pests Control Products
Registered by the Pest Control Products Board,
Nairobi, March 2003

Appendix 9

Some common and fully or provisionally (*) registered fungicides

(Those under temporary registration are not included)

Trade name	Active ingredient	Range of effectiveness
Afugan 30 EC	Pyrazophos	Systemic; controls powdery mildew on a wide range of crops
Aliette 80 WP	Fosetyl-Aluminium	Systemic; primarily effective against phytophtora and downy mildew
Antracol 70 WP	Propineb	Contact; a broad spectrum protectant for the control of diseases on vegetables, fruit crops and flowers
Bayfidan 250 EC	Triadimenol	Systemic; controls i.e. powdery mildew on fruit crops
Benlate	Benomyl 50 %	Systemic; control of many diseases of cereals, vegetables and fruits
Cercobin *	Thiophanate	Contact; fungicide for use in fruits, vegetables and cereals
Clortocaffaro 75 WP *	Chlorothalonil	Contact; controls CBD[1] and is also used in agricultural crops
Cobox	Copper Oxychloride 50 %	Contact; controls CBD and leaf rust on coffee but also several vegetable diseases
Copper Nordox	Cuprous Oxide 50%	Contact; controls coffee diseases and also useful on horticulture crops
Daconil 2787	Chlorothalonil 75%	Contact; a broad spectrum protectant of many diseases on fruit and vegetables

Appendix 9 cont.

Trade name	Active ingredient	Range of effectiveness
Dithane M-45	Mancozeb 80%	Contact; protectant for the use on a broad spectrum of horticultural crops
Isacop	Copper Oxychloride 85%	Contact; protectant for the control of a wide range of diseases on horticultural crops and coffee
Kocide DF	Copper Hydroxide	Contact; broad spectrum protectant for the control of a wide range of diseases on horticultural crops
Kumulus DF	Sulphur 80%	Contact; controls mites and powdery mildew on vegetables, fruit crops and flowers
Merpan 83 WP	Captan	Contact; a broad spectrum protectant of many horticultural diseases
Nimrod 25 EC	Bupirimate	Systemic; control of powdery mildew on a wide range of horticultural crops
Nustar *	Flusilazole	Contact; for use in grapes and citrus
Polyram DF *	Metiram Complex	Contact; broad spectrum: controls many diseases of fruits, vegetables and ornamentals
Previcur - N	Propamocarb	Contact; controls soil borne diseases
Rova 75 *	Chlorotalonil	Contact; fungicide against CBD and various other diseases in vegetables and flowers
Rovral 50 WP	Iprodione	Contact; controls botrytis in fruits and vegetables
Saprol 20 EC	Triforine	Contact; control of fungal diseases in horticultural crops

Appendix 9 cont.

Trade name	Active ingredient	Range of effectiveness
Thiovit - Jet	Sulphur	Contact; controls powdery mildew and mites on a wide range of fruit crops.

Source: Fungicides registered by the Pest/Disease Control Products Board, Nairobi, March 2003.

(1) CBD - Coffee Berry Disease

Appendix 10

Some common horticultural insecticides/ fungicides and their recommended pre-harvest intervals

