THE INSTITUTE OF AGRICULTURAL RESEARCH
ETHIOPIA

THE POSSIBILITIES OF IMPROVING AND DEVELOPING
FRUIT CROPS WITH PARTICULAR REFERENCE TO CITRUS

by

Henri Chapot
FAO Consultant (Horticulture Department)

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Report prepared for the
Government of Ethiopia
by the
Food and Agriculture Organization of the United Nations
acting as executing agency
for the United Nations Development Programme

based on the work
by
Henri Chapot
FAO Consultant (Horticulture Department)
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HAILE SELASSIE I PRICE TRUST FARM, BIER QOTA
In accordance with the Plan of Operation of the UNDP Special Fund Project "Institute of Agricultural Research", the Food and Agriculture Organization of the United Nations appointed Mr. Henri Chapot as Consultant (Horticulture Development).

The expert served in the country from 2 April to 14 May 1969.

His terms of reference were:
- to assist the Project Manager in establishing cropping patterns for the area as they affect the production of fruit crops;
- review the information on irrigation requirements of fruit crops;
- make recommendations for any further investigations by the Project to complete the above information.

The areas visited included: Addis Ababa and vicinity, Debre Zeit, Holletta, Ambo, Goudar, Sako, Wolisso, the Ghibie valley, Nazareth, the river Awash valley (Metahara, Awash Station, Melka Werer), Harrar (Alema), Dire Dawa (Brer Gota), Jimma, Asmara (Ghinda and Elaberet), and Awasa (Melgue Wondo).

Acknowledgements

Mr. Werque Mekasha, Assistant Minister, General Manager of the Institute of Agricultural Research, Addis Ababa, offered all possible assistance in the survey of fruit production.

All the material problems raised by visits to different provinces, various means of communication, search for accommodation were solved by Mr. Seyoum Solomon, from the same Institute, who was also a competent and tireless guide.

Sincere thanks are also due to Mr. Gelachew Wolde Emmanuel at Addis Ababa and Ghibie valley, Mr. Melaku Asfar at Brer Gota and Mr. Elias Mailou at Monji for assistance rendered to the expert.
1. CITRUS

1.1 PRESENT STATUS OF CITRICULTURE (Figs. 1-13, 37, 38)

1.1.1 Production, Export and Import

Available sources indicate that citrus production in Ethiopia for 1966 was 70,000 metric tons. This figure seems high. For the same year, exports were about 1,150 tons (1,802 tons in 1967) directed equally to Saudi Arabia and Italy. In 1966, imports were about 610 tons and 284 tons in 1967. The main suppliers were Israel, U.A.R., Lebanon and Italy.

Fruit and vegetables play a minor role in the diet. They are consumed only by foreigners and by the wealthy upper class: long established food habits are difficult to modify. However, the high prices of these commodities on the local markets should be noted. In March, on the Addis Ababa market, local oranges fetch Eth.$ 1.00 kg. (Eth.$ 0.75 in full season) and limes Eth.$ 0.50, while imported and better quality oranges from Israel and U.A.R. are sold at Eth.$ 1.50 kg. The price for third quality oranges on the local market is 1.6 times higher than first quality navel oranges on French or German markets.

If prices were lower, for instance at about the same level as in North Africa (navels : Eth.$ 15; clementines : Eth. $ 40; mandarins : Eth. $ 20), fruit would be consumed by a wider range of the population.

As long as the selling price stays at the same level, the increase in domestic demand may not be sufficient to absorb additional citrus production when the new plantations start bearing. New outlets must be sought: export possibilities in countries like Saudi Arabia can be increased but to some extent only, and other countries must also be surveyed, mainly in the Indian Ocean area (Kuwait, Iraq and Iran).

1.1.2 Main producing areas

Present production is concentrated in two areas: Eritrea and the Upper and Middle Awash Valley region. In Eritrea the orchards are located in Elaberet and around Decamere and Guinda; in the Upper Awash valley, they are distributed from Wonji near Nazareth to Metahara, and in the Middle Awash at Meika Werer and extend to the east around Gota. Limited acreages are also found at various places, but one of no economic importance.

Eritrea is the main exporter of citrus fruit, more especially to Saudi Arabia but increasing quantities are exported from the Awash valley to the French Territory of the Affars and the Issas (formerly French Somaliland).

1.1.3 Varieties

With a few exceptions, the majority of the citrus varieties in Ethiopia are un-named and are of unknown origin: trees are usually said to have been "bought from the Asmara region".
1.1.3.1 Sweet orange

Seedy varieties of unknown origin, possibly from Italy, predominate. Some orchards are planted with Shamouti (Jaffa) and Ovale Calabrese varieties. Shamouti is a good variety in some privileged areas of the Near East, but is very variable according to ecological conditions. Adaptation trials with more suitable varieties would probably decide against Shamouti. Ovale Calabrese is a good, late-maturing orange but has a strong tendency to give off-season fruits of little, if any, commercial value (stubborn disease ?). In any case, Valencia late is superior by both its lateness and mainly its juice qualities. This has been observed, for instance, in a large orchard at Elaberet.

A curious, inferior variety of navel orange may be observed and is generally confused with standard navels. It has a very characteristic upright growth and its fruits show a large secondary internal fruit which lessens its commercial value. Flowers are abnormal and exhibit distorted forms. In some characteristics, this variety resembles the Bourouhaine orange of Tunisia but is much inferior. Its propagation should be abandoned and trees could be top-worked with more interesting varieties, such as Washington.

An important orchard at Elaberet is planted partly with Thomson navel, instead of Washington. Thomson is usually considered as a variety of inferior quality: fruit too large, rind colour lighter than that of Washington, juice content lower. According to the owner of this orchard, Thomson oranges are exported to Saudi Arabia only, where consumers appreciate large fruits.

New plantings with Washington navel and Valencia late have been initiated. Unfortunately, budding material is from old clones which probably carry virus diseases. Washington is an excellent early variety but must be cautiously planted because of its poor adaptation to tropical climates and because of the impossibility of using culls for juice processing. Valencia late is the most important variety in the world and can be considered as suitable for the different regions of Ethiopia where citriculture is possible: Valencia should have first place in plans for extending orange plantings.

1.1.3.2 Mandarins

The most common mandarin is the Mediterranean or Willow leaf mandarin, probably of Italian origin. In other countries it often carries Cachexia and sometimes Concave Gum. It is an alternate bearer and its commercial value is decreasing in European markets because of the competition with Clementine, a seedless variety of better fruit quality.

Clementine is second in importance. In Ethiopia too, this variety is very early and of excellent quality but with too many seeds as a consequence of cross-pollination. Yields are excellent everywhere and, at some locations, the large size of the fruits is impressive. In a few orchards, a tangerine which seems to be the Cape Maartje of South Africa is grown. This variety has, in fact, been introduced from South Africa by a large estate at Elaberet, near Asmara and probably propagated and spread by local nurseries.

In other places another variety, of inferior quality, is grown which looks like the Mandarino Sanguigno of Italy and always shows a heavy puffing.
1.1.3.3 Grapefruit

The majority of the grapefruit trees are Marsh seedless.

1.1.3.4 Lemons

All types of lemons grown are unnamed. Some trees show large fruits and large leaves which are characteristic of Interdonato lemon. With the exception of earliness, this variety is of no interest because of its too large fruit size. In a 10 year-old estate near Melka Werer, among other lemon trees, some seedlings which are probably lemon-lime hybrids were noted, producing very juicy fruits of medium size, with a thin peel. Some trees yield seedless fruits, as does Fearss lime.

Rough lemon seedlings are found in quantity everywhere, sometimes they are abandoned never having been budded, sometimes they are grown instead of standard lemon trees. The fruit is harvested and sold as ordinary lemons, in spite of their emetic and bitter aftertaste.

1.1.3.5 Limes

A lime of the West Indian or Mexican type is found throughout the country and, in spite of lack of management, yields well. Proper care could improve the number and size of the fruits. It is an excellent substitute for the standard lemon (and superior to the Rough lemon), commonly served with papayas.

1.1.3.6 Sour oranges

Sour oranges are seldom found and the seed supply for nurseries is difficult. Some of the sour orange trees are seedlings of unknown origin, probably of the standard spiny type. Others, through seedlings, are thornless and their fruits and leaves show some characteristics similar to those of ornamental varieties. Bouquetiers, sour oranges and Bergamot seem unknown.

1.1.3.7 Miscellaneous

Citron trees of an acid type are found erratically. Fruits are used for jam.

Shadocks are seldom found: a seedless variety with dark red flesh is grown on a large estate near Melka Werer.

1.1.3.8 Recent introductions

The Project introduced three years ago, from a reliable nursery in California, trees propagated from virus-free buds of the world's main commercial varieties, budded on various rootstocks. This collection was planted in the Experimental Research Station, Melka Werer. The rootstocks are Troyer citrange, sweet orange, macrophylla, Cleopatra mandarin, Trifoliata, etc. The scions are from various nucellar clones, e.g. Washington naval, Valencia late, Ruby sweet oranges, Eureka and Lisbon lemons, Bearss lime, Fairchild and Dancy mandarins, Marsh and Red Blush grapefruits.

Due to their intrinsic qualities (freedom from virus diseases which usually plague old lines of citrus varieties and reduce tree size and yield) but also to good management (large spacing, adequate
windbreaks, good cultural practices, especially irrigation), these
trees show a superb growth, possibly equal to that of the best trees
in the world. The diameter of the trunk and the volume of the canopy
are at least double that of common trees in Ethiopia.

These trees may be considered as foundation-blocks of capital
importance for further development of the Ethiopian citrus industry
and they must be the only source of budding material to be allowed
for use in the future, until private nurserymen and State agencies
have at their disposal similar foundation-blocks in their own nurseries
and orchards.

1.1.4 Rootstocks

The main rootstock is Rough lemon. Its main advantage is
tolerance to Tristeza but its drawbacks largely exceed this advantage:
susceptibility to Phytophthora gummosis, poor results in heavy soils,
low soluble solid content of the fruit budded on it. Sour orange is
second in importance. Seedling citrus trees are uncommon, with the
exception of Rough lemon.

The choice of a standard rootstock depends entirely upon its
status concerning Tristeza: if this virus is present, sour orange
cannot be recommended and it must be replaced by, e.g. Troyer citrange
for sweet oranges, mandarins and grapefruits, Cleopatra mandarin for
limes. If Tristeza is not present, and if one may rely on a strict
enforcement of quarantine regulations prohibiting imports of citrus
material from foreign countries, sour orange can be used, at least to
a limited extent, for instance for scion varieties for which virus-
free budwood is not yet available in sufficient quantity, as is the
case of Clementine in Ethiopia. Sour orange is also suitable for
lemons.

1.1.5 Cultural Practices

1.1.5.1 Spacing (Appendix I)

Planting distances vary considerably according to the type of
cultivation, generally from 2 x 2 m in the traditional orchards to a
maximum of 8 x 8 m in the few modern plantations. On the average
trees are spaced too closely and there is frequent association with
other tree crops, such as coffee, guava, pomegranate, papaya. These
crowded orchards require heavy pruning to allow a minimum of mainten-
ance work between rows of trees.

1.1.5.2 Irrigation

Water for irrigation is obtained from rivers and streams, some-
times from either natural lakes or dam lakes. No wells were observed,
with only one exception (Eritrea), and it seems that the underground
water resources are not taken into consideration.

The quality of irrigation water is not always good, especially
when pumped from natural lakes subject to heavy evaporation. There
is also a general and widespread claim for irrigation water and con-
sequently, a reduction in the volume supplied to trees as well as a
limitation of plantations in some areas where climate and soils are
suitable for citriculture. This inadequate irrigation is probably
also the cause of the frequent off-blooms (and off-fruits) and of the
poor quality of fruits, more especially their low juice content and
thick peel, noticeable more especially in grapefruit.
1.1.5.5 Tillage

There is no general policy for tillage. In large estates, tillage is periodically undertaken, weather and soil permitting, to remove weeds and to make basins and furrows. In smaller estates, tillage is not so regular and weeds are almost permanently present (1.1.13).

1.1.5.6 Pesticide treatment

Scales are submitted to routine treatments with stock chemicals (phosphoric esters), though infestations are often light and could be suppressed by using white oils which do not destroy hyper-parasites (1.1.12.2).

1.1.6 Nurseries (Appendix II)

The bulk of the citrus trees planted in Central Ethiopia were brought from the Asmara area. There is no nursery of any importance in this part of the country; the small ones which do exist only supply their owners, private persons or State controlled agencies, with trees for their plantations. These nurseries show some lack of basic knowledge, for instance in the matter of rootstock choice, selection and grading of seedlings before transplanting, spacing before budding, preparation of rootstock for budding and training of young trees after budding.

1.1.7 Virus diseases

Virus diseases are the major problem in all citrus-growing countries. They are the main reason for the medium or poor yields which subsequently affect fruit prices. In some countries, such as Brazil, Argentina, Spain and, to a lesser extent U.S.A. (California), hundreds of thousands or even millions of trees have been rapidly killed.

After such a short visit to Ethiopia, no formal assessment can be presented of the virus situation. Only a factual report of observations will be given here. Many virus diseases, by lack of external symptoms, can be ascertained only after carrying out indexing procedures on adequate indicator-plants; many rootstocks and scion rootstock combinations are symptomless carriers, and, although infected, do not show any leaf, bark, fruit or other symptoms, but they can contaminate other trees by budding and grafting, by using pruning shears inadvertently infected or by insect vectors.

1.1.7.1 Tristeza (Appendix XV)

Presence of Tristeza is indicated, on West Indian type lime trees, by leaves showing vein-clearing and trunks showing "stem pitting". These symptoms are generally not visible on sweet oranges, mandarins, lemons (but stem pitting is frequent on grapefruit trees). Formation of pits in the wood and of pegs in the corresponding part of the bark, and also the contrary (pegs in the wood and pits in the bark, i.e. "inverse pitting") is attributed by some authors to Tristeza, but the Consultant does not agree with this conclusion.

The leaves of many lime trees were observed but nothing suspect was observed. In an old mixed plantation in Erer Gota, according to a previous report, an orange tree was considered as Tristeza affected.
No symptoms of this disease were observed by the present Consultant. The decline of half and not the whole of the canopy can be attributed to termite infestation, common on the trees in that plot.

Neighbouring lime trees, possibly infected if this orange tree carries Tristeza, do not exhibit any leaf symptoms.

Until results of indexing on Mexican lime prove the contrary, it can be concluded that Tristeza is not yet present in Ethiopia.

However, plantations in Elaberet give some cause for concern. According to the owner, trees of various varieties were introduced from South Africa, where Tristeza disease is known for at least 60 years. These trees are budded on Rough lemon, a Tristeza tolerant rootstock. For both reasons, one can suspect these trees of being symptomless carriers. Also of importance is that many citrus trees now grown in various parts of Ethiopia originated from this area and could also be symptomless carriers and, as a consequence, a source of virus for transmission by insects (or by budding).

1.1.7.2  Psorosis

It was not the season to look for leaf symptoms of the various forms of Psorosis; observations were limited to the trunks.

Scaly Bark (Psorosis A) is not uncommon in sweet orange trees, more especially in Valencia. Concave is also frequent in sweet oranges and in Mediterranean mandarin. Some questionable cases of Blind pocket were also observed. It is certain that indexing would show other cases of Psorosis on apparently healthy trees.

1.1.7.3  Exocortis

In Ethiopia citrus is budded on tolerant rootstocks, and symptoms of Exocortis, especially bark scaling and striping, cannot be observed. The status of Exocortis can be ascertained only after indexing. It is probably the same as in other countries, where usually only old lines carry the virus.

1.1.7.4  Cachexia

Because of lack of time (samples must be taken of bark both sides of the bud-union line, and trees are budded very low and deeply planted), it was not possible to undertake research in Cachexia.

Mediterranean (Willow leaf) mandarin and Shamouti (Jaffa) sweet orange in other countries, frequently carry Cachexia, and it may be presumed that the situation is the same in Ethiopia. This could be verified through indexing.

