FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

POSSIBILITIES OF IMPROVEMENT OF FRUIT CULTURE IN SOMALILAND

BY

PROFESSOR

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Acknowledgements

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POSSIBILITIES OF IMPROVEMENT
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Introduction

Geographical setting:

Location: Somaliland is situated on the eastern horn of Africa and lies between 08 – 11 degree parallel north and between 42 and 49 meridian east of Greenwich. It shares borders with the republic of Djibouti to the west, the federal republic of Ethiopia to the south, the Puntland region to the Northeast and Somalia to the southeast. Somaliland has 740km of coast with the majority along the Red Sea. Somaliland covers an area of 137,600 km² (53, 100 sq. miles).

Somaliland has an estimated population of 3.5 million. The majority of the population in the rural areas are pastoralists while a reasonable number are also agro-pastoralists. In the urban settings large, medium and small scale enterprises are the main occupation of the people.

Climate: Somaliland’s climate is a mixture of wet and dry. The northern part of the country is hilly and in many places the altitude ranges between 900 to 2,100 meters (300-700ft) above sea level. The highest point, “Shimbiris”, 2,416 meters high which is located in Erigavo District. Extreme recorded temperatures range from -3.3 C at Erigavo to 47.7 C at Berbera. However, the average yearly temperature is 31 C.

Economy: Somaliland’s economy is in its developing stage as is the country itself which declared its cessation/independence from Somalia in May 1991. The Somaliland Shilling is stable with an exchange rate of 6900 Somaliland shilling to a US dollar.

Livestock is the mainstay of the country’s economy. The bulk of Somaliland’s exports are of livestock, which has been estimated to be at 24million yearly. In 1996, 3 million heads of livestock were exported to the Middle East. In February 1998, this export was negatively impacted by a Saudi Arabian ban on imports of beef. The ban was eventually lifted in December 2006 and thus allowed the industry to recover. Other exports include hides, skins, myrrh and frankincense.

Agriculture in Somaliland is of two types, rain-fed farming and irrigated farming. Rain-fed farming area is mainly west of Hargeisa and forms the breadbasket of Somaliland. The main crops grown are sorghum and maize and the land is tilled by tractor or oxen. While the irrigated farms of the program area are located near the valleys of seasonal riverbeds. Irrigated farms are mainly cultivated with horticultural crops like oranges,
mangoes, papaya, guava, and mandarins are cultivated in the country which are located near the valleys of the seasonal riverbeds and irrigated from shallow wells; with very good prospects for their development for exports; particularly to Djibouti and Arabia. Dates are also cultivated in the Sahel region.

![Figure 1: Map of Somaliland](image)

**TERMS OF REFERENCE:**

This is a mission to Somaliland commissioned by the Food and Agriculture Organization of the United Nations (FAO) during the period 08 – 24 May 2012 to provide technical advice to the Ministry of Agriculture in promoting more profitable Date palm, Citrus and Mango production. The terms of reference for the mission are:

Under the overall supervision of the Officer-in-Charge for FAO Somalia, the Agriculture Sector Coordinator, the general supervision of the technical divisions at FAO, and the direct supervision of the Project Manager, the Date Palm/Citrus Expert will be responsible for the following:
• Assess present level of date palm cultivation in the target areas, available opportunities and existing/prevailing challenges, current varieties being grown, their performance and recommendations; if any, for further introduction of the most profitable varieties.
• Identify suitable agricultural areas to establish date palm and citrus plantations demonstration farms for promotion of the most profitable varieties.
• Supervise establishment of the demonstration plots and cultivation of the identified varieties.
• Get farmers’ views on date palm cultivation and marketing.
• Develop guidelines for handling and distribution of the TC date palm seedlings.
• Develop cultivation guidelines on GAPs to be used by the beneficiary farmers.
• Conduct a TOT, which will be largely practical-oriented to provide participating farmers with hands-on experience to qualify as Nursery Para-technicians/Grafters, for 20 identified lead farmers from the date palm and citrus cultivation communities.
• Develop an economic analysis of date palm cultivation and marketing under the Somali context.
• Prepare a detailed mission report.