Insecticides			Fungicides		
Trade name	**Active ingredient**	**Pre-harvest interval/days**	**Trade name**	**Active ingredient**	**Pre-harvest interval/days**
Actellic 25 EC	Perimiphos-Methyl	7	Benlate	Benomyl	14
Agropyrifos 48 EC	Chlorpyrifos	14 - 40	Morocide	Binapacryl	14
Agrozinon 60 EC	Diazinon	14	Nimrod	Bupirimate	7
Basudin 600 EW	Diazinon	14	Moduna	Captafol	7
Brigade 25 EC	Penvalerate	14	Orthocide	Captan	7
Chenothion 50 EC	Fenitrothion	10	Morestan	Chinomethionate	10
Danadim 40 EC	Dimethoate	7	Cupravit	Copper	7
Decis 2,5 EC	Deltamethrin	14	Copper 50	C. hydroxide	7
Dipterex 95 SP	Trichlorfon	14	Cobox	C. oxychloride	7
Folimat 500 SL	Omethoate	21	Green Copper 50	C. sulphate	7
Furadan 5 G	Carbofuran	21	Karathane	Dinocap	10
Gusathion-M 200 EC	Azinphos-Methyl	14	Dithane	Mancozeb	7
Karate 17,5 EC	Lambdacyhalothrin	14	Rovral	Iprodione	7
Kelthane 18,5 EC	Dicofol	7	Ridomil	Metalaxyl	7
Malathion 50 EC	Malathion	7	Polyram Combi	Metiram	7
Mesurol 500 SC	Methiocarb	7	Antracol	Propineb	7
Metasystox 50 EC	Oxydemeton-Methyl	14 - 21	Afugan	Pyrazophos	7
Methomex 90	Methomyl	21	Thiovit	Sulphur	7
Nemacur 50	Phenamiphos	28	Bayleton	Triadimefon	7
Sevin 85 S	Carbaryl	7	Calinix	Tridemorph	7
Thiodan 35 EC	Endosulfan	28 - 40	Saprol	Triforine	2
			Lonacol	Zineb	7

Source: Agricultural Insect Pests of the Tropics and their Control, Dennis S. Hill, Cambridge University Press, 1983

Source: National Agricultural Laboratories, Kabete/Kenya, 1988

Appendix 11

Avocado main maturity seasons in respective Provinces

Province	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Central												
Rift Valley												
Nairobi												
Eastern												
Nyanza												
Western												
Coast												

Source: Data collected by author, 1983 and 1986

Appendix 12

List of registered tree nurseries propagating avocado trees (among others)

B - DISTRICTS				
Name	**District**	**Division**	**Sub-location**	**Address**
Bungoma FCT Pekera Resort Marigat	Bungoma	Sirisia Baringo Box 32 Marigat	South Ndolondo	Box 33 Bungoma Marigat
E - DISTRICTS				
Embu Prison Kamiu Hort. Nursery Kamuruguru Project Johnstone Chelanga	Embu Embu Embu Elgeyo Marakwet	Gachoka Embu Embu Tot	Kamuyu Municipality Gichiche Sagat	Box 35 Embu Box 727 Embu Box 202 Embu Box 249 Iten
H - DISTRICT				
Afforestation Programme	Homa Bay	Township	Township	Box 646 Homa Bay
I - DISTRICT				
Isiolo Prison	Isiolo	Central	Central	Box 1 Isiolo

Appendix 12 cont.

K - DISTRICTS				
Name	**District**	**Division**	**Sub-location**	**Address**
Coast Dev. Authority	Kwale	Kwale	Diani	Box 1322 Mombasa
Samsaad Alzalkhan	Kwale	Matuga	Waa	Box 96246 Mombasa
Vincent M. Kega	Kwale	Matuga	Waa	Box 96346 Mombasa
Kiarwe Products Ltd.	Kiambu	Kiambaa	Kiambaa	Box 44982 Nairobi
Riara Orchards	Kiambu	Kiambaa	Kiambaa	Box 57093 Thika
Tata Nurseries	Kiambu	Juja	Kiu	Box 47398 Thika
Kiambu Prison	Kiambu	Kiambaa	Ndumberi	Box 121 Kiambu
Ruiru Prison	Kiambu	Thika	Katambya	Box 363 Ruiru
Elina Plant Nurseries	Kiambu	Gatundu	Ngenda	Box 220 Gatundu
Kerugoya Prison	Kirinyaga	Ndia	Kerugoya Township	Box 7 Kerugoya
Baricho Nurseries	Kirinyaga	Ndia	Mwera	Box 392 Kerugoya
Kimbibi Nursery	Kirinyaga	Mwea	Nyangati	Box 112 Wanguru
Mubari K. H.	Kirinyaga	Kianyaga	Gatu	Box 233 Kianyaga
Self Employment Training Ltd.	Kirinyaga	Kianyaga	Kaguyu/Kabare	Box 263 Kerugoya
Kitui Prison	Kitui	Central	Township	Box 122 Kitui
Joseph Ndinga	Kitui	Mutomo	Kituti	Box 30 Kibwezi
Kisii Prison	Kisii	Keumbu	Municipality	Box 931 Kisii
Kisumu Prison Annexe	Kisumu	Winam	Kazando	Box 1923 Kisumu
Kibos Prison	Kisumu	Winam	Kibos	Box 1725 Kisumu
Sartur Hort. Farm	Kisumu	Bondo	Kagwa	Box 128 Bondo
Levi Wadera	Kisumu	Kisumu	Sivile	Box 1923 Kisumu
Dr. Pius S.W. Owino	Kisumu	Maseno	Sunga	Box 32 Maseno
Kericho Prison	Kericho	Belgut	Koengo	Box 329 Kericho