1.1.7.5  Stubborn

Stubborn is considered as the most threatening virus disease of Citrus, probably more than Tristeza. Transmission is probably by insects but has never been demonstrated. A similar disease (if not identical), Greening, very damaging to Citrus in South Africa, the Philippines and India, is known to be transmitted by two different species of Psylla. No control methods have been established.
1.1.9.2 Minor elements

Zinc deficiency symptoms are widespread. Mottling is the most common manifestation, but in some cases, short internodes, smaller leaves and a slightly bushy appearance, can also be noted on some branches.

Iron deficiency seems to be present in some orchards, as indicated by the almost total lack of chlorophyll in leaves and chlorotic appearance of the leaf blades. No incidence on fruits was noted (it was not the fruit season). The problem is complicated by the addition of Manganese deficiency symptoms, often difficult to distinguish from Iron deficiency. Lemon trees often show Manganese deficiency symptoms.

Magnesium deficiency can be sometimes found, but of no particular gravity.

Other deficiencies are probably present, but they were not noticeable.

1.1.10 Excesses

At only two places were symptoms of excesses noted:

(a) Experimental Station, Melka Wercr: on some trees, leaves showed tip burns, orange discolourations between the veins and slight deposits of gum, very characteristic of Boron excess. Damage had been more severe previously. Irrigation water from River Awash is suspected to be the cause, rather than a possible high Boron content of the soil.

(b) College of Agriculture, Haile Selassie I Imperial University, Alema: Avocado trees showed very heavy leaf tip burns, due to irrigation with salty water. This is confirmed by similar damage on several plants in the glasshouse.

The citrus plot had poor growth, various discolouration on leaves and an unhealthy look. This may be attributed to the irrigation water pumped from the neighbouring lake which is subject to intense evaporation.

1.1.11 Troubles of unknown origin

1.1.11.1 Creasing

Although it was not the right time to look for possible damage due to creasing (fruits were far from ripe), this trouble was observed in a few locations and is supposed to be more frequent. Its exact cause is not known; Californian scientists attribute it to Potassium deficiency, an opinion which is not universal. Creasing does not lower the quality of the fruit but makes it unsuitable for shipping (cracks in the albedo appear during packing when the lid is pressed against the box).

1.1.11.2 Rumple (Appendix V)

Clear symptoms of Rumple were found on grapefruits in two estates, one at Metu Abo, the other near Monji. The two estates are completely different in respect to soil, management, origin of plants, etc.
1.1.11.3 Bark cracks

Longitudinal bark cracks are reported in various countries in only a few varieties of sweet oranges, for instance Shamouti (Jaffa) and Portuguese Blood. In Ethiopia, it seems to be the rule for almost all species and varieties. These cracks are often deep (but affect only the bark and not the wood) and broad. Affected trees apparently do not suffer and gum exudation has been observed only in few samples.

1.1.11.4 Leaf spots

At different places, leaves of some species and varieties show spots of oily appearance. This trouble resembles Greasy spot. It is of minor importance.

1.1.12 Insect pests (Appendix VII)

1.1.12.1 Mediterranean Fruit Fly

Ceratitis capitata is, with scales, the major pest in Ethiopia. Moreover, it could easily invade future plantations because it is sheltered by many host-plants other than citrus, producing fruits all the year round and consequently allowing an unbroken development cycle.

This fruit fly was apparently present everywhere during the visit and although not the fruit season, many oranges were found to be stung. Other fruits, more especially guavas, were also damaged and full of maggots. It is said that coffee berries are also hosts of the fly. The presence of coffee trees, which are often planted mixed with citrus, is probably one of the main causes of the constant infestation.

No control seems to be carried out.

1.1.12.2 Scales

Only Cottony cushion (Icerya purchasi), Black (Saissetia oleae) and Florida Red (Chrysomphalus aonidum) scales, rarely heavy infestations, were observed.

Control treatments are generally carried out with white oil, and organic phosphorus compounds but apparently without taking into consideration the best period for treatment or the correct formulation: a misuse was made of phosphoric esters, which destroy hyperparasites of other pests (mites, red spiders), allowing these pests to develop unchecked. In many cases, simple treatment with white oil alone could have controlled light infestations of scales without destruction of beneficial predators. The rapid multiplication of silver or rust mite (Eriophyes or Phyllocoptruta) in some plantations is the direct consequence of such bad practices. In addition, they limit the development of the Australian lady-beetle (Novius cardinalis) which could control (free of charge) the Cottony cushion scale.

In Erer-Gota, treatment against scales is undertaken by plane with sprays of a micronized emulsion of white oil and parathion. Probably better results could be obtained by using a ground sprayer.
1.1.12.3 Mites

The Citrus bud mite (Aceria sheldoni) is present on almost all the lemon trees. Damaged (fingered) orange fruits are also not uncommon. No treatment is given.

A silver or rust mite damages lemons and probably other species in the Bliaberet area. No diagnosis was attempted (probably Eriophyes or Phyllocoptera). No specific treatment is undertaken.

1.1.12.4 Various pests

Many aphids can be found on leaves, and leaf miner damage is sometimes common (for instance in Alemaya). Another trouble of unknown origin, but presumably due to an insect, looks like depressions embossed on the lower side of the leaf blade, resulting in a kind of hollow protuberance on the upper side. Depressions are often occupied by larvae or the young of Red scale. This trouble, observed on Citrus only in Alemaya, is frequent on wild plants in other locations.

In Alemaya, several trees show leaves with damage produced by the feeding of the nymphs of the citrus psylla, Trioza erytreae. The insect deposits its eggs on young leaves, the larvae develop on the underside of the leaves and produce characteristic pits by their feeding.

The insect is not dangerous as a pest but is a very efficient vector of greening virus disease. It would not be surprising if greening was present in Ethiopia (1.1.7.5).

1.1.13 Weeds and Parasitic Plants

The most frequent and important weeds in citrus orchards are Nutgrass (Cyperus rotundus), Bermuda grass (Cynodon dactylon), Sudan grass (Sorghum sudanense) and some Pennisetum (P. olandestinum and P. schimperi ?). It is obvious that normal tillage does not succeed in controlling these weeds, especially Nutgrass.

In a neglected and nearly abandoned orchard (Rough lemon seedlings, citrons, pomegranates, guavas) near Chion (Wolisso), several trees of Rough lemon and citron and other species are invaded by mistletoes and are in a severe state of starvation. These mistletoes are Loranthus woodfordioides Schweinfurth and Loranthus globiferus A. Rich. (identifications from original samples by the Royal Botanic Gardens, Kew, England.

1.1.14 Harvesting

As the citrus season was over at the time of the visit, it was not possible to observe harvesting methods. Judging by those applied to other fruits (bananas, papayas, etc.) it is reasonable to suppose that methods must also be improved for citrus. The fruits sold on the Addis Ababa market often show marked Mediterranean Fruit Fly damage, as well as blemishes of various origins. Citrus fruits are harvested when still very green and juiceless (more especially mandarins and sweet oranges). No care is taken to cut the peduncle gently; fruits are simply pulled from the twig and during this operation lose part of their skin together with the calyx ("button"), thus producing an entry for moulds and rots which are frequent in
Citrus, e.g. Penicillium green and blue moulds. Grading is not practiced and all quantities and sizes are sold in bulk.

Even if the domestic market is of little importance and does not demand high quality, these practices could prove harmful in the future, when growers and sellers are required to offer a standard quality for export.

1.2.1.5 Fruit quality

It was not possible to observe fruits from the winter crop but, in general, it would seem that they do not possess the standard characteristics shown by citrus produced under the Mediterranean climate, more especially with respect to rind and juice colour, juice content and sugar/sour balance.

Though Citrus are native to tropical countries, with little or no chilling during winter, their best qualities are obtained only when grown under climates showing considerable falls in temperature during winter, e.g. Mediterranean countries, California, South Africa. In a more tropical climate, fruits are not of so good a quality; their outer colour always remains greenish or, at the best, yellowish instead of being an attractive orange or reddish colour. With the exception of grapefruit, the juice content is lower and the taste flatter, due to a poor balance between sugars and acids.

Sweet orange juice shows a light colour, which is a big drawback if processed juices are to be exported to countries which are particular about this characteristic, e.g. Germany.

1.2.1.6 Processing

Citrus fruits are not yet industrially processed in Ethiopia; the fruit supply is still too short to satisfy even one factory. Also, the country is not ready to compete on the world market with more developed countries which have long experience in this field. The price of fresh fruit for processing is too high.

But a small industry, designed to meet the domestic market, preparing a limited quantity of products, using a minimum of simple equipment, could prove possible and economic.

1.2 CONCLUSIONS

The problem of outlets will not be considered here. Some countries bordering the Indian Ocean, mainly Saudi Arabia, are traditional importers of Ethiopian citrus; others in the same area could also begin to be buyers, like Iraq and Iran, possibly Kenya. European markets are less encouraging. Possibilities of industrial processing, more especially concentrated juices, are still impossible to assess owing to lack of technological data on the locally produced fruits.

It is concluded that:

(a) in all the regions visited - Addis Ababa, Harer, Wolker, Mende, Middle Amsach Valley, Keila Werer, Brer, Midline, the Ogb Valley, the Ambo-Guder area, the Blaberet and Ginda areas, even Jimma and the Amsach regions, for instance the Wolque Monda area - and also in many other parts of the country, citrus can be grown at a viable economic level and without raising any major technical problem which cannot be solved by standard methods, provided that:
- irrigation water is of good quality (not salty) and permanently available in sufficient quantity;
- soils are not too heavy or at least possess a good natural drainage.

(b) **Plantations must first be developed**

- where communications (asphalted or permanent roads, railroads) are available at a reasonable distance, or are expected to be built within a few years;
- where other plantations or other agricultural complexes exist with which they could constitute concentrations of marketable commodities justifying improvement of communication ways, development of transportation activities, foundation of packing houses, processing plants, etc.

It is believed that citrus plantations must be developed first in the Middle and Upper Awash River valley (Netahara area; Erer area; irrigation water permitting). Unless water resources are found to be sufficient, no special effort is suggested in Eritrea.

(c) **Citriculture will pay in the future only if**

- orchards are planted with trees of a limited number of commercial varieties from virus-free buds on adequate rootstocks (principally Tristeza tolerant);
- planting is at sufficient spacing (with possibly catch-crops or interplantings during the first years);
- irrigation water of good quality is supplied in sufficient quantity;
- chemical fertilizers, mainly nitrogen, are generously applied;
- orchards are routinely treated to control Mediterranean Fruit Fly and scales.

With the increase in citrus production and a consequent lower selling price and possibly with some changes in world trade, industrial processing of an important part of the Ethiopian citrus crop will become probable.
Important plantations of banana are found throughout the country; local consumption, although difficult to ascertain, is considerable, contrary to that of other fruits, papaya excepted.

Bananas, whatever the type or variety, are always of high quality, from the very small ones, no longer than 10 to 12 cm to long ones, 20 cm or more, always with an excellent fragrance.

All types of cultivation may be observed, from practically abandoned plants growing close to the dwellings, to regular plantations, with periodic irrigations and good general maintenance: it is not possible to give standard information on cultural practices because of the wide diversity of methods used.

Some points are noted below:

(a) In spite of their relatively high selling price (Eth.$ 1.00 kg on Addis Ababa market), the domestic outlet for bananas is not always good. In a small and well managed plantation in the Gebio valley, at least 50 bunches of perfect quality were observed ready for harvesting. There was no possibility to transport them to Addis Ababa and the crop was lost. Three weeks later, the entire plantation was uprooted by the owner.

(b) Bananas are represented by at least a dozen types and varieties, generally of unknown origin and sometimes with conflicting names. On the whole, dwarf types seem preferable in modern culture, but some small plantations contain a very tall variety, with slender stems and giving only short bunches of a small number of hands; apparently with a very poor yield per acre. In spite of this characteristic, this culture was said to be "interesting" ...

(c) In all plantations, suckering is inefficient or nonexistent. Generally speaking, the number of suckers allowed to grow is excessive and when it is not too great (less than 4 stems, including the main one), they are not properly chosen, many often being of the same age, instead of being separated by intervals of three months.

The male inflorescence is allowed to grow until harvesting. In many countries, it is considered that its removal results in an increase of about 1 kg in the weight of the bunch.

Mulching, to improve the physical quality of the soil and to decrease water evaporation, is not practised, though good possibilities exist for cutting and collecting weeds in non-cultivated fields.

(d) Bacterial wilt (Xanthomonas musae) is the most important disease; it also threatens the culture of "Enset" (Ensete edule) and there is probably a relationship between the two plants in respect to environment conditions for the spread of this disease.

In a plantation in the Gebio valley, in some bunches, fruits showed a black rot starting from the pistillar scar and able to destroy the affected fruit which emits an offensive smell. The cause is
Similar fruit tip rots have been reported in Cameroon (Trachysphaera fructigena), in Israel (Botschierella gregaria) and in other countries (Neightoniella torulosa).

Very rough conditions were noted in the transportation of bunches; no care is taken in handling and the bunches or hands hanging in the retail shops in Addis Ababa commonly show deep cuts in the peduncles, sometimes followed by heavy softening of the basal part of the fruit. The shop owner cuts off the damaged fruits and throws them away, apparently not taking such losses into consideration.

2.1.2 Papaya

Papaya (Carica papaya) is one of the most popular fruits in Ethiopia and is found everywhere, in regular plantations as well as single specimens in dooryards or even in hedges. It is served in restaurants as a breakfast and dessert fruit.

Commercial plantations are apparently well managed and highly productive. Fruits fetch a reasonable price on the Addis Ababa market (Eth.$ 0.40 to 0.50 kg). They are in general of a large size and oblong shape and their skin and flesh colours are not very well developed. The flesh is somewhat tasteless.

The principal problem of papaya culture is the high proportion of male plants in the orchards, sometimes over 50%. Moreover, in good commercial plantations, papaya plants are very tall and difficult to harvest. Pollination (always natural) seems satisfactory, for fruits are of good shape, not misshapen and full of seed.

The Consultant was asked how to detect the presence of male plants in seedbeds before plantation. The method has not yet been found.

Processing of Papaya for papain is not practised in Ethiopia. Only a market survey could determine whether such an industry - which is feasible in Ethiopia - would be economic.

2.1.3 Avocado (Appendix VIII)

2.1.3.1 Introduction

In Ethiopia, as in most other countries, Avocado may be considered as a neglected fruit, in spite of its unique qualities, among others its richness in oil, which is easily digestible due to its emulsification in the flesh cells, its high content in liposoluble vitamins as A, D and E (uncommon in other fruits) and its good proportion of proteins and minerals.

In a country like Ethiopia, where people abstain from animal products, meat as well as butter and eggs for at least half the year, where the main part of the diet is provided with carbohydrates only ("tef" and "enset" flours), avocado is the cheapest, the easiest and one of the most suitable ways to get a more balanced diet. Door yard cultivation of a few avocado trees, the varieties selected in such a manner that they secure the longest season of production, should be the best method, followed by commercial plantings.

In all the areas visited, avocado trees thrive well, generally with a minimum of care. In some places, superb crops were observed, for instance at Asbe Tefori; in other locations, in spite of total
lack of maintenance, trees were covered with fruits. In Lake Wando (Lake Awasa), avocado trees are used as windbreaks and hedge plants for coffee trees, and apparently bear good crops.

2.1.3.2 Varieties

With one exception, all avocado trees observed in Ethiopia are seedlings of unknown origin. In a beautiful plantation, at Asbe Teferi, trees are said to be from seeds introduced from Madagascar. In a large estate at Blaboret, some roads inside the plantation are bordered with grafted avocado trees, but the variety name(s) has apparently been lost.

It was not possible to determine if the small collection established at the Agricultural School, Debre Zeit, is grafted or not.

With the exception of a few trees at this School, it is difficult to ascertain the race of the seedlings grown in Ethiopia; fruits are generally large, often purple and thin-skinned, with a watery flesh and large seeds, all characteristics suggesting the West Indian race, but often with a light to very light anise smell when crushing leaves. As in other countries, these seedlings are probably hybrids.