Methodology:

The Consultant travelled to Hargeisepulic of Somaliland on 08 May 2012 and met with the Minister of Agriculture, Professor Farah, the Director General of the Ministry of Agriculture, Dr. Abdillahi Ismail. Dr. Mohamed Jama and Mr. Mohamed Warsame Farah from FAO Somaliland Office of in Hargeisa were also present in the meeting on 8/5/2012. An itinerary/schedule of visits depicted in table 1 below was developed and agreed upon to enable the Consultant achieve the intended objectives of his mission.
<table>
<thead>
<tr>
<th>Dates</th>
<th>Activity/ Venue</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12/0512</td>
<td>Field assessment visits to citrus and mango growing locations for one day each:</td>
<td>Locations outside Awdal project area as suggested by MoA</td>
</tr>
<tr>
<td></td>
<td>Gabiley, (Arabsio, Hulluq, Biyo Ma’an, Jaleelo, Humboweine, Daraweine, Malluugta, Horohaadley, and Agabar.</td>
<td></td>
</tr>
<tr>
<td>13–15/0512</td>
<td>Field assessment visits to date palm, mango and citrus growing areas in Awdal</td>
<td>During FFS training sessions</td>
</tr>
<tr>
<td></td>
<td>region (Lughaya, Osoli, Gargaara, Garbodadar, Baki, Ruqi)</td>
<td></td>
</tr>
<tr>
<td>17–20/0512</td>
<td>Field assessment visits to date palm, mango and citrus growing areas in Sahil</td>
<td>Focus is for both Citrus and Date palm study</td>
</tr>
<tr>
<td></td>
<td>region (Dubaar, Biyoguure, Bixinduule, Elsheekh)</td>
<td></td>
</tr>
<tr>
<td>21-22/0512</td>
<td>Field assessment visits to date palm, mango and citrus growing areas in Sahil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>region (Dubaar, Biyoguure, Bixinduule, Elsheekh)</td>
<td></td>
</tr>
<tr>
<td>23/05/2012</td>
<td>Debriefing at Hargeisa</td>
<td>With Ministry and FAO staff</td>
</tr>
<tr>
<td>24/05/2012</td>
<td>Travel from Hargeisa to Nairobi</td>
<td></td>
</tr>
<tr>
<td>25/05/2012</td>
<td>Travel from Nairobi to Khartoum</td>
<td>End of mission</td>
</tr>
</tbody>
</table>

The consultant utilized various tools and methods to collect data and extend the required technical assistance and advice. These include: review of the meteorological data of Somaliland, country files and documents, meetings with FAO and government officials, field visits and surveys, interviews with farmers and traders and group discussions.

In the field visits, the situation of the various cultivated horticultural crops were assessed, and the agronomic, pests, climatic problems constraining their development were identified, recommendations for improvement, new varieties, technical advice and training were given/conducted.
Survey of cultural practices in the fruit orchards at Somaliland

The main goal of the survey:
To Increase Productivity, Production and Diversification of Production of fruit trees through:
1. Exploring the possibilities for improved and sustainable production of Citrus, Mango and Date palm.
2. Exploring possibilities of establishing of M.o.A basic facilities for the prevention and control of internationally dangerous pests, diseases, and invasive weed plants.

This survey covered Arabsio, Dararweine, Malluugta, Borama, Garbodadar and Berbera during the period 10-22/05/2012. This was in addition to a three days training of Farmers Field Schools at Ammoud University. The survey aimed to describe the general situation of the target crops and try find answers to the existing problems affecting fruit trees and hamering the development of the horticultural center in the country.

Observations and Discussion:
Varieties:
Somaliland's climatic conditions are considered highly favourable for the production of a wide range of Citrus, Mango, Date palm, Papaya, Guava, Grape, pineapples and passion fruits. In spite of this fact, it was found that all the surveyed orchards planted with poor cultivars, from unknown source, propagated directly from available seeds without budding or grafting on rootstock, even the budded seedlings are on wrong rootstock as Rough lemon which they used it for all citrus species plantation.