Appendix 12 cont.

M - DISTRICTS				
Name	**District**	**Division**	**Sub-location**	**Address**
Machakos Prison	Machakos		Eastleigh	Box 150 Machakos
Anthony Ngumbi Mathuba	Machakos	Nunguni	Kilome	Box 403 Nunguni
Sweeter Land Hort. Farm	Machakos	Mwala	Mithini	Box 59708 Nairobi
Thomas M. Kitumu	Machakos	Nunguni	Kaiti	Box 123 Nunguni
Yatta Farm Ltd.,	Machakos	Yatta	Kiwanzi	Box 67121 Nairobi
Elizaphan Njeru M. Mutere	Meru	Chuka	Ndangani	Box 67 Chuka
New Mitunguu	Meru	Mitunguu	Kerendere	Box 76 Mitunguu
Alice Mucheke	Meru	S. Imenti	Kathera	Box 184 Nkubu
Edward Ngari	Meru		Kirendene	Box 985 Meru
Dedan Chege	Meru	N. Imenti	Kithoka	Box 113 Meru
Mitunguu Co-op. Society	Meru	S. Imenti	Kirendene	Box 310 Nkubu
Muuti Nurseries	Meru	C. Imenti	Nkadone	Box 260 Meru
Menia Nurseries	Meru	Karimune	Kirendene	Box 105 Meru
Joseph Mwikya	Makueni	Makueni	Nziu	Box 72999 Nairobi
Kyee Mwea Self Help Group	Makueni	Makueni	Iuani	Box 220 Kilala
Umoja SHG	Makueni	Kaiti	Kyamuoso	Box 43 Makuyuni
Kibwezi Hort. Nurseries	Makueni	Kibwezi	Kikumbolyo	Box 316 Kibwezi
Joseph Hungo	Murang'a	Makuyu	Kigoro Ridge	Box 35 Maragua
Maranjau Prison	Murang'a	Kigumo	Maranjau	Box 109 Murang'a
Timothy Kamu	Murang'a	Kandara	Mukuria	Box 651 Thika
KNFU Nursery	Murang'a	Kiharu	Kamathi	Box 206 Murang'a
Wangu Investment Co.	Murang'a	Kiharu	Njogu-ini	Box 910 Murang'a
Eco. Green Nurseries	Maragua	Maragua		Box 28044 Nairobi

Appendix 12 cont.