2.1.3.3 Diseases and Pests

Root-rot (Phytophthora cinnamomi) does not appear to be present or at least does not cause any damage. In Lake Wando, the leaves of one tree exhibited round spots, 8 to 12 cm in diameter, cream coloured with a light orange ring in the middle. Determination is underway (Lichen?). Chlorophyll disappears from such leaves, which turn greyish and/or purple and fall.

Very often, black spots and areas can be seen around the stylar scar, similar to those due to mites in other countries.

Tip burns on leaves were observed in Alemaya and attributed to irrigation with salty water. An avocado tree at the Agricultural School, Debre Zeit, exhibited mottling similar to that induced by "Sun Blotch" disease.

2.1.3.4 Culture

There are no plantings of avocado in Ethiopia. Plants are scattered in orchards of other species. Often they are not even irrigated. In several locations, where average rainfall is high, it seems that artificial irrigation is no longer necessary after plants are well established, at around 8 to 10 years old. This is worth an experiment.

2.1.3.5 Production Calendar

It is difficult to give an accurate calendar for present production. It is probable that good cultivation practices, mainly regular irrigations, would modify the present observations made from rather "wild" trees.

The main period seems to be from mid-March onwards, but it was possible to find, in all the regions visited, avocado trees with fruits at all stages of development, securing a crop all the year round, or nearly so.
2.1.3.6 Extension

Even if large, modern plantations of avocado are considered non-economic, it is highly desirable that small numbers of avocado trees are planted around houses, exactly as are Ensat plants. A minimum of manure, some irrigation during the first years (if necessary with the building of "impluvium") could secure a good start and later a decent production immediately usable by the grower and his family, with a minimum of expense and care.

2.1.3.7 Markets

Avocados are sold only on the Addis Ababa market, and possibly on that of Asmara, in low quantities but at a high price (3th.$ 1.25 kg, minimum).

Any export must be by air freight and, if directed to European markets, during a period when competition with other more privileged producers (e.g. Israel) is not feared - from April to July, from September to November (in August, imports are voluntarily restricted). Export would seem feasible, with a correct choice of varieties and good cultural practices, but the cost of the air freight must be evaluated in the calculation of the expected returns.

Avocado can also be utilized for the production of oil, mainly for cosmetics. However, the market is at present saturated. Careful studies on the production of an edible oil, and the cost of such an oil, are required to determine whether such an oil could have a place on the local market.

2.1.4 Mango (Appendix VIII)

2.1.4.1 Introduction

Mango has excellent potentialities. It is, however, still of minor importance since there are no plantings devoted to its culture in spite of the extremely suitable climate and soils, at least in the not too high lands.

All the regions visited during the survey display a wide range of possibilities as evidenced by the numerous trees, more or less half wild, which can be seen everywhere. Moreover, in spite of the bad cultural conditions and although all the trees are seedlings giving only small and fibrous fruits, the intrinsic quality (e.g. colour and taste) is good.

2.1.4.2 Varieties

All mango trees observed were seedlings, giving a vast range of fruits, from very small with large seeds and an abundance of fibres, to large ones, with medium size seeds and not too much fibre. They are not so good as the grafted, named varieties, but a special survey of the plant material grown could probably disclose some better forms.

The origin of these seedlings is not known. Fruits are yellow or light orange.

2.1.4.3 Diseases and pests

Time was insufficient to draw up an accurate list of diseases and pests. Black spots of various diameters were observed on the
skin of the fruit, similar to those produced by Anthracnose (Colletotrichum gloeosporioides). It was not possible to observe it on flowers ("Blossom blight") as it was not the season.

2.1.4.4 Culture

Mango trees are grown together with other fruit trees, e.g. citrus, avocado, papaya.

An apparently abandoned mango orchard was observed just before Blaberet (Acmara side), planted both sides of a dry stream. In spite of a complete lack of management, the trees were excellent, some of them producing very reasonable crops. At other places, when associated with citrus and allowed to obtain their share of irrigation water, fruit size was observed to be good and quality excellent, yield not too poor. Only the presence of fibres and the large size of the seeds are drawbacks.

With properly chosen grafted, named varieties, it would be possible to start an interesting mango industry with a good chance of exporting at least a part of the crop.

2.1.4.5 Production Calendar

It is difficult to form an opinion about the main mango season, at the same time, and even on the same tree, fruits at different stages of maturity are often found. Generally speaking, the main season starts at the end of April, about two months earlier than the other countries supplying European markets.

2.1.4.6 Extension

Although less interesting from the nutritional point of view than Avocado, mango trees should be planted by farmers and others around dwellings.

Mango is one of the few fruit cultures which can also be developed on a commercial, modern basis. Ecological conditions are suitable and there are probably good markets in Europe for high quality mangoes, transported by air, provided they comply with special requirements.

This raises the problem of the supply of grafted trees and consequently of nurseries, methods of grafting, mother trees, etc.

2.1.4.7 Markets

Present mango production is entirely absorbed by the Addis Ababa market and probably also by that of Acmara. If avocado is mainly consumed by foreigners and the wealthier Ethiopians, mango, on the contrary, may be found for sale even on the large, open market of Addis Ababa. Fruits are of a quality inferior to those in retail shops, but this shows that there are some possibilities for mango in Ethiopia itself. Best quality mangoes are locally sold at Bth. $1.50 kg (minimum).

Production is too small and too scattered to feed an expert market, even by trading the best fruits (e.g. from Monji, Asbe Teferi, Ketahara). But a study of the European market would probably show that there is room for Ethiopian mangoes if they comply with special requirements:
large fruits, with a small seed and thick "cheeks", without fibres.

- good external colour, if possible deep orange or reddish purple.
- good grading (size, colour) and homogeneity in individual boxes.

It is probably not difficult to include air freight rates in the selling price while still obtaining good returns for the grower. At present, European markets are supplied, with the exception of Israel, by countries which are not well organized, or where commercial plantations are not common. If Ethiopia can start commercial plantations, established according to modern methods of planting and growing, with selected varieties, production can find a place on the European markets.

2.1.5 Pineapple

Only one pineapple plantation of any importance, situated near Bongo in the Kaffa province, was noted, though other very small plantations (or, rather, plots) can be seen in different regions. One, near Zako, planted with Smooth Cayenne and probably Red Spanish, had weak plants with yellow leaves, small fruits, often sunburnt. A high proportion showed fasciations. They were planted too far apart in too light a soil, with probably no care at all.

The Bongo plantation is established on slopes, with the smooth Cayenne variety. Yields are apparently satisfactory and fruits are usually sold in the Addis Ababa market at Birr.3-25 kg, a high price according to world standards. The plantation is crowded, with short spaces between rows. The leaves are light coloured denoting deficiencies (Nitrogen?). No care is taken to protect fruit from sunburn, nor to raise fallen plants with their growing fruits.

2.1.6 Annonaceous Fruits (Cherimoya, Sweet Sop, Sour Sop)

Annonaceous fruits are not uncommon in Ethiopia. Mainly Sweet Sop (Annona squamosa), then Cherimoya (Annona cherimola) are found. Sour Sop (Annona muricata) is rarer.

All trees are seedlings. Fruit production seems low. Cherimoya fruits are often small, misshapen and imperfectly developed, probably due to imperfect pollination. This species almost always requires hand pollination to obtain fruits of acceptable size.

2.1.7 Tree Tomato

Only one small plot of tree tomato (Cyphonandra betacea) was observed (Alema). Growth of plants seemed excellent, but a disease is progressively destroying the stem from the terminal bud downwards. Investigation as to the nature of the disease is in progress. Plants are covered with young fruits and clusters of flowers. Without this disease, good crops could be expected.

2.1.8 Pepito or Melon Pear

The pepito or melon pear (Solanum muricatum) is often locally called "Egg fruit" which is the name commonly applied to a different genus (Lucuma nervosa). It is only grown in the vicinity of Chion (Woliso) by small farmers who also grow tomatoes and various other...
vegetables, and is treated like tomatoes. Production starts in April and is said to be entirely absorbed by the Addis Ababa market at a price rewarding to the farmer.

2.1.9 Amberella

There is only one plantation of Amberella (Spondias cytherea) in Ethiopia, in the Metehara area, covering a few acres. Trees are planted in rows, like adjacent citrus trees. Production is limited, as is the outlet for this fruit.

2.1.10 Guava

Guavas (Psidium guajava) are frequent, usually grown among other fruit trees. They are always seedlings, very vigorous (some plants are trees 5 to 6 m high) but bear only small crops of poor quality fruits. They are mainly of the round (var. pomiferum) type, with a white or very light pink flesh.

This fruit species seems to be little prized, and fruits are sometimes not harvested. They are severely damaged by the Mediterranean Fruit Fly and often shelter maggots which secure a round-the-year survival on the fruit.

2.1.11 Granadilla (Appendix IX)

The Granadilla or Passion fruit (Passiflora edulis) is not common but some beautiful plants can be found, scattered among other fruit trees, and generally receiving only a part of the care granted to the other plants. Nevertheless, they grow very well and fruits are plentiful. Vines, 12 to 15 m high, were noted in As Be Teferi, climbing high cypresses, without particular cultural care.

2.1.12 White Sapote

White sapote trees (Cassimiroa edulis) are scattered among other fruit trees, in small numbers and are only seedlings. Fruits are rather peach-shaped (with a marked nipple rather than the common, round or flat shape). They contain about four seeds, quite well developed; the flesh is sweet, soft, not very tasty. Trees are vigorous, with very good crops but the white sapote remains a secondary fruit.

2.1.13 Grape (Appendix X)

Grapes are found everywhere, either in plantations, trained on wires, pergolas or unsupported.

2.1.13.1 Varieties

Even in the large estates, the origin of the plants is not known; varieties are said to be "white grape" or "white grape from Asmara". In an estate in Gobie valley, named (and grafted) varieties were introduced from California. Due to a late planting this year (March 1969), plants have not taken very well and a heavy loss must be expected.

2.1.13.2 Calendar

It is difficult to draw-up a production calendar. Observations differed from one orchard to another. For instance, in a vineyard not far from Addis Ababa, grapes were said to be ripe in January, but
in Nazareth, on a pergola, vines were covered with almost fully ripe fruits in April. In Kethara, in a very good-looking commercial vineyard, with two pruning per year, two crops are obtained – one in July, one in January. In a small vineyard near Asmara, the crop was expected for June and July.

Fresh grapes were sold in the Asmara market in April and in Addis Ababa market in May. The exact season of production seems to be greatly influenced by the time of pruning and by cultural practices.

2.1.13.3 Market

There is an excellent market in Ethiopia for grapes, both for wine making and for the table. Grapes are never sold at less than 8th.$ 0.9C kg, and in May the production from Debre Zeit realized 8th.$ 2.00. It is difficult to understand how it is possible to make wine and to sell it at the present (relatively) medium price, when grapes are so expensive.

Grape growing in Ethiopia must be encouraged, but only for the local market.

2.1.14 Rosaceous fruits

The majority of Rosaceous fruits, namely Apple, Pear, Quince, Peach, Plum and, to a lesser extent, Apricot, require a period of dormancy, which is usually obtained through the colder winter months. Ethiopia does not have the ideal climate for such crops, at least in the areas surveyed; pomeaceous trees are generally weak, more especially apple, with disturbed vegetative cycles. This culture is of no economic importance.

2.1.14.1 Apple

Apple trees are the poorest rosaceous fruit trees; leaves and flowers appear at various periods on the same tree. As nearly all varieties require dormancy, improvement of culture is difficult.

2.1.14.2 Pear

Pear trees are uncommon in Ethiopia and probably show the same poor adaptation as apple.

2.1.14.3 Peach (Appendix XI)

Peach trees show the best adaptation of the rosaceous plants. Specimen are widespread, with an apparently normal growth and good appearance. Beautiful trees, 5 to 6 m high were observed in the Bateya Wando area (Lake Awasa), but the fruit is of low quality, small size, greenish colour and very hard flesh, difficult to use as a table fruit. Nevertheless, peaches are readily sold on the Addis Ababa market.

2.1.14.4 Plum

Plum trees were noted only in the Asmara area, with fair results. These trees are Golden Drop and also Santa Rosa, which is of the Japanese type.
2.1.14.5 Apricot

Apricot is one of the Rosaceous fruits with the least chilling requirements. Curiously enough, it is non-existent in Ethiopia. Cultural experiments are desirable.

Apricot is very susceptible to the Mediterranean fruit fly. There is little reliable information on the biological cycle of the Mediterranean fruit fly in the country and as varieties, because of their earliness, mature before flies appear, it is difficult to recommend any particular one. For reasons of possible damage due to fungus diseases during the rainy season, early varieties would probably give better results than the mid-season and late ones, more especially if they are routinely treated for the Mediterranean fruit fly. For this purpose, very early varieties are recommended.

2.1.14.6 Loquat

The Loquat (Eriobotrya japonica) is common in Ethiopia but never grown in orchards; it is wild and does not enjoy any particular care.

Trees are always seedlings, apparently of inferior quality, with respect to the fruit, but thrive well elsewhere and are free from pests and diseases.

Loquat has no importance for the export market but could be easily improved by growing grafted, named varieties and by being given a small irrigation during the late winter months, during the period when fruit size is increasing.

2.1.15 Pomegranate

Pomegranate plants (Punica granatum) are frequent in Ethiopia, growing wild, fruits harvested or not. They are commonly sold on the Addis Ababa market, but are of little importance.

2.1.16 Fig

Fig trees (Ficus carica) are common, but never planted in orchards, with the exception of some rows among other fruit crops. The origin of the trees is not known. It was difficult to assess accurately the adaptation of this fruit species to the country. It is locally said to be a good bearer, but fruit seemed to be of a small type.

Haile Selassie I University College of Agriculture, Alemaya, maintains a plot of seedling fig trees (Appendix XIII).

2.1.17 Minor fruits

2.1.17.1 Kei-apple (Doxyalis caffra)

This shrub may be found at different locations mainly as a hedge plant. Fruit, which is of poor quality, does not seem to be consumed.

Kei-apple is a permanent host plant for the Mediterranean Fruit Fly and further propagation should be stopped.
**2.1.17 2 Frickly pear (Opuntia ficus-indica)**

Opuntia is often used as a hedge plant. The fruit is locally consumed, some being sold in the Addis Ababa market. Another Opuntia, growing wild, gives smaller and deep red fruits which are considered poisonous and not eaten; they are in fact perfectly edible.

Good spineless varieties of *Opuntia ficus-indica* could be introduced; the fruits are edible and the 'leaves' are usable as a fodder. When selecting a variety, it must be remembered that some of the thornless types do not bear fruit, while others do.

**2.1.18 Wild fruit**

**2.1.18.1 Jujube**

The wild jujube, the fruits of which are gathered and sold by street vendors, belongs to *Zizyphus spinosa-christi* (local information). The fruit is round, like a tiny apple, 12 to 14 mm in diameter. The seed is round and the flesh is like that of other species in Mediterranean countries (*Zizyphus lotus*).

It is impossible to plan any project for improving this species, but many locations in Ethiopia could suit the culture of different varieties of *Zizyphus sativa* (the Chinese Jujube), more especially Li and Lang. Both varieties are large-fruited, Li with small apple-like berries, Lang with pear-shaped ones. The flesh is abundant, sub-acid and very pleasant before maturing, and suitable for confectionary ("Peking Dates") or for sun-drying.

Chinese jujubes are hardy, tolerant to frost in winter, resistant to heat and require only a small amount of irrigation water. Only grafted trees must be planted and consequently must be imported from California. In some countries, fruits are very susceptible to flies (*Carpomys incomplete* and *Ceratitis capitata*) and to a beetle (*Aderetus pallens*).

**2.1.18.2 Tamarind**

Very large trees of Tamarind (*Tamarindus indica*) are common; the fruit is rarely eaten. It is a forest tree rather than a cultivated one and improvement would not be economic.

A possible use of the fruit would be in the form of a small food processing industry: a factory using various fruits for different purposes, could also benefit from tamarind pods by preparing flesh extracts and syrups.