This report will be limited only to discuss Citrus, Mangos and Date palm situation in Somaliland. According to the reviewed metrological data of various Somaliland districts, it is suggested that efforts be limited for development of the following varieties of Citrus, Mangos and Date palm instead of investing on very many fruit crops at the time-being :-.
1-  *Citrus spp.*

**Introduction**

Citrus crops were introduced into Hargeisa in 1930 from Cyprus and Australia. A citrus nursery was started at Arabsio in 1945 with new citrus introductions, but there was no record of their origin. The Arabsio nursery was transferred to Geed Deeble in 1951, but had to be closed later because of lack of water. From 1951 to 1962 the two nurseries functioned together. The Arabsio nursery supplied seedlings to all farmers, while the Geed Deeble nursery worked only for the government. New citrus introductions were made in 1959 from various countries including Ethiopia, the United States of America, Kenya and Zanzibar.

**Oranges (C. Sinensis).**

1- Navel Orange group

Navels are low heat-requiring group of sweet oranges for maturity; therefore expected to do best in the coolest part of Somaliland. Navels are also known to be early maturing seedless group of sweet oranges. The variety is rich in flavor and develops intense yellowish orange rind color at maturity. Most Navel Orange fruits inspected in Somaliland were granulated; especially so when the trees were budded on rough lemon rootstock. The stylar end of some fruits was also invaded by microorganisms. All the surveyed orchards were found to be planted with unknown navel orange cultivars. It is recommended that the following cultivars in table (2) to be adopted by navel orange growers.

**Table (2): The Physiochemical characters of the recommended cultivars of Navel orange**

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Fruit weight(g)</th>
<th>Juice volume(ml)</th>
<th>TSS%</th>
<th>Citric Acid</th>
<th>Ascorbic Acid/100g juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frost Navel Orange</td>
<td>243.1b</td>
<td>80a</td>
<td>9.6b</td>
<td>1.45a</td>
<td>47.9a</td>
</tr>
<tr>
<td>Gillette N.O.</td>
<td>161.7d</td>
<td>35c</td>
<td>9.8ab</td>
<td>1.28b</td>
<td>43.5b</td>
</tr>
<tr>
<td>Parent N.O.</td>
<td>263a</td>
<td>75a</td>
<td>9.5b</td>
<td>1.3ab</td>
<td>47a</td>
</tr>
<tr>
<td>Sukkary N.O.</td>
<td>203.1c</td>
<td>46b</td>
<td>10.2a</td>
<td>1.4a</td>
<td>43b</td>
</tr>
</tbody>
</table>

* Letters in the columns indicate means separation by Duncan's multiple range test at 5% level.
2 - Valencia Orange group

The total heat requirement for maturity of the Valencia orange is so high that only in the hottest regions is it satisfied prior to succeeding bloom. Valencia also is the latest citrus variety and hence its importance in extending the season of citrus production in the country can be overlooked, as they have the advantage of having a higher acid content than Navel orange. All the surveyed plantations were poor standing with unknown Valencia orange cultivars. Some Valencia orange fruits inspected at Malluugta village showed tendency towards granulation. Whether this was because the trees budded on Rough lemon rootstock or due to other factors needs further investigation. It is suggested the following cultivars in table (3) to be adopted by Valencia orange growers (Frost Valencia, Butler, Nouri 16 and Hamlin).

Table (3): The Physiochemical characters of the recommended cultivars of Valencia orange

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Fruit weight(g)</th>
<th>Juice volume(ml)</th>
<th>TSS%</th>
<th>Citric Acid</th>
<th>Ascorbic Acid/100g juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frost Valencia</td>
<td>211.7a</td>
<td>92a</td>
<td>11.8ab</td>
<td>1.5a</td>
<td>47.5a</td>
</tr>
<tr>
<td>Butler</td>
<td>185.9b</td>
<td>70c</td>
<td>9.8bc</td>
<td>1.1c</td>
<td>41.5b</td>
</tr>
<tr>
<td>Nouri 16</td>
<td>175.3c</td>
<td>71c</td>
<td>12a</td>
<td>1.1c</td>
<td>40c</td>
</tr>
<tr>
<td>Hamlin</td>
<td>215a</td>
<td>81b</td>
<td>11.9ab</td>
<td>1.4b</td>
<td>47.1a</td>
</tr>
</tbody>
</table>

* Letters in the columns indicate means separation by Duncan's multiple range test at 5% level.