N - DISTRICTS				
Name	**District**	**Division**	**Sub-location**	**Address**
Nairobi West Prisons	Nairobi	Lang'ata	Lang'ata	Box 30556 Nairobi
Isaac M. Ngatia	Nairobi	Nairobi	Kahawa Sukari	Box 53314 Nairobi
Gardenia	Nairobi	Lang'ata	Lang'ata	Box 931 Nairobi
Lang'ata Women Prison	Nairobi	Kibera	Mugumoini	Box 44769 Nairobi
Kamiti Maximum Prison	Nairobi	Kasarani	Kasarani	Box 6551 Nairobi
David Koech	Nandi	Mossop	Biribiriet	Box 1653 Eldoret
Pauline M. Mwan	Nyeri	Municipality	Mukaro	Box 723 Nyeri
Gardenia Nurseries	Nyeri	Municipality	Municipality	Box 931 Nyeri
David Mugutu	Nyeri	Ekieni	Gathuku	Box 112 Nanyuki
Nyeri Prison	Nyeri	Municipality		Box 114 Nyeri
Nakuru Prison	Nakuru	Municipality	Nakuru	Box 14 Nakuru
Naivasha Prison	Nakuru	Naivasha	Naivasha	Box 146 Naivasha
Peppers Ltd.	Nakuru	Bahati	Lanet	Box 879 Nakuru
Mwiritu Women Group	Nakuru	Mbogoini	Subukia East	Box 65 Subukia
James Barno	Nakuru	Molo	Sachangwa	Box 103 Molo
Joseph Mwangi	Nakuru	Bogoini	Subukia East	Box 65 Subukia
Samuel Mwenji	Nakuru	Elburgon	Gacharage	Box 65 Thika
Ajub Karuri	Nakuru	Gilgil	Karunga	Box 2 Gilgil
Umoja SHG	Nakuru	Njoro	Mugumu	Box 2748 Nakuru
Muhoro Muchiri	Nakuru	Bahati	Mahingo	Box 47 Kabazi
Jason Chege Gitu	Nakuru	Solai	Kabazi	Box 6 Solai
Mwangi Mucheru	Nakuru	Bahati	Lanet	Box 7411 Nakuru

Appendix 12 cont.

N - DISTRICTS				
Name	**District**	**Division**	**Sub-location**	**Address**
CDN Agricultural Nakuru Prog.	Nakuru	Nakuru	Bahati	Box 938 Nakuru
Stephen Nderu	Nyandarua	Olkalau	Mawingo	Box 559 Olkalau
Gardenia Nurseries	Nyandarua	Municipality	Ndurum Ward	Box 873 Nyahururu
Nyahururu Prison	Nyandarua	Municipality		Box c/o Prisons HQ
T - DISTRICTS				
Paul Mwangi	Trans Nzoia	Sabati	Kapkoi Sual	Box 2221 Kitale
Kitale Prison	Trans Nzoia	Kitale	Milimani	Box 94 Kitale
Benjamin M. Lugano	Trans Nzoia	Kitale	Kapsara	Box 323 Kitale
Kakuzi Ltd.	Thika	Thika	Ndera	Box 24 Thika
Ruiru GK Prison	Thika	Ruiru	Gatambaya	Box 363 Ruiru
D.D. Kamau	Thika	Thika	Gakara	Box 1588 Thika
Wilmau Agro Ltd.	Thika	Thika	Ndia-ini	Box 1682 Thika
Charles Karaja	Thika	Thika	Karurumo	Box 757 Thika
U - DISTRICT				
Ngeria Prison	Uasin Gishu	Kesses	Chepyakwai	Box 461 Eldoret
Eldoret Prison	Uasin Gishu	Municipality	Municipality	Box 824 Eldoret
Arror Nurseries	Eldoret	Eldoret	Arror	Box 2660 Eldoret
Tot Nurseries	Eldoret	Eldoret	Endoo	Box 2660 Eldoret
Elgon View Nurseries	Eldoret	Eldoret	Elgon View	Box 95 Eldoret

Appendix 12 cont.

U - DISTRICT				
Name	**District**	**Division**	**Sub-location**	**Address**
Weiwei Nursery	Eldoret	Eldoret	Korellach	Box 2660 Eldoret
Cheplambas Nursery	Eldoret	Eldoret	Cheplambas	Box 2660 Eldoret
Etang Kenya	Eldoret	Kapsabet	Langas	Box 5688 Eldoret
W - DISTRICT				
Name	**District**	**Division**	**Sub-Location**	**Address**
Kapenguria Prison	West Pokot	Kapenguria	Siaji	Box 10 Kapenguria

Source: Horticultural Crops Development Authority, January 2004

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

DFID
Department for International
Development of the UK Government

Ministerie van
Buitenlandse Zaken