**2.1.18.3 Eugenia**

Some shrubs seen growing wild near Woliso were apparently an *Eugenia* (*Eugenia owariensis*). Fruits are very small and without commercial interest. They are eaten by shepherds.

**2.1.18.4 Rubus sp.**

Some *Rubus* shrubs are said to grow wild at different places, the fruit being locally eaten, despite the very small size.
2.2 CONCLUSIONS

Mango is the only fruit which could supply an export trade and is worth air transport. It could also find some outlets locally as a fresh fruit and as a material for processing.

Avocado could constitute an excellent fresh fruit for the local market, as well as a family culture and could thus greatly improve the local diet, which is low in lipids. Selected fruits, appearing on the market at a season different from that filled by avocado from Israel, could be worth air freight to Europe.

With a good choice of varieties suitable for different locations, it would be possible to grow Mango and mainly Avocado in almost all the locations where citrus are cultivated. But these commercial varieties must be introduced from abroad.

The export market for Banana appears restricted and prospective markets in the Indian Ocean region must be sought. In spite of its relatively low price on the domestic market, Banana culture could be interesting for this market if giving high yields. Many locations are suitable for Banana, particularly if the right variety is grown at the right place.

Pineapple will remain a crop for the local market only, because of the heavy and cheap production of many other countries. If its local price becomes reasonable, it could be processed into natural flavours for various industries, among other, soft drinks. Cultivation is limited to lowlands.

Passion fruit grows well and could be cultivated in many places, without too much care or expense. It could be an excellent material for processing into concentrated or single strength juices both for export and for domestic markets (flavour for carbonated beverages, ice cream industry, etc).

Grape is possible in many locations. There is a marked demand for wine grapes, and table grapes also obtain good prices on the local market which justify a sizeable development of the cultivation of this fruit. Good varieties for both purposes must be introduced.

Rosaceous fruits, because of the lack of dormancy in the areas visited, do not thrive very well, with the exception of the Peach; cultivation of some American varieties not requiring too important chilling requirements could give good results and supply the local market. Apricot could be tested in the cooler areas. Loquat is neglected but thrives well everywhere - introduction of named, large-fruited grafted varieties would improve this crop and produce marketable fruits. Caneberries, like Boysenberry, Loganberry, still unknown in Ethiopia, could prove valuable for the local market.

Development of the above fruits is handicapped by the lack of reliable information regarding their period of maturity under normal cultivation, for instance with irrigation, and mainly by the absence of good, selected, grafted plants of named varieties. Many fruits are represented only by seedlings (Mango, Avocado, Peach) or by varieties of unknown name and origin (Banana, Grape).
3.1 CITRUS

3.1.1 Varieties

Clementine is an interesting commercial variety but is prized on European markets only if seedless. Being self-incompatible, Clementine is normally seedless but after cross-pollination by various other citrus, its fruits are very seedy and lose much of their value for export, although not for the domestic market. If the cultivation of Clementine is encouraged, and it must be, only unmixed plots of Clementine should be planted; there must be no interplantings with other varieties nor possible pollinators in the vicinity. Washington navel, Valencia late and many other seedless sweet oranges, as well as Catauma mandarins, have little or no influence on the seed development in Clementine fruits.

Apparently the California lines of Clementine, locally called Algerian tangerine, do not have the same pomological qualities of the Old World clones. Consequently, the propagation of the type introduced to Melka Werer cannot be recommended and that grown, for instance, in Mr. Elias Haileou's orchard at Wonji is preferable. Material for this orchard must be grafted on sour orange (or Rough lemon, or Cleopatra mandarin) as it is not known whether it is free from Exocortis: if infected, the reaction with these rootstocks will be mild; if not, it would react badly on Troyer citrange.

In some countries, different varieties of mandarins and sweet oranges give excellent results, for example Hamlin orange in Florida and in some Mediterranean countries Salustiana and Cadenera sweet oranges in Spain, Ortanique and Ugli mandarins in the West Indies (Jamaica). Florida and California breeders have developed new hybrid mandarins, such as Eureka, Robinson, Cecelca, Lee, Fortune and Fremont which generally have large fruits and are either early or late maturing. These varieties should be included in adaptation trials and for that purpose budwood should be introduced. This has already been done for Fairchild mandarin.

3.1.2 Rootstocks

If indexing, to check the presence of Tristeza in Ethiopia, is positive, only Troyer citrange must be propagated for sweet oranges, mandarins and grapefruits. The use of Troyer implies budding with Exocortis-free material, such as that grown in Melka Werer.

If Tristeza is not present, the possibility of introducing this disease must not be forgotten; also the black citrus aphid (Toxoptera citricidus) could find many places in Ethiopia suitable for multiplication and spread. It is, therefore, preferable to use Troyer citrange in the proportion of 30% of the trees in the new plantations, the remaining 20% being on sour orange (mainly lemons).

Cleopatra mandarin, although a Tristeza-tolerant rootstock, cannot be fully recommended because of its susceptibility to Phytophthora gummecia, and mainly because of the difficulty in budding (experienced in many Mediterranean countries and, recently, in Ethiopia, in a Ghibie valley nursery).

With the exception of Rough lemon, there is no source of rootstock seed in Ethiopia. The following recommendations are therefore
made:

(a) introduce some budsticks of the main rootstocks, i.e. Troyer citrange, Cleopatra mandarin, Trifoliate, and graft on locally available rootstocks so as to establish a foundation block of rootstock mother-trees, which will supply the country’s future needs of seed. This foundation block could be located at Helka Merer.

(b) in the interim, purchase Troyer seed yearly from California, to supply the needs of private nurseries and State agencies. Sour orange seed may be easily obtained, at moderate expense, from Morocco.

3.1.3 Cultural Practices

3.1.3.1 Spacing

Ethiopian orchards can take their place in world competition only if planted at distances large enough to allow mechanical work in the fields - e.g. tillage or use of self-propelled weed-killers, sprayers (in the case of non-tillage), establishing furrows and basins or putting of water pipes and sprinklers, use of high efficiency tractor towed sprayers and hedging machines (Appendix I).

3.1.3.2 Pruning

Pruning must be stopped in orchards, with the exception of the removal of dead wood or the care of accidentally broken branches. Foremen and labourers must be forbidden to carry pruning shears in the field.

Correct pruning must be carried out in nursery and in orchard during the two years following planting.

3.1.3.3 Fertilizers

Normally citrus trees require only applications of Nitrogen fertilizers. Potassium and Phosphorus are generally present in sufficient quantity: they must be applied only when deficiency symptoms are observed.

Details on Nitrogen fertilizer use are given in Appendix III. Without mineral Nitrogen fertilizers, it is impossible to achieve the yields which make a plantation competitive.

3.1.3.4 Tillage

For the immediate future, and until nutgrass can be controlled by a weed killer, the standard methods of cultivation by shallow ploughing are the only ones recommended, more especially in soils infested by this weed. The system using light ploughing and basin or furrow irrigation is, for the present, cheaper (less investment, but more expense in irrigation water).

If nutgrass is not present (but often it is not long in invading orchards, tubers being brought in mixed in roots of nursery plants, in irrigation water, in manure), or can be controlled with a herbicide, non-tillage is recommended, but it is not possible, in the environmental conditions of Ethiopia, to make a choice between the destruction
of weeds by herbicides or by cutting and mulching. Either methods imply sprinkling irrigation by different designs: aluminum pipes with rotating sprinklers, aluminum or plastic pipes with independent moveable sprinklers, aluminum or plastic perforated pipes. Non-tillage (whatever the system, sprinklers or perforated pipes) permits culture of not perfectly levelled lands or even of slopes, improves the biological conditions of the soil, allows a heavier development of top roots and consequently a better absorption of nutrients and saves irrigation water.

3.1.3.5 Pesticide treatment

A biological study of the cycle of the main scales and other animal pests of major importance to determine the right time to carry out treatment is required (3.1.8). The most urgent work is to reduce the use of phosphoric esters insecticides in favour of white oil alone when infestations are not too heavy so as to prevent subsequent development of mites, and to start a warning scheme for the treatment of the Mediterranean Fruit Fly.

3.1.4 Nurseries

If possible, multiplication of Rough lemon must be discontinued, to the profit of Troyer citrange (seed must be imported yearly from United States) and for sour orange (until a certain limit).

Use of budding material from old lines must be discontinued; buds must be taken exclusively from nucellar or virus-tested sources. At present, the only source is the foundation blocks at the Research Station, Melka Werer. The exception to this policy is for Clementine (3.1.1).

Basic methods for the establishment, management and maintenance of a nursery must be followed (Appendix II).

3.1.5 Virus diseases

3.1.5.1 Tristeza

It is urgent to start indexing to clarify the situation concerning Tristeza. Such a work may be carried on with a minimum of facilities, to obtain a general view - space could be allocated in a greenhouse, if possible with quarantine possibilities, or even a simple shelter with benches to hold pots or metal cans for growing indicator plants.

Procedures to be followed are indicated by USDA (1968) 1/. If true Mexican lime seed is not available, the common local small lime can be used instead.

Priority in testing should be as follows: (1) the so-called Tristeza-affected sweet orange tree in Erer Gota, (2) trees of different species and varieties (Thomson and Valencia oranges, Cape mandarins, Bureka lemon), planted in Elaberet and introduced from

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South Africa, (3) all declining trees reported, the decline of which cannot be attributed to known causes (termites, water-logging, root rot, foot rot).

To prevent possible introduction of Tristeza by infected material imported from foreign countries, it would be advisable to pass a law regulating imports of Citrus and relatives into Ethiopia, at least budded or grafted trees, seedlings, budsticks, cuttings, etc., but not of fruits and seeds which are considered as not able to transmit the virus (Appendix IV).

3.1.5.2 Psorosis, Exocortis and Cachexia

It is not feasible to start an elaborate scheme of indexing for Psorosis, Exocortis and Cachexia, nor to establish a programme for the production of nucellar lines. The best solution is to introduce from reliable nurseries in California nucellar or virus-tested lines of the commercial varieties and of Tristeza-tolerant rootstocks which are still lacking. In the future, seedlings for plantation of virus-free trees can be filled exclusively from the imported material.

It would only be interesting to index local Clementine sources (especially Mr. Elias Harlou's near Venzi) for Exocortis; American sources are questionable from the pomological point of view and the local sources can be suspected of carrying Exocortis, which forbids grafting on Troyer citrange

Indexing must be carried out on Btrog citron (seeds or budwoods of the most reactive lines can be obtained from the University of California Citrus Research Centre, Riverside). Procedures are described in USDA (1958).

3.1.5.3 Stubborn

Tools, such as pruning shears, grafting knives, etc., transmit Exocortis virus, and must be disinfected. The threat of this disease is second in importance only to Tristeza. The same research facilities should be granted as for Tristeza; if possible, work in a glasshouse under quarantine, if not, under shelter. Indicator plant should be Madame Vinous sweet orange, seed of which can probably be obtained from Riverside. Procedures to be followed are described in USDA (1968).

3.1.6 Fungus and bacterial diseases

To combat fungus and bacterial diseases in existing plantations, mainly those on Rough lemon rootstock, earth accumulated against the trunk should be removed to the first main top roots, and a rim of earth raised around the trunk, about 30 cm from it. Irrigation water must be supplied only between this rim and the outer edge of the basin.

When Phytophthora damage becomes noticeable, all dead parts of the bark must be removed with a chisel, and the wound covered with a thick Bordeaux mixture.

For future plantations, Phytophthora susceptible rootstocks, such as Rough lemon and, to a lesser extent, Cleopatra mandarin, must be avoided. Sour orange, Troyer citrange, etc., should be used.
3.1.7 Deficiencies

3.1.7.1 Major elements

Animal manure should be considered as a soil conditioner only, to improve the physical properties of the soil, and not as a source of Nitrogen, unless properly collected, stored and fermented. Chemical fertilizers are the best source of Nitrogen for citrus trees.

"Complete" or "composed" fertilizers should be avoided and, unless symptoms of Phosphorus and Potassium become apparent, only Nitrogen fertilizers (Ammonium sulphate, Ammonium nitrate, Urea) should be applied: 100 g pure N/year of age/per tree; yearly with a maximum of 1500 to 2000 g for adult trees (Appendix V).

3.1.7.2 Minor elements

Zinc deficiency can be controlled easily and cheaply by spraying trees with zinc salts (Appendix V).

Manganese and Magnesium deficiencies can also be controlled as for Zinc, and by soil applications (Appendix V).

Iron is difficult to control: spraying the canopy with iron salts or applying them on the soil does not give good results. Using acid fertilizers (avoid, for instance, Calcium nitrate), preventing excess irrigation, could help, but the only solution is to use iron chelates, such as Sequestrene 138 H Fe. This is an expensive treatment.

3.1.8 Excesses

In the reported areas, the cause of excess symptoms should be investigated by analysing irrigation water and possibly also, for Melka Werer, by analysing the soil of the plot exhibiting the heaviest leaf scorch.

After having determined the nature of the salts involved, foreign experiment stations should be contacted for advice e.g. Weslaco, Texas and Indio, California. Some rootstocks or scion/rootstock combinations are possibly better than the standard ones and could justify a small scale experiment.

3.1.9 Troubles of unknown origin

Observations on Rumpole should be continued to find symptoms of this trouble on varieties other than lemon and grapefruit, for instance on sweet orange and mandarin.

3.1.10 Insect pests

3.1.10.1 Mediterranean Fruit Fly

Plantations of citrus mixed with other fruit trees acting as host-plants of the Mediterranean Fruit Fly, such as coffee trees, guavas, kei-apples, must be avoided. Plantations of these fruits must be as far as possible from citrus, and regularly treated.
Whenever possible, host-plants must be grubbed out of citrus plantations.

In areas with large concentrations of citrus trees, a warning scheme is required using baited plastic (or glass) traps located in different orchards, and in each orchard in each particular plot. (variety, proximity of other fruit cultures, etc.). Records of periodic captures will determine the exact beginning of the infestation and consequently the right start for treatments.

In the same areas, modern methods of treatment (using, for instance, protein hydrolysates and insecticides) should be applied, or at least old methods used (molasses and insecticides). (Appendix VII).

3.1.10.2 Scales

Cottony cushion scale may be naturally controlled by the Australian Indybeetle and does not need chemical treatment. 'Black scale may also be controlled biologically.

Treatment must mainly be concentrated on Red scale. The problem lies less in the choice of a suitable chemical (Appendix VII) than on the right times of application: these dates must coincide with - (1) the beginning of the development of larvae, and (2) the season of adults before depositing of eggs. These dates, which probably differ according to the area, can be determined after some years of observation and data collection by a trained entomologist.

3.1.10.3 Mites

Citrus bud mite can be controlled by using Chlorobenzilate, but the right time of application can be determined only after biological investigations, as for Red scale.

Silver or rust mite could be controlled by Chlorobenzilate or micronized Sulphur.

3.1.10.4 Aphids

Related to the presence of Tristeza in Ethiopia, the question of the presence of an insect vector, more especially the Tropical Black Citrus Aphid (Toxoptera citricidus) must be answered. This answer could be obtained by an Aphis survey. Identification of the types trapped could be made in a specialized laboratory in the United Kingdom.

At the same time, this survey could supply information on the presence of the two Teyilla vectors of Stubborn in the region.

3.1.11 Weeds and parasitic plants

Large citrus plantations should be managed according to the "non-tillage" system, by destruction of weeds with chemical herbicides, without ploughing. There is still no weed killer to combat Nutgrass, which in many countries remains the major obstacle to non-tillage. Trials using mulching without weeds could be interesting at least in preventing Nutgrass from developing too much. It is also a good method to reduce water evaporation, over-heating of the soil and to favour growing of citrus top roots and worm and bacterial populations.
3.1.12 Harvesting

Fruit should not be harvested too early.
Care should be taken not to damage the fruit.

Good methods and the correct tools are needed—special clippers, harvesting bags, standard field boxes, elimination in the field of damaged fruits, washing, sizing, etc. The methods should not be too sophisticated, but at least a minimum of care and attention is needed to guarantee the customer wholesome and saleable fruit.