3. Mandarins (C. reticulate)

The whole mandarin acreages was planted with Willow leaf cultivar, except few trees from other unknown cultivars. Very few healthy prolific trees were found deficient in micronutrients; primarily in Zinc. Twig die-back, xylorrhosis, sun scorch, and greening were also factors contributing to the very poor growth of trees and their low yield. Mandarin fruits of trees budded on Rough lemon rootstock were severely granulated than trees on own mandarin stock. It is recommended the following cultivars in table (4) to be adopted by Mandarin growers:
Table (4): The Physiochemical characters of the recommended cultivars of Mandarin

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Fruit weight(g)</th>
<th>Juice volume(ml)</th>
<th>TSS%</th>
<th>Citric Acid</th>
<th>Ascorbic Acid/100g juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilking</td>
<td>79d</td>
<td>59.6d</td>
<td>15.00a</td>
<td>1.15d</td>
<td>31.4b</td>
</tr>
<tr>
<td>Karra</td>
<td>213a</td>
<td>179.2a</td>
<td>13.05c</td>
<td>1.71b</td>
<td>27.7d</td>
</tr>
<tr>
<td>Honey</td>
<td>120.2c</td>
<td>99.4c</td>
<td>12.00d</td>
<td>1.19c</td>
<td>37.1a</td>
</tr>
<tr>
<td>Temple</td>
<td>153.6b</td>
<td>125.7b</td>
<td>14.60b</td>
<td>1.84a</td>
<td>29.5c</td>
</tr>
</tbody>
</table>

*Letters in the columns indicate means separation by Duncan's multiple range test at 5% level.

4. Limes (C.aurantifolia)

Somaliland is a highly potential area for lime production. But the most lime trees surveyed were poor in growth, quality, grown from seeds and infected with so many diseases. Current loss in Mexican lime seedling trees caused by phytophthora foot rot and probably other factors could be cut down by vegetative propagation on Volkameriana rootstock. Bud from thorny branches can be safely worked with a piece of wood. Accordingly, I recommend the following cultivars in table (5) budded on Volkameriana or Citrus macrophylla root stock, to be adopted by lime growers (Bearss lime, Tahity lime, Improved (Saad) and Improved(Ashraf)

Table (5): The Physiochemical characters of the recommended cultivars of Lime

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Seed No/fruit</th>
<th>Fruit weight(g)</th>
<th>TSS%</th>
<th>Citric Acid</th>
<th>Ascorbic Acid/100g juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearss lime</td>
<td>0 -2</td>
<td>88.2c</td>
<td>7.1b</td>
<td>8.84a</td>
<td>48.9a</td>
</tr>
<tr>
<td>Tahity lime</td>
<td>0 -2</td>
<td>75.3d</td>
<td>7.2b</td>
<td>7.56b</td>
<td>30.7c</td>
</tr>
<tr>
<td>Improved (Saad)</td>
<td>5 -8</td>
<td>101.4a</td>
<td>9.0a</td>
<td>7.60b</td>
<td>49.5ab</td>
</tr>
<tr>
<td>Improved(Ashraf)</td>
<td>0 -2</td>
<td>95.2b</td>
<td>7.1b</td>
<td>8.82a</td>
<td>45.1b</td>
</tr>
</tbody>
</table>

*Letters in the columns indicate means separation by Duncan's multiple range test at 5% level.

5. Lemon (C.limon)

Few trees of sweet lemon and Adalia lemon included in the surveyed were found to be grown in various orchard. But unless limes are out of the market, there is no demand for lemons in the local market, I suggest the following cultivars in table (6) budded on Volca or Citrus macrophylla root stock, to be adopted by lemon growers (Cascade YL Eureka, Cook YL Eureka, Rosenberger Seedling Eureka, and Santa Barbara YL Eureka
Table (6): The Physiochemical characters of the recommended cultivars of Lemon