3.1.13 Fruit quality

Improvement of the juice content can be obtained by controlled irrigation during the dry season, balance of sugar and acid by picking fruits as soon as routine juice analysis has shown that the desired solids/acid ratio is reached. Improving the outer colour can be done in two ways:

- by degreening which consists in treating fruits with ethylene in special chambers under controlled relative humidity and temperature for a period. Green fruits of a minimum natural maturity, after such a treatment show a more yellow colour. However, this colour remains lighter and less attractive than the natural orange colour in Mediterranean countries. Such a process is tolerated in almost all importing countries, provided fruits comply with a minimum of maturity specifications (juice content, solids/acid ratio, etc.).

- by addition of colour, by spraying fruits with an authorized dyestuff. Fruits must be previously degreened according to the above process, then dyed, and are then stamped "colour added". Such a process is considered fraudulent by many importing countries in Europe but could be profitably used in Ethiopia, if importing countries in the Indian Ocean area have no enforced regulations to the contrary.

3.1.14 Processing

A small processing industry, designed to meet domestic needs, preparing a limited quantity of products, using a minimum of simple equipment, could prove possible and economic.

Such a plant should produce only single strength juices (not only of citrus, but also of granadilla and, possibly, of tomato), comminuted fruits (citrus) and other bases (citrus, mango, pineapple, etc.) for carbonated beverages, nectars (mango) and various other products, such as marmalades (citrus) and jams (citrus, guava, papaya), halves or chunks in syrup (mango, pineapple), chutneys, etc.

To be economic, the plant must work 7 to 8 months a year and must be supplied with a minimum of 25 000 tons/year of fruit, bought at US $ 2.5 to 3.5 kg.

Other industrial treatments for citrus, e.g. rind oils and flower oils, are also feasible, but economic studies are first needed, taking into account export possibilities.

The most appreciated rind oils are Bergamot oil, processed from Bergamot oranges and Portugal oil, processed from not too ripe sweet oranges. Bergamot orange is not known in Ethiopia and would have to
be introduced; analysis of such oil would also be required by specialists to determine if Ethiopian production could comply with the requirements of perfumery. The culture of bergamot is possible in Ethiopia, exactly as for other citrus fruits. The greenish sweet oranges of Ethiopia could be also an excellent source of Portugal oil, but the problem lies in its cost compared with production in other countries.

Flower oil or "Neroli" is processed from flowers of special sour orange varieties called "Sauquetters". These varieties are not known in Ethiopia, but could be imported and grown, without difficulty.

Hand oil processing is easy and does not require expensive equipment (small individual machines, USD 200 each, and a centrifuge). Flower oil can be steam distilled at low cost or extracted by volatile solvents (petroleum ether, hexane, etc.). This last method would need a big and expensive factory and repeated import of solvents. It is only feasible if undertaken by specialized firms.

3.6 FRIUITS OTHER THAN CITRUS

3.6.4 Banana

Banana culture can be improved by following some basic methods and by carrying out a minimum of research.

It would be interesting to collect and grow the different types and varieties present in Ethiopia, at least to constitute a collection of genes.

The most usual commercial types could be put in experiment plots, if possible at different locations, at least for adaptation experiments.

To complete this collection, the main commercial types still lacking could be introduced from other countries, for instance Cobo Michel, Spinata, Foyo and Canary Island Dwarf. Great attention must be paid not to introduce with these types (mainly if from Central and South America) dangerous diseases like Panama disease (Fusarium oxysporum var. cubense) and Sigatoka disease (Cercospora musae).

Experiments which are not too complicated could be carried out (spacing and mulching, suckering), together with adaptation trials using the five or six main commercial varieties.

Extension work on existing plantations could demonstrate better suckering and cutting of the male inflorescence - this must be done the month following the emergence of the inflorescence; the male bud can be cut away when it is separated from the last female flower hand by 25 cm of stem. This practice induces an increase of more than 4% of the bunch weight.

3.6.5 Papaya

Some improvement could be obtained through cultivation of different varieties of papaya, in particular some lines of Solo. This variety selected in Hawaii gives medium size fruits, averaging 1/2 kg and round in shape, and is composed mainly of hermaphrodite plants.
Such hermaphrodite plants have a progeny of 100% of fruiting plants (2/3 bisexual and 1/3 female).

A culture of Solo types should be developed and then, after selecting the most suitable types, a sufficient number of hermaphrodite plants, grown even under open pollination, for distribution (99.9% of self pollination, occurs in open-pollinated fruits).

3.2.3 Avocado

Some effort should be made to develop avocado cultivation. With the exception of salty irrigation water and some very heavy, undrained soils, many locations are suitable.

First, good commercial varieties must be introduced in the form of budded trees (Appendix VIII). As climate is sometimes a little chilly in winter, mainly in the highlands, Mexican, Mexican-hybrid and a few Guatemalan varieties should be tried, as these are less susceptible to low temperatures than the West Indian ones, and of higher quality.

Research is needed on the local conditions and methods for grafting or budding avocado trees: best season, age of seedling, shield budding, side grafting, etc., to determine the best method to be used in nurseries, both State and private, for quick and easy propagation.

Search for foot rot must be carried out also on soils from different locations suitable for avocado culture, using Zentmyer’s method (Appendix VIII).

Observations are required on the adaptation of the different varieties introduced: ripening season, importance of the crop, oil content of fruit, etc.

3.2.4 Mango

Mango is one of the few fruits grown in Ethiopia worth air transport to foreign markets. Competition with other producing countries is not to be feared in the near future and the apparently early production of Ethiopia could be a definite advantage.

Grafted plants of commercial varieties must be introduced to constitute foundation-blocks as well as adaptation plots (Appendix VIII). There are two types of mango - tropical, with very large and usually light coloured fruits, more suitable for a warm climate, and the Floridian, with smaller fruits but more deeply coloured (deep red or purple) and better adapted to subtropical climate.

There is probably room for both types in Ethiopia, in the lowlands and highlands respectively.

A method of propagating the Mango for further intensive application in nurseries must be perfected according to local conditions: for example, mango trees are very often propagated by inarching (approach-grafting) which requires a large number of mother-trees, or very large mother-trees, able to give a sufficient quantity of terminal shoots. This will not be possible in Ethiopia for a long time, unless a large quantity of mother trees are introduced and grown. For instance, shield budding must be tried.
Investigations must be carried out to determine the earliest varieties as well as the earliest locations, in order to produce fruits which could reach the European market as soon as possible before the month of May, or as late as possible from November on (a second crop is obtained in some countries). Also to study the influence of agricultural practices, e.g. on earliness, irrigation.

Methods for controlling Anthracnose (and other diseases) which is probably present in Ethiopia and could constitute a serious threat to good quality fruits, must be adapted to the local climatic conditions.

Some research in technology also seems advisable, for instance the processing of unripe and ripe mangoes into jam and into 3C preserved pulp (for jam processing in foreign countries), the production of mango "cheeks" in syrup and that of various chutneys.

3.2.5 Pineapple

Better management and some fertilizer applications would greatly improve the pineapple crop. Although local opinion is that valley bottoms are always colder than slopes, it is felt that such valley plantations could be more interesting with the present methods of management.

Planting on slopes should be in double rows 60 cm apart, with suckers every 30 cm in the row, at alternate places on the two rows. Each group of rows should be separated from the other by a space about 3.90 m wide. If possible, mulching must be applied before planting: weeds growing in non-cultivated fields can be removed and applied before planting at the rate of about 50 m. tons/hectare.

Processing is questionable because of the strong competition from other countries, for instance Malaysia. But in the processing of other products, for instance juice, bases and flavouring material for citrus, granadilla and other fruits, pineapple could find room for supplying a small industry devoted to the domestic market, e.g. limited production of slices in syrup, of juice and of bases for soft drinks.

3.2.6 Annonaceous Fruits

Annonaceous fruits have little local interest and none for export. It can only be suggested that grafted, named varieties of Cherimoyas, for instance Ott, Chaffey, Deliciosa, be introduced as well as that of the hybrid Atenoya (Sweetsop x Cherimoya).

3.2.7 Tree Tomato

The tomato tree (Cyphomandra betacea) could constitute an excellent dooryard fruit.

3.2.8 Guava

If Guava culture is to be improved, better, named varieties must be introduced, for instance from Florida. If not, growers must be advised to pull out existing trees, unless they are routinely treated against the Mediterranean Fruit Fly.
3.2.9 Granadilla (Appendix IX)

Granadilla is still of minor importance but could have an important place in a soft drink industry. Passion fruit juice makes an excellent base for carbonated beverages, a highly appreciated flavour for the ice-cream industry, not to mention single strength and concentrates used plain or for blending.

There is a good market in Europe for such a juice, for instance single strength. Domestic consumption could be raised, by starting new types of carbonated beverages: there are various mineral water springs in Ethiopia (Ambo, Babile) as well as firms carbonating tap water, which could easily absorb an important production of juice to flavour this water and sell as "fizzy" drinks.

Juice processing from Granadilla does not require costly equipment, if limited to the production of single strength juices. Such a production could be associated with that of other juices, to meet only local demand, as quality and cost would make it impossible to compete with other countries. The factory could also prepare other types of canned products, for instance jams, marmalades and jellies (from papaya, mango, guava, etc.), fruit pulps preserved with SO2 (for jam and marmalade processing in, e.g. Europe), fruits in syrup (mango "cheeks", orange and grapefruit segments), preserves ("goyabada", mango chutneys, etc.). Such a factory could operate all the year round.

3.2.10 White sapote

Improvement of white sapote is difficult. In Florida and California, some grafted, named varieties of probably superior performance, can be found.

3.2.11 Grape

Good, named, commercial varieties of grape must be introduced. Because of the absence of Phylloxera in Ethiopia, only cuttings to be locally rooted should be imported. This is also to prevent a possible introduction of Phylloxera with grafted rooted plants.

The best table varieties to be tried are: Cardinal, Alphonse Lavallée, Chasselas doré de Fontainebleau, Muscat of Hamburg, Italia and Rosaki (Dattier de Beyrouth)

For wine making, the choice of varieties to be recommended is wide. However, unless experiments, mainly adaptation trials, are carried out in Ethiopia, it is safer to propose only those tried elsewhere, in countries with a similar climate.

For red wines, experiments could cover Cabernet-Sauvignon, Petite Syrah, Merlot and Carigan, and, for white wines, Semillon and Sauvignon.

Almost as important as the choice of varieties, is the practice of pruning (Appendix X).
3.2.12 Rosaceous Fruits

3.2.12.1 Apple

It can only be recommended to try very early varieties of rosaceous fruits such as Astrakan and Borovitsky and, with probably more certain results, Mediterranean varieties such as Llorca (from Spain) and Bou Tabgaia (from Tunisia). Both have a rather inferior quality but they could probably offer an acceptable production. Recently in Israel three new sub-tropical varieties of apples (Ma-agin, Michel and Shulamit) have been on trial.

3.2.12.2 Pear

If pear is to be grown, it is advisable to try very early varieties, e.g. Wilder Frecoce de Trevoux and Docteur Jules Geyot. All need careful pruning. Better results in performance - but not in the fruit quality which is rather poor - could be obtained with Coscia.

3.2.12.3 Peach

Much better results could be obtained, mainly in the coldest locations of the highland, by planting varieties which do not need too long a dormancy, for instance the varieties selected in Florida and California (Appendix XI). It might be possible to achieve small-scale cultivation, sufficient at least to supply the domestic market.

3.2.12.4 Plum

Culture of European type plums is advisable in the main climatic zones of Ethiopia, but the Japanese plums are worth a trial, e.g. Ogden Japan (also called Golden Japan), Formosa, Methley, Beauty, Santa Rosa.

If small quantities of prunes could find an outlet in the domestic market, Stanley, an excellent variety for sun-drying in sub-tropical areas, could be tried.

3.2.12.5 Apricot

Very early varieties suggested for apricot are: Canino, Bullida and Del Patriarca. Canino is very suitable for canning (halves in syrup). Bullida is sometimes susceptible to some darkening of the flesh around the seed. Both can be purchased from nurseries in Spain and North Africa. Del Patriarca is found only in Morocco.

If a small processing industry can be established in Ethiopia for fruits, apricots could supply a good raw material to be processed after the citrus season and before that of many other subtropical fruits.

3.2.12.6 Loquat

It would be advisable to introduce better varieties of loquat to give fruits of a larger size, at first Tanaka, the best of all, then Early Red and Champagne.
Irrigation during the fruit growing season (December to April) would considerably improve the quality and size of fruits, as well as the importance of the crop. It would also respond well to applications of fertilizers.

3.2.13 Pomegranate

The maxim suggested to improve the culture of pomegranate is the introduction of named varieties, mainly from the Mediterranean area, for instance from Spain and the Middle East. They can easily be multiplied by cuttings.

3.2.14 Fig

Culture of figs could be improved first by introducing good Mediterranean varieties, if possible only those not requiring caprification, like Kadota (Dottato) and Adriatic. If caprification is required, double cropping varieties (i.e. producing, in Mediterranean countries, two crops yearly, the first in June, the second in August-September), are probably more suitable than the autumn varieties, producing only one crop per year (August-September). Though considered as not requiring caprification, these types must be pollinated with the exception of a few varieties. Among the autumn varieties, the most appreciated is Smyrna, which needs caprification.

If selected varieties are introduced to Ethiopia, it is essential to import at the same time caprifig varieties and a small population of the fig wasp, responsible for caprification (Blastophaga psenes).

Fig will probably never be of any importance in Ethiopia.

3.2.15 Minor fruits

Further cultivation of the Kei-apple, which is a permanent host plant for the Mediterranean Fruit Fly, must be stopped.

Good spineless varieties of Opuntia ficus-indica should be introduced.

3.2.16 Wild fruits

3.2.16.1 Jujube

Many locations in Ethiopia are suitable for the cultivation of different varieties of Zizyphus sativa, particularly Li and Lang. Only grafted trees must be planted.

3.2.16.2 Tamarind

A small food processing industry could possibly find use for tamarind.

3.2.16.3 Eugenia

Eugenia which could thrive well in the mildest places of Ethiopia, are the Jambolan (Eugenia jambolana - Syzygium jambolanum) easily propagated by seed, the Roco-apple (Eugenia jambos - Syzygium jambos), and the Surinam cherry (Eugenia uniflora - S. Michelia). All are of minor importance.
Different types of Caneberries, bred in California and Oregon, could be tried, for instance, Loganberry, Boysenberry, Youngberry, which give good crops of attractive fruits. Both thorny and thornless types of these crops exist. These plants could give excellent results in the mildest locations, more especially if conditions allow even a short period of dormancy. They have to be grown on trellises, but this expense is counterbalanced by the good yields.
APPENDIX I

PLANTING DISTANCES AND PRUNING PRACTICES RECOMMENDED
FOR ETHIOPIAN CITRUS PLANTATIONS

SPACING

The spacing generally adopted in modern citrus plantations is 7m x 7m. This practice is not popular in Ethiopia as growers feel that the land will not be fully utilized until the trees are 10 to 12 years old.

To answer this objection, there are two possibilities:

(a) to grow cash crops, such as vegetables between the rows; such crops must be carefully selected (e.g., they must not interfere with irrigation) and extra fertilizers must be applied;

(b) to inter-plant: in each row, between two trees of the main variety, an additional tree of a different variety is planted, chosen for early production, upright growth, good yield, etc. The distances are thus reduced to 7m x 3.5m. The space between rows (7m) is sufficient for cultivation, spraying, and other cultural activities. A suitable variety for this purpose is Wilking mandarin, which starts to bear fruit the year after planting and crops heavily almost every year. Another is Washington Blood (Washington sanguine) sweet orange, a dwarf tree. Clementine should not be inter-planted with other mandarins, with the exception of Satsuma. The extra trees are pulled out when 10 to 12 years old. There remains a normal 7m x 7m plantation.