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Seed No/fruit</th>
<th>Fruit weight/g</th>
<th>TSS%</th>
<th>Citric Acid</th>
<th>Ascorbic Acid/100g juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade YL Eureka</td>
<td>4.4d</td>
<td>105.6a</td>
<td>6a</td>
<td>9.6ab</td>
<td>66.2a</td>
</tr>
<tr>
<td>Cook YL Eureka</td>
<td>7.2c</td>
<td>105.2a</td>
<td>5.9a</td>
<td>9.7a</td>
<td>59bc</td>
</tr>
<tr>
<td>Rosenberger Seedling Eureka</td>
<td>10.8a</td>
<td>102.1ab</td>
<td>5.6b</td>
<td>9.7a</td>
<td>59.9b</td>
</tr>
<tr>
<td>Santa Barbara YL Eureka</td>
<td>9.3b</td>
<td>103ab</td>
<td>5.7ab</td>
<td>9.2c</td>
<td>64.3ab</td>
</tr>
</tbody>
</table>

*Letters in the columns indicate means separation by Duncan's multiple range test at 5% level

6. Grapefruits (C. paradise)

This is a high heat requiring group of fruits and the policy in the production of this group should not only aim at satisfying the demands of the local market, but also the export one, accordingly I suggest certain highly exportable cultivars (table 7) budded on Carizzo citrange or Troyer citrange rootstock, to be adopted by Grape fruit growers (◊Red Blush, Frost march and Miami)

Table (7): The Physiochemical characters of the recommended cultivars of Grapefruit

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Fruit weight/g</th>
<th>TSS%</th>
<th>Juice volume/fruit ml</th>
<th>Ascorbic Acid/100gm juice</th>
<th>Citric Acid%</th>
<th>Rind thickness Mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>◊Red Blush</td>
<td>526.8a</td>
<td>11.1b</td>
<td>135c</td>
<td>32.1a</td>
<td>1.4a</td>
<td>9.1b</td>
</tr>
<tr>
<td>Frost march</td>
<td>496.6b</td>
<td>10.9c</td>
<td>182b</td>
<td>32.6a</td>
<td>1.3ab</td>
<td>9.8a</td>
</tr>
<tr>
<td>Miami</td>
<td>491.4c</td>
<td>11.4a</td>
<td>192a</td>
<td>30.4b</td>
<td>1.4a</td>
<td>8.4c</td>
</tr>
</tbody>
</table>

*Letters in the columns indicate means separation by Duncan's multiple range test at 5% level

General observations and characteristics of Citrus Rootstocks

Rough lemon is the most rootstock that is widely used in all the surveyed orchards. This rootstock is sensitive to cold, unsuitable for wet and poorly drained soils. Rough lemon is recommended for lemons and limes; but not for mandarins and orange cultivars. This Rough lemon rootstock ensures proper vigor and productivity in scion but gives very poor fruit quality.

Generally a wide variety of citrus rootstocks are available, each having desirable attributes. The success of a rootstock is determined by its tolerance to prevailing conditions of soil, climate and disease, while still producing high yields of good quality fruit.
Selecting the right rootstock for your orchard is very important. A root system that is compatible with your chosen variety, that is healthy, and well suited to its environment is essential if your orchard is to be a success.

The perfect rootstock is very crucial. Selection is a matter of determining which stock will perform best in your situation. Generally, rootstocks should be selected accordingly to the following:

1. Ability to perform under your soil and climatic conditions;
2. Resistance to pests and diseases;
3. Compatibility with the variety you are planting; and
4. Positive impact they have on fruit yield and quality

To choose the right rootstock it is essential to have all the relevant information about Soil, Pests and diseases, Climatic conditions, Irrigation & Compatibility with the variety you intend to grow.

**Soil:**
- Type and structure
- Depth and drainage
- pH and salt content

**Pests and diseases:**
- Is it a replant or a virgin soil?
- What is planted there already?
- What is the virus/disease status of your trees?

**Climatic conditions:**
- Extreme summer and winter temperatures (frosts etc)

**Irrigation:**
- Water quality: salt and pH
- Type of irrigation system (sprinklers, drippers).

**Compatibility with the variety you intend to grow.**
In other citrus growing states, there has been a trend towards obtaining comprehensive soil surveys that include a soil profile description of proposed orchard sites prior to planting trees. This is a positive move that should be considered by all growers to help in rootstock selection and overall planning and management of the orchard.
Cultivars of roots stocks

1- Troyer and Carrizo Citrange

Hybrids of sweet orange and trifoliate orange are referred to as citranges. Those two named citranges are visually indistinguishable and are both hybrids of Washington Navel and P. trifoliata. Troyer citrange is currently the most widely used rootstock in the most producing citrus counties. Both rootstocks are cold hardy, produce vigorous trees and perform well on most soil types though they will not grow well in calcareous soils or under saline conditions.

Trees on these rootstocks can be prone to micronutrient deficiencies, especially on calcareous soils. They are tolerant to the citrus tristeza virus, citrus nematode (Tylenchulus semipenetrans) and phytophthora root rot. But it is susceptible to severe strains of the citrus exocortis viroid. Both of these stocks are responsive to viroid dwarfing and recommended for viroid dwarfing of oranges and are suitable for use in replant sites.

Compatibility: Troyer and Carrizo Citrange are compatible with most common varieties of citrus except lemon and lime.

2- Cleopatra Mandarin

Cleopatra mandarin is a small-fruited mandarin, which has been used as a rootstock in so many citrus producing countries for many years. It is the most salty and lime tolerant of the commercially available stocks. Trees are slow growing in the nursery and in the first three years in the field; i.e. its early production tends to be poor with trees taking a long time to reach maturity. Trees reach a large size at maturity. Fruit quality is good but small fruit size may be an issue with some varieties. Trees perform well on both heavy and light soils with best results on loam.

Cleopatra is tristeza and exocortis tolerant and moderately susceptible to phytophthora root and collar rots. It is susceptible to citrus nematodes and not generally recommended for replant sites.

Compatibility: No reported compatibility problems and is considered a good stock for most mandarin varieties. Trees on Cleopatra are slower to bear and yield than those obtained on sour orange.

3- Volkameriana (Volkameriana Lemon)

This is a relatively new rootstock, which may have a potential to grow in lighter sandy soils and as an alternative rootstock for ‘Eureka’ lemon.

Volkameriana seedlings are fast growing and vigorous and are adaptable to a wide range of soil conditions. Like Rough Lemon, it will grow well in deep sands where some other citrus rootstocks struggle. It is likely that
fruit quality will not be as good as that produced on Citrange and trifoliate stocks, however, it is reported to be better than that produced by Rough Lemon.

Volkameriana is not susceptible to tristeza virus or exocortis and xyloporosis viroids. It is susceptible to citrus nematodes. Volkameriana is also susceptible to phytophthora root rot but less so than Rough Lemon. It is not recommended for replant situations.

Compatibility: Volkameriana is compatible with lemons, and most orange and mandarin varieties. Mandarin varieties that are susceptible to internal granulation (drying) such as Imperial should not be planted on Volkameriana as this stock has been shown to enhance this problem.

4- *Citrus macrophylla*

It is an alkaline and salt tolerant citrus. We recommend to lemon and lime. It is tolerant of tristeza virus and exocortis and xyloporosis viroids.

5- *Rough Lemon (Citronelle)*

It produces large vigorous, highly productive trees that are drought tolerant. It grows well on a wide range of soils but is particularly well adapted to deep sandy soils. It does not perform well on poorly drained soils and is also sensitive to saline conditions. Fruit quality can be poor. Poor skin colour and thick skins are a potential problem. Good water and nutrient management is important to get the best out of this stock.

Rough Lemon is susceptible to citrus nematodes and phytophthora root rot and is not recommended in replant situations. It is tolerant of tristeza virus and exocortis and xyloporosis viroids.

Compatibility: Rough Lemon is unsuitable for all citrus varieties except Lime and Lemon varieties. As with Volkameriana it should not be used with mandarin, oranges and grape fruit varieties which are susceptible to internal granulation (drying), especially in areas where this is a problem.

6- *Sour orange (C. aurantiunm)*

Is the standard rootstock in the most producing citrus countries, being generally well adapted to wide range of soils. It is somewhat tolerant to salinity, alkalinity and less than optimal drainage, and is relatively tolerant to cold, cotton root rot and Phytophthora. It is susceptible to citrus nematode and citrus tristeza virus. Grapefruit and Orange yields on sour orange are moderate, with average fruit size and good quality.
7- Swingle citrumelo

This is a trifoliate hybrid that reportedly equals or exceeds sour orange in most of its characteristics. It is resistant to nematodes and Phytophthora, tolerant to tristeza and produces a vigorous tree with excellent yields and excellent fruit size. It is reported as tolerant to xyloporosis and exocortis, but some stunting has been observed with old-line bud wood having those viruses. Swingle citrumelo is intolerant of poor drainage and exhibits severe chlorosis in heavy soils, so it should be limited to well-drained, very deep sandy soils.