PRUNING

Nursery:

The objectives of pruning in the nursery are:

- to obtain an early and clean cut of the rootstock "snag" (temporarily used as a stake for the developing shoot of the bud) in order to obtain a smooth and closed scar, and so prevent decay;

- to promote the arrangement of lateral shoots which will later become the main branches of the tree - allowing not more than 4 branches to grow, ensuring that they emerge at different sites on the stem and not at the same level, and start 50 to 70 cm above the soil;

- to remove extra or misplaced shoots as well as suckers from the rootstock, and to cut out too vigorous and tall shoots to induce formation of lateral branching.
Plantation:

The aim in the plantation is to obtain a symmetrical development of the canopy.

Pruning has been successful if, when the tree is 5 to 6 years old and when observing the tree at a distance of 5 to 7 m, it is noted that the trunk is hidden by low branches – these are the most fruitful. This is mainly true for sweet oranges, mandarins and tangerines, and limes.

On grapefruit, with the very heavy production, in the interior of the canopy which is often followed by the death of branches and twigs, it is sometimes necessary to remove the dead wood.

Lemon trees show a strong tendency to issue strong, vertical, quick-growing shoots or "suckers". These shoots are late to bear fruit and when they do so, the heavy, terminal production (very noticeable on Bureka lemon) may cause breaking of branches and asymmetry in the canopy. Lemon trees must be pruned ("topped") by cutting a part of these shoots, allowing buds of the lower portion to develop, or even entire shoots when they are crowded in the canopy.

What can be done to improve the production of badly pruned trees, the branches of which are bare of branchlets and twigs up to a height of 1.5 m? It is possible to top work such trees, but only if they fill certain conditions and at the loss of two or three years of cropping. If they are not grafted too high and if the lower part of the trunk does not show too much bark damage, the trees are cut 80 cm above the soil level, always at a sufficient distance above the bud union junction. This is done in late winter. The cut is covered with a horticultural tar (Flinthkote is suitable and cheap) and the trunk with white lime paint to prevent sun burn. A number of latent buds will develop on the trunk; all those growing on the part below the bud union junction are carefully removed by cutting with a grafting knife as close as possible to the bark. Four buds are then chosen above the bud union junction, one for each direction of the compass, not far from the top and not all at the same level. All the other shoots are removed, as done on the lower part of the trunk. These four shoots are each accompanied by smaller lateral shoots issued by the multiple buds; they are carefully cut, paying attention not to damage those which must be saved and are left free to grow. Periodic visits to these trees enable the farmer to remove the new shoots appearing on the trunk, until the four chosen shoots are strong enough to inhibit the development of others.

When the four shoots have reached a diameter of 1 cm, they are cut at 1 m above soil level to allow the development of new lateral twigs which will constitute the canopy.

If the tree is grafted too high, the stem must be cut at about 40 cm above the soil and worked as mentioned above to obtain four shoots. These four shoots are budded at 10 cm above the place where they originate. The variety used for budding can be different from that of the old tree; thus, this is also a method of replacing unwanted varieties by more desirable ones. After these four buds have taken and sprouted, the four shoots are cut above these buds which are allowed to develop and are subsequently treated as indicated above.
ESTABLISHING, MANAGING AND MAINTAINING A CITRUS NURSERY

Basic information on establishing, managing and maintaining a citrus nursery is given below.

1. Seedbeds should be raised 10 to 20 cm above the general soil line to prevent "damping off" and other fungus diseases during the rainy season (unless the soil is light and perfectly drained). The soil is held laterally by boards and stakes. If "damping off" appears, the soil must be treated with fungicides, e.g. Dithane, Cryptonol (oxyquinoline sulphate).

Rootstock seeds are sown either in lines, 1.5 cm apart in the line with 10 cm between lines, or in shallow pits, 1.5 cm deep, made in the soil with a specially designed board bearing numerous conical pegs, 1.5 cm high and 1 cm in diameter. The pegs are arranged on the board spaced at 2 x 2 cm apart.

2. When seedlings have reached the diameter of a pencil, they are pulled out and stored under shade for a short time during which they are sorted and graded. Seedlings showing bark damage due to insects, snails or mechanical injuries, or bent roots immediately below the soil level ("crooknecks") are discarded. The remaining plants are graded according to their diameter and simultaneously "dressed": the smallest ones, about 10%, are discarded - their small size is probably due to genetic differences which could have an effect on the growth of budded trees. The others are sorted in three or four different grades according to diameter. Broken rootlets are pruned, a few centimetres of the main root are also cut to induce the formation of rootlets. The top of the plant is pruned a few centimetres and all the leaves cut with sharp pruning shears - never by hand pulling. Seedlings then have their roots dampened in a mixture of well decomposed cow manure, soil and water, using for a container, for instance a 200 l oil drum. Such "treated" plants can be stored for a few days during planting operations with their roots in a small trench and covered with well moistened earth and the shoots with a moist burlap.

3. Planting is done in rows 90 cm apart, and seedlings are spaced 30 cm apart in the row. Small holes are dug; a labourer puts a seedling in a hole, then a second labourer holding the plant vertically with one hand fills the hole with top soil finely worked by his other hand, packing the earth around the stem with his fist. The earth is then trampled to pack it around the roots. Another labourer who follows, pours water generously around the plant.

4. During the months after transplantation, all shoots which appear on the stem between the soil and a height of approximately 40 to 50 cm are removed during periodic visits, in order to allow only one vigorous stem to grow.

5. Seedlings are ready for budding when they reach a minimum diameter of 1 cm and when the sap is moving. A T-shaped cut is made with a very sharp budding knife on the stem about 30 cm above the soil (never at more than 50 cm); if done during, or just before, the rainy season, it is better to make an inverted T-cut. A bud is taken from the budstick, about 2 cm long and with a thin piece of wood (the wood
may be removed after without damaging the eye tissues, if the worker is skilful) and immediately slipped under the two rims of the T-cut, previously lifted from the wood. The lower end of the bud is then cut at a length matching that of the incision. Bark rims of the root-stock are pressed lightly with the fingers against the bud to expel air and to give the bud a good position close to the wood, and the whole is tightly tied with a moistened raffia strip or, better, with a tape of polyethylene, 1 cm wide. Tying is upwards with inverted-T cuts, downwards with normal T cuts.

6. Two or three weeks after budding, the plants are inspected. Those which show dead buds must be budded again; to discover whether the bud is dead or not, push the leaf petiole left below the bud at the time of budding smoothly downwards — if it comes off at the level of the bark, the bud is alive and has taken. If it resists the pressure it is dry. New budding is performed 2 or 3 cm below the unsuccessful one.

7. The stem of plants successfully budded is bent by hand 25 cm above the bud and gently broken, but not completely so as to permit some movement of sap. When buds have grown 2 to 3 cm long, the rootstock is cut about 12 cm above the bud. When the shoot from the bud is half the diameter of a pencil, it is tied to the left-over part of the rootstock which acts as a stake. When it reaches the diameter of a finger, this snag is cut out obliquely as close as possible to the place where the shoot starts and the cut is covered with horticultural tar.

Sometimes after budding, the bud produces more than one shoot. Only the central one or the most vigorous shoot should be preserved, while the others should be removed while the shoots are still very young.

During the development of the main shoot, latent buds appear below the budded one. These must be gradually suppressed.

After a few months, the single shoot, now a stem, is cut at about 50 or 70 cm above the soil, to help lower buds develop into twigs which will become the four main branches of the adult tree. Their place on the stem is chosen so that they do not originate at the same level nor on the same side. The other shoots and twigs are cut level with the stem.

Trees are suitable for planting at their permanent site, season permitting, when the stem is of a diameter not larger than 2 cm.
In normal soils which are sufficiently rich in Potassium and Phosphorus, it is generally sufficient to apply only Nitrogen to meet the needs of citrus.

The rule is to supply trees with 100 g of pure N/tree/year of age per year. For instance, an 8-year old orange tree, must receive

\[ 100 \text{ g} \times 8 = 800 \text{ g} \]

of pure Nitrogen annually, and a 12-year old tree

\[ 100 \text{ g} \times 12 = 1200 \text{ g} \]

per annum. A quantity of 1500 to 2000 g is considered as maximum, unless trees are very fruitful and need an extra application.

To provide 100 g of pure Nitrogen, one must apply about

- 500 g of Ammonium sulphate, or
- 300 g of Ammonium nitrate, or
- 200 g of urea (at 45% of N).

Thus an 8-year old tree, for 800 g of pure N must receive:

- 500 g \times 8 = 4000 g of Ammonium sulphate, or
- 300 g \times 8 = 2400 g of Ammonium nitrate, or
- 200 g \times 8 = 1600 g of urea.

Under the climatic conditions of Ethiopia, it would seem that the main part of this quantity should be applied at the end of the winter two months before the rainy season, for instance during the first rains of February, the remaining part two weeks before the end of the rainy season, before the beginning of the winter (September or October).

Should Ethiopian soils be shown to lack Potassium and Phosphorus, or if the above formula seems too much of an innovation, an alternative formula may be recommended, for instance:

- no change in the quantity of N : 100 g per year/tree/year of age.
- 25 g of pure P, per year/tree/year of age (maximum 250 g).
- 30 g of pure K, per year/tree/year of age (maximum 300 g).

This is supplied by:

- 25 g of pure P - 300 to 400 g of superphosphates.
- 30 g of pure K - 52 g of Potassium sulphate.

Taking again the example of 8-year old trees, they must receive

\[ 400 \text{ g} \times 3 = 1200 \text{ g} \] superphosphates and

\[ 52 \text{ g} \times 3 = 156 \text{ g} \] potassium sulphate.

Both should be applied just before the rainy season, e.g. February or March.
SUGGESTED REGULATIONS TO PREVENT THE POSSIBLE INTRODUCTION
OF TRISTEZA INTO ETHIOPIA

A law should be passed to regulate imports of living Citrus plant material so as to prevent any introduction of Tristeza into Ethiopia.

A suggested law is outlined below:

"Considering the potential disastrous consequences to the country's citriculture of the introduction of virus diseases and more especially of Tristeza (Quick Decline);

Art. 1 - All imports of living plant material are strictly forbidden, with the exception of fruits and seeds, belonging to the family Rutaceae, sub-family Aurantioidae, particularly the genus Poncirus, Fortunella and Citrus and their hybrids.

Art. 2 - Shipments of all kinds infringing these regulations and reaching Ethiopian territory through land or sea ports of entry, airports, post offices, etc. will immediately be confiscated and destroyed against written statement, without compensation of any sort, including financial, for the addressee, sender, carrier and in general any person dealing with activities concerning these shipments.

Art. 3 - In the event of the packing of prohibited material together with other plants not subject to the preceding regulations, the entire shipment should be confiscated and destroyed under the same conditions as in Art. 2 above.

Art. 4 - Exceptions to Art. 1 above can be granted in certain cases by the Minister of Agriculture to the Director of the Institute for Agricultural Research and special import permits issued to persons authorized by the Director of this Institute, under the conditions mentioned in Art. 5 hereunder.

Art. 5 - Import permits referred to in Art. 4 are delivered only upon submission of a document giving the name and address of the supplier, name of variety and number of buds to be introduced, phytotechnical guarantees given by the supplier, location of the nursery and/or of the orchard where the introduced material is to be planted, and expressly permitting qualified officers of the Plant Protection Section to visit these nurseries and plantations at any time.

Art. 6 - The original permit must accompany the shipment, either inside the container or attached to the transport documents; the delivery to the consignee may be made only through the Addis Ababa airport, the Addis Ababa Central Post Office or any other port of entry maintaining plant quarantine facilities.

Art. 7 - If nurseries and plantations established from material imported under permits referred to in Art. 4 are subsequently found showing unquestionable symptoms of transmissible diseases or pests which could imperil the country's citriculture, their total or partial destruction may be decided by the Minister of Agriculture under the same conditions as in Art. 2 above.
Art. 8 - The Minister of Agriculture through his Directors of the Plant Protection Section and of the Institute of Agricultural Research, and the Minister of Finance, through the Director of Customs, are responsible for enforcing the present Law."
APPENDIX V

CORRECTION OF THE MAIN DEFICIENCIES IN CITRUS

Zinc:
Foliar sprays with one of the following formulas:

- Zinc sulphate (26% of metal) 600 g
  Calcium carbonate (lime) or
  Sodium carbonate 300 g
  Water 100 l

- Zinc sulphate (36% of metal) 375 g
  Calcium carbonate (lime) or
  Sodium carbonate 300 g
  Water 100 l

- Zinc oxide (80% of metal) 150 g
  Water 100 l

Sprays may be carried out whatever the zinc salt, provided the quantity of metal corresponds to 125 g metal Zinc/100 l water.

Soil applications of 150 - 350 g of Zinc sulphate/tree/year, after modification of the soil pH (which should be made more acid).

Manganese:
Foliar sprays with the following formula:

Manganese sulphate 375 g
Calcium carbonate (lime) or
Sodium carbonate 185 g
Water 100 l

Sprays may be carried out whatever the Manganese salt, provided the quantity of metal corresponds to 120 g metal Manganese/100 l water.

In low pH soils, Manganese salts can be applied directly in the soil.

Magnesium:
In acid or neutral soil, application of 2 to 3 kg/tree of Magnesium sulphate prevents this deficiency for one or more years. In orchards which are heavily irrigated or subject to strong leaching, Magnesium must be applied with other standard fertilizers, for example by using dolomite (Magnesium and Calcium carbonate). In chalky soils, foliar sprays only can be used, with the following formula:

Magnesium sulphate 1 500 g
Calcium carbonate (Lime) or
Sodium carbonate 750 g
Water 100 l
Iron:

Iron deficiency is practically impossible to correct, especially by applying Iron sulphate on the foliage or to the soil.

It is possible to use Iron chelates, for instance the Ethylene-diamine tetracetate (EDTA) or the Ethylene-diamine Di(o-hydroxyphenyl) acetate (EDDHA). In an acid or neutral soil, the Fe-EDTA has a quick action. In alkaline soil, results are more or less marked; in Mediterranean countries it is considered that from 150 to 350 or even 500g/tree 1/ are necessary to obtain response. Considering the present price of such chemicals, routine treatments are not economic.

Agricultural practices can help to minimize the problem by:
- preventing excessive irrigation;
- using acid fertilizers, such as Ammonium nitrate (avoid Calcium nitrate);
- applying heavy animal manure and growing green manure;
- preventing excessive phosphate fertilizer use.

Time of Treatment

Foliar applications can be performed at any time, except when subsequent rains would wash away the deposits, but the best season is when trees produce new growth, for instance in spring, and in some countries at the end of the summer. If after a spray, marked results do not appear, for instance one or two months later for Zinc, treatment must be repeated. At least for Zinc, routine treatments must be performed each year, but with doses of Zinc of half the quantity mentioned above.

1/ of a commercial brand like Geigy's Sequestrene 138 H Fe (for alkaline soils).
"Rumple" disease was first reported only a few years ago, from Sicily by L.J. Klotz and F. Russo. It was found later by L.C. Knorr in Ethiopia and Florida and by other workers in Lebanon, Cyprus and Turkey.

It was known initially only on standard lemon, but in 1968 H. Chapot observed it also on Palestine sweet lime in Turkey.

The trouble consists of deep and irregular depressions in the outer part of the peel forming a number of bumps between these depressions (see ill. 6). The fruit does not lose its qualities but is not marketable. "Rumple" is known to produce as much as 75% of rejects in some countries.

The origin of this trouble has not yet been determined; it is considered in Florida as not due to a virus, nor to a fungus, and probably to be of physiological origin.

Grapefruit in Ethiopia has been found to be affected by this trouble. This is the first time that "Rumple" is reported damaging fruit other than lemon and sweet lime, a type of lemon.
APPENDIX VII

TREATMENTS AGAINST MEDITERRANEAN FRUIT FLY, SCALES AND MITES

Mediterranean Fruit Fly Control

Modern methods use protein baits mixed with Malathion or Ethion, sprayed on trees. One row in every four is treated.