2- Mango (Mangifera indica L.)

In spite of the fact that metrological data of Somaliland districts were highly potential for mango production but only few trees were found in some districts as Garbodadar and Gargaara, although it is unknown cultivars grown from seeds but most of them were healthy bearing good yield with high quality fruits.

The main objective of this survey is to:-

Evaluating adaptability of different mango growth, quality and yield parameters under different agro climatic condition of Somaliland to exploring new areas where similar mango production can be established as in Sahil region. From the best of my knowledge and my experience in mango plantation, as a World market standard for Export 1, can recommend the following cultivars
Recommended cultivars to be adopted by mango growers

1- Tommy Atkins

- This variety dominates the current world market (80% of mango in UK supermarkets is Tommy Atkins). In Florida (USA) the trees of Tommy Atkins come into bearing 3-4 years after planting and bear regular, heavy crop up to about 300 kg/tree.
- The fruit is medium to large with orange-yellow ground colour and a bright red blush.
- The flesh is medium to dark yellow with a good flavor.
- Fruit is resistant to anthracnose but internal breakdown may be serious in some years.
- Early cultivar.
- Large fruit (450-700 g) with an ovoid to slightly oblong shape and an attractive skin colour.
- Shelf life is good and the cultivar is tolerant to bacterial black spot and anthracnose.
- Trees are of average size and produce regular high yields.
- Fruit is not entirely fibreless, has a watery taste and is susceptible to internal breakdown, jelly seed and stem-end rot. Because of its attractive external appearance good prices are realized on both local and export markets.

1. Keitt

- Keitt is the latest maturing of all the recommended cultivars. The fruit size is medium to large (400-500 g). The fruit is fibreless, oval with rounded base. Skin colour often poor. The fruit has an exceptional keeping quality and can be left on the trees long after normal harvest time without the risk of jelly seed developing.
- The trees are of medium size and the growth habit is characteristically open and appears somewhat disorderly with slender branches.
- The cultivar is highly susceptible to bacterial black spot and is only recommended for very hot and dry areas.

2. Kent

- Trees are large and give consistently satisfactory yields
- Harvesting period is classified as late midseason.
- Fruit is large (500-700 g) with a rounded base, fibreless and the internal quality is very good. The skin colour in cooler, humid areas, is often poorly developed.
- Kent is considered as one of the best tasting mangoes.
3. **Haden**

- Haden was the first superior Mango cultivar selected and named in Florida. Distinguished by a smooth thick skin which is tough, adherent, and an oval, slight kidney shape.
- Ground Color is bright yellow with crimson or red blush and numerous large yellow dots. It weighs just under a pound, has a flat, oval pit, bright yellow-orange flesh, and firm texture.
- Firm, juicy deep yellow flesh with a rich sweet flavor and pleasant aroma.

4. **Elphonse**

- This cultivar is also called Alphonso.
- The tree is cylindrical, has extending fruiting season early to midseason, it yields 1300 fruits/tree.
- The leaf is flat, elliptic lanceolate, acute tip, wary margin, light green with brownish new growth, length 31.3 ± 11.5 cm, width 5.3 ± 1.7 cm and petiole length 5.3 ± 2.4 cm.
- The inflorescence is broadly pyramided, red axis, light green flowers, very dense found terminal and contains leaf bracts, 46.3 ± 11.1 cm long.
- The fruit is yellow, oblong of no beak and groove, ventral shoulder is slightly higher than the dorsal, has rounded apex.
- The weight 333 ± 39.5 g, width 7.9 ± 0.4 cm, length 9.7 ± 0.4 cm, circumference 24.8 ± 1.2 cm, volume 300 ± 49.0 cm^3 , TSS 18.6%.
- The peel weight is 64.2 ± 8.2 g, thickness 1.1 ± 0.1 mm, palatable, easily separating. Long fibers attached to the peel.
- The flesh yellow, soft, contains 2.2 ± 1.5% fiber, 27.8 mg ascorbic acid and 0.32 TA. The ratio of pulp to peel plus stone fresh weigh is 2.4.
- The seed weight 34.7 ± 3.7 g length 7.5 ± 0.3 cm, width 3.8 ± 0.2 cm, thickness 2.0 ± 0.1 cm. The veins raised and very conspicuous, 0.5 – 1.0 cm apart, short fibers found on the ventral side, mono-embryonic.
- The average storage period of fruits is 11.0 days.