More important than the formula is the date of treatment: a warning scheme must be operated to determine the right time to undertake the applications. This time corresponds to the first appearance of adult flies and is determined by hanging in the canopy of trees chosen at random in the orchard traps made of glass or, better, of plastic filled with a special bait (based on angelica liquor). These traps are checked every third or fourth day, cleaned and filled again, until the first flies are caught. Treatment can then start.

Control of Scales

Generally speaking, treatment against scales by aircraft, using white oil and parathion is ineffective, because scales are found on branches and twigs inside the canopy of the tree and chemicals can reach them only with difficulty. Even with automatic sprayers operated on the ground, penetration is not good, although the blast has a pressure of 40 kg and works at 1 m from the canopy.

Some scales are naturally controlled by parasites, for instance the cottony cushion scale, Icerya purchasi which is held in check in many countries by the Australian lady-beetle Rodolia (Novius) cardinalis. But this parasite preys only on that scale and not on others, while other lady-beetles are specific, for instance Cryptolaemus montrouzieri and Scymnus lineatus, prey on Planococcus citri and Pseudococcus adeniidum.

Until a biological control scheme can be established, scale control is carried out by spraying various chemicals.

(a) California Red Scale and Diaspinae

- In areas where the temperature is favourable to the development of these scales and consequently where infestations are very heavy and spraying treatments difficult, the basic method is by hydrocyanic fumigation.

- In areas where ecological conditions are not particularly favourable for these scales and when the density of scales per tree is low, treatment is carried out by spraying one of the following formulae:

  White oil: 1.5% of oil (Blanchol by Shell; Essospray by Esso, Niagara by BP, Volck, etc). These chemicals cannot be used during hot winds nor above 30°C, nor before the "June drop". Consequently, if there is a pullulation of larvae on fruits before fruit setting, followed by their fixation, one must turn to parathion, with all the drawbacks involved in using this organic phosphorus compound - development of mites, of Coccus hesperidum, etc.
parathion: this chemical is mainly active on young larvae. It must be used, therefore, mainly when they are present and before they stick on the fruit. The formula is 35 to 40 g of active ingredient (a.i.)/100 l. Treatment is started as soon as young larvae begin to develop. The number of treatments is decided according to the density of scales per tree.

white oil + parathion: use ready-mix formulae, such as Oleobladen by Bayer or Typholine by Frocida, or prepare the mixture on the farm, using 1% white oil (grade "medium") and 35 to 40 g of a.i. of parathion.

This formula combines the advantages of both chemicals and because of its oil content, is more effective against adult scales.

sevin: trees may be sprayed with sevin (80 g of a.i.) or with a mixture of sevin and white oil (1% of oil). A big drawback is the fast subsequent spread of mites.

(b) Lecaninae (for example Saissetia oleae).

Use either:
- white oil, 1 to 1.5 l/100 l of mixture, or
- parathion, 50 g of a.i./100 l of mixture, or
- malathion, 65 g of a.i./100 l of mixture, or
- sevin, 80 g of a.i./100 l of mixture.

(c) Coccus hesperidum

Use white oil or malathion; in many countries, this scale is often naturally parasitized and is harmful only when parathion is used which has no action against it. At that time, it becomes as harmful as California Red Scale.

Control of Mites

The species of mites involved must first be determined because miticides must be used only for specific treatments. All mites are not inevitably killed by any miticide even specific.

(a) Tetranychus telarius

Use Kelthane (50 g of a.i./100 l) or Tedion (30 g of a.i.) or Chlorobenzilate (30 g of a.i.). Because of the high price of the chemicals, treatment should be carried out only when absolutely necessary. These chemicals must not be mixed with parathion or sevin, as these stimulate egg-laying by mites.

(b) Phyllocoptruta oleivora

Use sulphur (480 g/100 l water). Do not apply during hot weather and allow two months to elapse after an oil application. Sulphur powder may be dusted, too. Use also Chlorobenzilate, wettable powder (25% of a.i., 120 g/100 l water) or Zineb, wettable powder (65% of a.i., 120 g/100 l water).
APPENDIX VIII

AVOCADO AND MANGO VARIETIES RECOMMENDED FOR VARIETY COLLECTIONS

Avocado

<table>
<thead>
<tr>
<th>Variety</th>
<th>Climate Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaheim</td>
<td>M: more suitable to Mediterranean climates (North Africa, Israel, California).</td>
</tr>
<tr>
<td>Bacon</td>
<td>M: May also give good results in subtropical and tropical climates; fruits always much appreciated commercially.</td>
</tr>
<tr>
<td>Benik</td>
<td>M: more suitable for subtropical and tropical climates (West Indies, Florida).</td>
</tr>
<tr>
<td>Booth 7</td>
<td>T: Some varieties may thrive under Mediterranean climates but fruits are less appreciated.</td>
</tr>
<tr>
<td>Booth 8</td>
<td>T: May also give good results in subtropical and tropical climates; fruits always much appreciated commercially.</td>
</tr>
<tr>
<td>Ettinger</td>
<td>M: more suitable for subtropical and tropical climates (West Indies, Florida).</td>
</tr>
<tr>
<td>Fuorte</td>
<td>M: Some varieties may thrive under Mediterranean climates but fruits are less appreciated.</td>
</tr>
<tr>
<td>Hasa</td>
<td>T: May also give good results in subtropical and tropical climates; fruits always much appreciated commercially.</td>
</tr>
<tr>
<td>Itzamna</td>
<td>M: more suitable for subtropical and tropical climates (West Indies, Florida).</td>
</tr>
<tr>
<td>Jalna</td>
<td>M: May also give good results in subtropical and tropical climates; fruits always much appreciated commercially.</td>
</tr>
<tr>
<td>Lula</td>
<td>M: Some varieties may thrive under Mediterranean climates but fruits are less appreciated.</td>
</tr>
<tr>
<td>Nabal</td>
<td>M: more suitable for subtropical and tropical climates (West Indies, Florida).</td>
</tr>
<tr>
<td>Rincon</td>
<td>N: Some varieties may thrive under Mediterranean climates but fruits are less appreciated.</td>
</tr>
<tr>
<td>Ryan</td>
<td>N: May also give good results in subtropical and tropical climates; fruits always much appreciated commercially.</td>
</tr>
<tr>
<td>Waldin</td>
<td>T: Some varieties may thrive under Mediterranean climates but fruits are less appreciated.</td>
</tr>
<tr>
<td>Wurtz</td>
<td>M: May also give good results in subtropical and tropical climates; fruits always much appreciated commercially.</td>
</tr>
<tr>
<td>Zutano</td>
<td>M: Some varieties may thrive under Mediterranean climates but fruits are less appreciated.</td>
</tr>
</tbody>
</table>

In the eventuality of introducing budded trees from California (and possibly also other countries), a specific quarantine scheme must be set up to prevent introduction of the Root-rot (Phytophthora cinnamomi) which is possibly still absent from Ethiopia. For more information about this disease, see:


Mango

<table>
<thead>
<tr>
<th>Variety</th>
<th>Climate Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphonso</td>
<td>T: suitable for tropical climates (India, West Indies)</td>
</tr>
<tr>
<td>Amelie</td>
<td>T: May also give excellent results in tropical countries.</td>
</tr>
<tr>
<td>Cambodiana</td>
<td>ST: more suitable for subtropical climate (Florida, warmest places of Mediterranean countries).</td>
</tr>
<tr>
<td>Haden</td>
<td>ST: May also give excellent results in tropical countries.</td>
</tr>
<tr>
<td>Irwin</td>
<td>T: more suitable for subtropical climate (Florida, warmest places of Mediterranean countries).</td>
</tr>
<tr>
<td>Julie</td>
<td>T: May also give excellent results in tropical countries.</td>
</tr>
<tr>
<td>Keitt</td>
<td>ST: more suitable for subtropical climate (Florida, warmest places of Mediterranean countries).</td>
</tr>
<tr>
<td>Kent</td>
<td>ST: May also give excellent results in tropical countries.</td>
</tr>
<tr>
<td>Mabrouka</td>
<td>T: more suitable for subtropical climate (Florida, warmest places of Mediterranean countries).</td>
</tr>
<tr>
<td>Mulgoba</td>
<td>T: May also give excellent results in tropical countries.</td>
</tr>
<tr>
<td>Paires</td>
<td>ST: more suitable for subtropical climate (Florida, warmest places of Mediterranean countries).</td>
</tr>
<tr>
<td>Palmer</td>
<td>ST: May also give excellent results in tropical countries.</td>
</tr>
<tr>
<td>Ruby</td>
<td>ST: more suitable for subtropical climate (Florida, warmest places of Mediterranean countries).</td>
</tr>
<tr>
<td>Zill</td>
<td>ST: May also give excellent results in tropical countries.</td>
</tr>
</tbody>
</table>
When cultivating granadilla for processing, the vines may be allowed to run on the soil. They require about 10 m² each, or 1000 plants/hectare; shoots must be controlled and regularly pruned.

For fresh consumption, vines must be trained on wires and poles as the external appearance of the fruit is important. Posts, 2.4 m long are sunk 60 cm into the ground at 6 m intervals in the rows, with strainer posts at the end of each row, and with others at 70 m intervals in the row. Rows are 3 m apart. Granadilla plants are spaced 4 to 5 m on the row. No. 12 steel wire is used; holes are bored in the posts for the wires. One is close to the top of the post, a second is 35 cm lower and the third 50 cm below the second one. Wires are fixed with strainers, of the small cast-iron roller type.

Fertilizers are initially placed in the planting holes (15 kg of barn manure plus 1.5 kg of superphosphates). This is followed by yearly applications at the rate of 0.500 g of ammonium sulphate per vine, and by broadcasting 0.500 g of 10-16-10 complete fertilizer around each plant or between rows. The use of mineral fertilizers is, however, questioned by some authors.

Pruning allows the growth of only two shoots from the seedling. These leaders when strong and long enough to reach the overhead wire, are tied to it when sideshoots are removed. In the early stages of development, the crop is carefully weeded, by tractor between rows, by hand around the stems. Culture of green manure is recommended (cowpea and pigeon pea can be tried). Irrigation is generally not necessary, except before the plant is well established and later, if flowering occurs during the dry season.

Harvesting is generally done by collecting the ripe fallen fruits.

Processing does not require expensive equipment; for example, a citrus juicer, with a rotating reamer is suitable for juice extraction from granadillas, previously cut into halves. Strained juice is then pasteurized and canned.
Pruning aims to give the grape vine a form which will save labour and will facilitate vineyard operations, will equalize production and get large average crops of high quality fruit, and will lessen or eliminate thinning in the control of the crop. The objective is to distribute the bearing wood over the vine, between vines and between years according to the capacity of the cane.

There are different systems of pruning; the main ones are:

- **head pruning** (also called vase or goblet pruning), in which the vine is given the form of a small upright shrub; suitable for Muscat d'Alexandria, Petit Sirah, Bottier de Beyrouth.

- **cordon pruning**, in which the vine has an elongated trunk which bears canes over the greater part of its length; suitable for Cardinal and Carignan.

- **cane pruning**, in which the vine is given a trunk similar to that in head pruning, but the head spreads more in the plane of the trellis; suitable for Seckelina (Thompson seedless), Cabernet-Sauvignon, Sauvignon blanc and most other varieties of American origin.

Each method has advantages and disadvantages. Whatever the system adopted, the choice must be made before the vineyard is planted.
Savage et al. (1938) give a classification of peach varieties according to chilling requirement (number of hours at or below 45°F required to break the rest period). About 110 varieties are listed, and chilling requirement is given for both flower buds and leaf buds.

A further variety which should be mentioned is the old China Flat, with only slight winter chilling requirement but bearing an ugly fruit compressed at both ends.

RESEARCH STATIONS DEALING WITH FRUIT COLLECTIONS AND TRIALS

The following stations in Ethiopia were visited by the consultant: Research Station, Holetta; Agricultural School, Debre Zeit; Research Station, Neika Wero; Haile Selassie I University, College of Agriculture, Almaya; Agricultural School, Jimma.

Research Station, Holetta

The Holetta Research Station is at the beginning of fruit research and has only a few grape vines.

The Director expressed the wish to start work on other fruits and to grow suitable plant material. Though citrus could thrive, it is suggested to limit the Station's activity to mild climate species, for instance grape, peach, apricot, Japanese plum, caneberrries. All material must be introduced from abroad.

The problem of irrigation water must be solved before planting starts.

Agricultural School, Debre Zeit

Initially, much interesting plant material was introduced at the Debre Zeit Agricultural School, but at present, at least in fruit culture, observations as well as common cultural practices, such as irrigation, seem to be discontinued.

Citrus

A collection of different varieties of citrus was established, but their origin is not known and they can be suspected of carrying various virus diseases, such as are present in old clones. Trees are dead, dying or in very poor condition and would not respond to any improvement in cultural practices. These trees should be pulled out.

Near a greenhouse, some pots were found containing Mexican lime seedlings, bearing the name of a well-known Florida virologist, which were apparently already budded. These may be for some indexing scheme for Tristeza studies. The same was noted with some seedlings of Florida sweet oranges (Citrus indexing ?). However, no record, nor any information was available.

Avocado

There are a certain number of avocado trees, with excellent performance, some of them covered with fruits. They seem to be seedlings, because no trace of bud-union could be found - but they could possibly by planted very deeply. The trees seem to be identical and both bear a heavy crop of Fuerte-like fruits (but probably not Fuerte). They could constitute, if further observations demonstrate they are not too alternate bearers, an interesting new variety, worth commercial propagation.

Together with normal fruits, a very high proportion of "cucumber" fruits was noted. The abnormality of these fruits is said to be due to the effect of frost at blooming, which kills the embryo but does not impede fruit development.
Mango
A small group of mango trees, in the same condition as the avocados, was observed; no records, apparently no budding, etc. Fruits being far from ripe, it was not possible to attempt to name these trees. Generally speaking, if growth is good, fruits are apparently of second quality.

Queensland Hut
A few trees of Macadamia, introduced from Hawaii, are present. Vegetation is good, but the trees were not adequately trained at the beginning and show asymmetrical tops. Apparently no production (too young?).

Banana
A banana plot of three different varieties of unknown origin (Gakkouri, Duncan's hybrid and Dwarf Cavendish) showed fairly good treatment. A kind of wilt, attributed to a lack of irrigation water, was said to be particular to the variety concerned.

This plot is only of slight interest.

The horticulturist in charge remarked on the lack of adequate irrigation water. Avocado, Mango and Queensland Hut appear to be worthy of improvement in management, by application of fertilizers, and sufficient irrigation water, etc.

Research Station, Kelka Werer
At Kelka Werer only citrus was observed.

The citrus plots are planted with 3-year-old trees introduced from a well-known Californian nursery, on Trifoliate-tolerant rootstocks, and nucellar or indexed budwoods. Most of the commercial varieties of sweet orange, lemon, grapefruit on various rootstocks are present. Trees of the same variety on the same rootstock are planted 7 x 7 m in small plots bordered by windbreaks. They are in good condition, the size of the canopy being like that of trees twice the age.

This is a basic improvement in Ethiopian citriculture; these plots must constitute the only future source of budding material for the extension of citrus plantations.

The plots are at present subject to irrigation experiments, which are indispensable for the improvement of citiculture in Ethiopia. Unfortunately, with the removal of a quantity of budding material from these foundation-blocks, it will probably be difficult to continue these experiments.

It is advisable to introduce some additional commercial varieties e.g. Hamlin, Caadenera and Salustiana sweet oranges, and hybrid mandarins (Walking, Robinson, Cecelia, Lee, Fortuna, Fremont, Ortanique, Ugli, etc.), and also budding material of varieties suitable for seed production (rootstocks) such as Treyer cistrange, Macrophylla, Trifoliate.
Clear symptoms of boron excess were found on a few trees. It is locally considered that damage was much heavier some months ago. It is believed that the cause lies in the irrigation water pumped from the River Awash, which is said to be fresher upstream.

This station could be ideal, irrigation water permitting, for the establishment of avocado and mango collections (Appendix VIII).

Haile Selassie I University, College of Agriculture, Alemaya.

The College of Agriculture maintains plots of Citrus, Fig, Avocado and Tree Tomato.

Citrus

Citrus trees were introduced from California, of the same origin as those of Melka Worer and almost the same varieties, but with the addition of Temple Orange.

They show many deficiency symptoms (among others of Zinc) and bear the indefinable look of suffering plants. Damage later observed on avocado trees and attributed to irrigation with salty water probably explains the actual cause. A few trees are particularly weakened, dwarf and without vigorous shoots. This could be the result of some virus disease (Stubborn?).

Under present conditions, this plot is of little practical importance.

Fig

All fig trees are seedlings locally obtained, and consequently the plot is very heterogeneous. They are said to be very fruitful, but at the time of the visit, the fruits were very small, although some looked nearly ripe. In any case, if the Alemaya area is demonstrated to be suitable for fig culture, the poorest Mediterranean fig variety should show itself better than these seedlings.

Many trees show black spots on leaves, locally called "tar spots".

Avocado

The Avocado trees are seedlings; they are very vigorous, generally upright in growth habit and seem fruitful. A large proportion of leaves show heavy tip-burns, probably due to irrigation with salty water from the neighbouring lake. This area is worth an experiment with good, named varieties of avocado.

Tree Tomato

A very small plot is devoted to Tree tomato. Plants grew well, with a profusion of flowers and young fruits, but they are progressively destroyed by a disease apparently starting from the tip and spreading downwards.
Agricultural School, Jimma

The Jimma school has a certain number of citrus, avocado and mango trees. They are of unknown origin, often seedlings, and practically growing wild. All trees are planted on a slope and are probably poorly irrigated.
The Brer Gota estate, Haile Selassie I Frize Trust, was visited to observe the fruit plots, more especially citrus, and talks were held with the Manager of the Farm on the problems raised by both present and future citrus plantations. A demonstration of basin building around trees using the double-basin device to avoid hazards of Phytophthora foot-rot contamination and of pruning of young citrus trees was undertaken in the field.

Old Citrus Plantation

The condition of the trees in the old plantation is extremely poor and limits any return on expenditure for maintenance. Many trees yield only a few kilogrammes of fruit, and are riddled with termite damage; the whole core of the trunk is reduced to a dusty nest of termites and the survival of these trees is secured only by the bark.

Probably this contamination by termites is partly the consequence of poor management over preceding years. The present weakness now favours the development of other parasites, such as Ganoderma-type fungi.

Another cause is probably the poor affinity observed between the rootstock and the scion, resulting in a bottleneck shape at the bud union junction, of the type frequently observed with Trifoliate rootstock. It could be caused by some virus, or virus-complex present in the scion as yet undetermined.

A cause of branch (and sometimes trunk) decline is probably sun scald, due to too heavy pruning. This decline is an easy entrance for other parasites and pests.

Phytophthora foot rot is uncommon in the orchard and the Farm Manager's fear of a possible spread of the disease would seem unfounded. Transmission from tree to tree by irrigation water or by rain splashes is theoretically possible, but with trees grafted on resistant rootstocks, with a bud union junction high enough above the ground and by using the double-basin device for irrigation, foot rot can easily be kept in check. In any case, this plantation does not show any tendency to foot rot.

The Farm Manager indicated an old sweet orange tree which a preceding visitor had said to be affected by Tristeza. Careful observation, however, indicated that it did not carry this virus but seemed to be only damaged by the decline observed on other trees in the plantation. Neighbouring lime trees were also observed for possible vein clearing on leaves, a characteristic Tristeza symptom, and were found normal. Consequently, and unless indexing on Mexican lime with standard procedures shows that this tree actually carries Tristeza, the consultant considers that this disease is not present on the estate.

Different scales are observed on citrus trees but they do not seem to be developing. Air-treatment with white oil and parathion is undertaken. In spite of the use of a micronized mist, the effect
of this treatment is doubtful. If infection is heavy, such a mist
cannot achieve radical control; if moderate, ground treatment with
white oil only could be sufficient and would prevent destruction of
hyperparasites which control naturally the development of mites. With
the renewal of such phosphoric ester treatments, proliferation of
mites is to be expected.

It is also locally believed that the Australian Ladybeetle
(Edelina cardinalis), active in controlling Cotton-cushion scale
(Icerya purchasi), could also prey upon other scales, such as Florida
Red and Black scales. The Consultant does not share this opinion,
but infestations of both can be kept at a low level by the conjunc-
tion of the climatic factors favourable to several species of para-
sites (Hymenopterae chalfideidea) and to hyperparasites (Coleopterae
coccinellidae).

Routine control of scales in the young plantations should be by
ground treatment with powerful sprayers.

New Citrus Plantation

A year-old plantation was visited, located a few kilometres
from the old plantation. It is in very good condition and well man-
age, but some comments are necessary.

- Certain trees did not take after planting and, because of a lack
of suitable trees on the Farm, they were replaced by other trees of
a different origin. These replacements are of poor quality and will
never give good results; they are budded incorrectly, the snap of
the rootstock above the bud was not cut down, the branches start too
high on the stem and are misplaced.

- Other trees, from the original planting are often incorrectly
trained; branches start high on the stem, and sometimes originating
at the same level, are too crowded and too upright. This last defect
is accentuated by tying of the outer branches and twigs with string
in order to obtain a kind of vase, with vertical growth. Removal of
these strings was recommended to the Farm Manager. But it is practi-
cally impossible to cope with the wrong shape of the canopy - some
badly placed twigs can be cut, but it is impossible to lower the
present branches, unless trees are completely cut 70 cm above the
ground and new branches allowed to develop. Three or four years
would be lost.

- New plantations are made exclusively from Shamouti orange. In
general this may be said to be one of the less suitable varieties for
the Ethiopian climate. Even in its country of origin, Israel, its
qualities may sometimes be inferior, with the exception of fruits
grown in the centre of the country, where it attains a very high
quality. Varieties like Valencia late, Hamlin, even Creed Calabrese
may be much more suitable than Shamouti. Propagation of this variety
should be discontinued.

Citrus rootstock plantation

Close to the new citrus plantation, is a plot planted with young
sour orange rootstocks, not budded. This practice was justified by
the lack of ready-to-plant trees in the nursery. It is not advisable,
because it is difficult to obtain a plantation of a uniform age. Bud-
ding in the field is hazardous, a certain number of buds do not take,
new buds are then required, season after season, maintenance of plants just after budding is difficult and requires repeated visits to the field, some buddings are always forgotten. Budding in the nursery allows a wide choice of trees before planting and consequently the establishment of an homogeneous orchard. There is no subsequent care for particular trees, all trees in the plantation being given the same maintenance.

As the rootstocks are sour orange, which is not susceptible to exocortis, the Farm Manager was recommended to bud on them, at least for a part, Clementine mandarin, so budded material of very good quality, but of old line origin was available near Wonji. Clementine could give excellent results in this area where other cross-pollinators are not present and so, unable to induce the formation of seeds in Clementine. Instead of Shamouti, it was recommended to bud Valencia late orange and, to a lesser extent, Washington navel, but it was stressed that all the budding material must be taken from the virus-free trees maintained at the Research Station, Melka Werer, with the exception of Clementine which is of Californian origin and probably not so good as the Mediterranean one available near Wonji.

Banana plantation

The banana plantation (Chinese Dwarf type) is in very good condition but shows some mistakes in maintenance - bad suckering (too many suckers allowed to grow on each stump, suckers too often of the same age instead of being chosen at 6 month intervals), no cutting away of the male flower. Better results could be obtained with closer planting, for instance 4 x 4 m. An experiment with 3 x 3 m could probably bring new ideas for a different spacing.

It was recommended to try mulching, from weeds collected in uncultivated plots of land.

The present variety, a kind of Cavendish, seems to suit the environmental conditions well. Some experiments with both Canary Dwarf and some giant or half-giant varieties (Lacatan, Poyo - also called Rough) could bring interesting information about their quality and their yield (Dwarf Chinese and Dwarf Canary allow high density plantations, Lacatan wide spacing, Poyo is intermediary).

Programme for further citrus plantings

There appears to be no fixed programme for the extension of plantations with respect to the relative proportion of species and varieties.

Varieties

The Consultant feels that the varieties previously grown on the Farm, like Mediterranean Mandarin, Shamouti, Common and Ovale Calabrese are obsolete and must be replaced by more commercial varieties.

The following quantities are suggested:

1) If the culture of sweet oranges and mandarins only is under consideration, Valencia, Washington, Hamlin oranges and Clementine mandarin should be planted as follows:
6) If lemons and limes are to be grown jointly with sweet oranges and mandarins, Bureka lemon and Boreas seedless lime, planting must be as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Valencia</th>
<th>Washington</th>
<th>Hamlin</th>
<th>Clementine</th>
<th>Boreas</th>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed</td>
<td>85%</td>
<td>50%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Percentage</td>
<td>30%</td>
<td>50%</td>
<td>50%</td>
<td>30%</td>
<td>20%</td>
<td>15%</td>
</tr>
</tbody>
</table>

8) If grapefruit is to be added to the preceding varieties, March only is suggested, or March and Ruby (if the red colour of the flesh is not attained under Ethiopian conditions, this fruit can be sold as a March grapefruit):

<table>
<thead>
<tr>
<th>Variety</th>
<th>Valencia</th>
<th>Washington</th>
<th>Hamlin</th>
<th>Clementine</th>
<th>Boreas</th>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed</td>
<td>30%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
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</tr>
<tr>
<td>Percentage</td>
<td>20%</td>
<td>30%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Rootstocks

When choosing a rootstock one must bear in mind the threat of Tristeza and the requirements of lemons and limes as well as of old line Clementine. To prevent possible losses in the eventuality of the introduction of Tristeza, Troyer citrange must be the main rootstock to be developed: but its suitability for lemons and limes is questionable (and it must be replaced by Macrophylla), and it is susceptible to Exocortis usually carried by old lines of Clementine which requires sour orange. Two solutions are possible: Troyer citrange only (with Macrophylla for lemons and limes, and Sour orange for Clementine) or a high proportion of Troyer, say 80% (with Macrophylla and Sour orange as above) and a smaller proportion of Sour orange for sweet oranges and grapefruit (and Clementine), say 20%. This last proportion is preferable.

Seeds

Where Troyer citrange and Macrophylla are used, seed imports are necessary yearly from California to fill the needs of a nursery. Imports of sour orange seeds would be also advisable — for instance from Morocco — even if some seed is available in Ethiopia.
Behaviour Trials

If the Farm has some acreage to devote to simple behaviour trials, it is recommended that other, less commercial varieties be tried, which could give good, marketable crops, e.g. early hybrid mandarins like Robinson, Cocoa and Lee; mid-season, large mandarins like Oranique, Ugli, Freeman, Fairchild, Fortune; mid-season or late, medium fruited mandarin like Wilking; early oranges (not navelos) like Caliscious and Cadenera, etc. Even if they prove of insignificant commercial importance, the fruit could be sold on the local market and could thus contribute to the expense of introduction and cultivation.

Planting Design

A special planting design for large spaced plantations (7 x 7m) when high returns are desirable during the first years until the space between trees is fully occupied, is mentioned below:

The main variety, for instance Valencia late sweet orange, is planted at 7 x 7m. In each row, in one direction only, a different variety with a smaller or a more upright canopy which will not disturb the normal growth of the Valencia, is planted. When these additional trees are too large, they are pulled out and the Valencia trees only are allowed to grow normally.

The Wilking mandarin is recommended for interplantations; it has a very upright, columnar growth habit (except when covered with fruits) and comes into production early. Its productivity is very high.
ILLUSTRATIONS

Figures 2, 3, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 19, 20, 21, 25, 28, 29, 31, 34, 35 and 38 : photographs by H. Chapot, FAO.

Figures 1, 4, 7, 16, 17, 18, 22, 23, 24, 26, 27, 30, 32, 33, 36 and 37: photographs by Seyoum Solomon, Institute of Agricultural Research, Addis Ababa.
Fig. 1 - Young Shamouti sweet orange orchard, at Erer Gota. Trees show upright canopy, as a consequence of inadequate training in nursery and of mistakes in pruning during the first years after planting.

Fig. 2 - Common shape of citrus trees in Ethiopia: all the lower branches were cut away.

Fig. 3 - A frequent mistake in training citrus trees: too many branches and all of them starting from the same level on the trunk.
Fig. 4 - Dead sweet orange tree showing typical bark scaling due to Psorosis A.
Fig. 5 - Concave Gum symptoms on sweet orange. Wonji.
Fig. 6 - Symptoms of "Rumple" on grapefruits of various ages. Wonji.
Fig. 7 - Zinc deficiency symptoms (and of Stubborn disease) on sweet orange near Bako.

Fig. 8 - Characteristic bad bud-union line ("virus disease ?) on sweet orange at Erer Gota.

Fig. 9 - Ganoderma applanatus fungus on a declining orange tree at Erer Gota.
Fig. 10 - Termite damage on a sweet orange tree at Erer Gota. The trunk is completely hollow.

Fig. 11 - Typical damage on sweet orange leaves caused by larvae of Trioza erytreae, feeding on leaves. This psylla is the vector of Greening disease in some African countries. Haile Salassie I University, College of Agriculture, Alemaya.

Fig. 12 - Rough lemon tree decline due to Mistletoe (Loranthus) near Ghion (Wolisso).

Fig. 13 - Decline of a Rough lemon branch invaded by Loranthus woodfordiiodes. In the same orchard, Loranthus globiferus is also present. Ghion.
Fig. 14 - Good banana plantation, Chinese Dwarf type, in the Chibi Valley.
Fig. 15 - Banana collection at the Agriculture School, Debre Zeit.
Fig. 16 - Giant banana variety, unfruitful. Agriculture School, Debre Zeit.
Fig. 17 - Giant type of banana, a poor bearer.

Fig. 18 - Banana rot of unknown origin. Bunch showing fruits at various stages of rot (Chinese dwarf).

Fig. 19 - -idem- Various stages of the rot on fruits, Chibi Valley.
Fig. 20 - Papaya plantation in the Chibi Valley. Undesirable high proportion of male trees.

Fig. 21 - Typical fruits of the local female papaya tree (large and elongated).

Fig. 22 - Female papaya trees are always very fruitful, but fruit is of a too large size.
Fig. 23 - Avocado seedling, Fuerte-like type, very fruitful. Debre Zeit Agriculture School.

Fig. 24 - Spots of undetermined lichen on avocado leaves. Mäggu Wando, Sidamo Province.

Fig. 25 - Smooth Cayenne pineapple, near Bako. Poorly managed culture: too large spacing, no fertilizers, no irrigation (soil very light). Note the very light color of the leaves (Nitrogen deficiency).
Fig. 26 - Mango tree with round fruits. Agriculture School, Debre Zeit.
Fig. 27 - Mango tree with long fruits. Agriculture School, Debre Zeit.
Fig. 28 - A seedling Mango tree, not irrigated, in an old abandoned Mango orchard near Elaberet.
Fig. 29 - Tree tomato plot at the Haile Selassie I University, College of Agriculture, Alamaya. In the foreground, plants dead or dying (disease of unknown origin).

Fig. 30 - *idem* - Plant apparently healthy.

Fig. 31 - White Sapote (*Casimiroa edulis*): fruit of a pointed shape.
Fig. 32 - Pepito or Melon-Pear (*Solanum muricatum*) culture near Ghion, (Wolisso).

Fig. 33 - *idem*. A plant of Pepito.
Fig. 34 - "Tar-spots" of unknown origin on Fig seedling leaves. Haile Selassie I University, College of Agriculture, Alemaya.

Fig. 35 - Tamarind twig with pods, Ghibi Valley.

Fig. 36 - Young plantation of grape varieties introduced from USA in the Ghibi Valley. Plants are protected from sun-burns by straw.
Fig. 37 - *Citrus* collection and rootstock experiment plot at Haile Selassie I University, College of Agriculture, Alemaya. Although of nucellar or indexed origin, trees have not made good growth.

Fig. 38 - Very poor orange tree in a new plantation. Lateral shoots badly pruned, abnormal bud union. Such a tree will never give good results.