5. **Totapuri (Abusamaka –Baida )**

- It is a late maturing cultivar.
• The tree has spreading growth habit, heavy and regular bearer. The average number of fruits per tree is 2500. The leaf is elliptic lanceolate, flat with straight margin.
• The tip is obtuse, in some flushes may be acuminate).
• The color of new growth is light green to brownish. The average leaf length is 24 ± 5.7 cm, width 6.0 ± 1.4, petiole length 3.3 ± 1.5 cm.
• The inflorescence shape is pyramidal with yellowish green flowers on red stem and has leaf bracts easily defoliated, terminal, some of them originated from the lateral buds, the length is 32.7 ± 9.3 cm.
• The fruit is yellow-reddish, elliptic, obtuse apex and point beak, shoulders are sloping equally for each side. Unlike other cultivars, that the most narrow area of the fruit is the base. It has very shallow groove 0.3 – 0.4 cm deep.
• The average weight is 415 ± 68 g, (on low yield years the average weight may reach 656 g), width 8.1 ± 0.5 cm, length 14.6 ± 0.9 cm, volume 394.3 ± 112.5 cm3, circumference 24.7 ± 1.4 cm. Peel weight 56.0 ± 4.1 g, thickness 1.5 mm, palatable, adhered. Flesh light yellow, firm, 14% TSS, contain 10.79 ± 3.6 fine un noticeable fibers, 8.0 mg of ascorbic acid, TA, 0.5, pulp/peel plus stone is 3.8. Seed weight 29.7 ± 2 g, length 11.3 ± 0.1 cm, width 3.7 ± 0.1 cm, thickness, 1.8 ± 0.1 cm, mono-embryonic, elevated veins, widely separated 0.6 – 1 cm, small cotyledons located towards the stone tip.
• The cultivar has an average storage period at room temperature (32 -34 °C) 13 days.

6. Taimour

• The tree is a drooping medium maturing type, produces an average of 1076 fruits/tree. The leaf is elliptic lanceolate of wavy margin and acuminate tip
• The color of young growth is light green with brownish. It is 35.5 ± 5.8 cm long, 7.1 ± 1.1 cm width and 5.4 ± 1.1 cm petiole length.
• The inflorescence is conical, pyramidal/ broadly pyramidal, light green flowers, red axis, loose, terminal and the leaf bracts absent, 35.0 ± 6.6 cm long.
• The fruit is elliptic, light green, has no beak or groove, the ventral shoulder is slightly higher than the dorsal, apex is rounded.
• The average fruit weight is 320 ± 58.5 g, width 7.5 ± 0.5 cm, length 10.2 ± 1.0 cm, circumference 23.4 ± 1.3 cm, volume 306.9 ± 54.2 cm3, TSS 13.4%. The skin weight 38.1 ± 3.3 g, thickness 1.0 ± 0.1 mm, un adhered with fibers attached, palatable.
• The flesh is yellowish-orange, soft. It contains 1.1 ± 0.3% fibers, 5.0 mg ascorbic acid, 2.6 TA.
• The ratio of pulp to peel plus stone fresh weight is 3.5. The seed weight 33.6 ± 5.6 g, length 7.4 ± 0.3 cm, width 3.5 ± 0.4 cm, thickness 2.0 ± 0.2 cm, monoembryonic.
• The fruit average storage period is 10.7 days.
• General observations and characteristics of Mango Rootstocks
  • Only poly-embryonic seeds are used as rootstocks. Seedlings derived from such seed will be true to type and uniform in growth and production habits. Mono-embryonic seeds are not suitable for rootstocks because they are not uniform. Currently mainly Peach and Sabeer seeds are used for rootstocks.
  • A poly-embryonic seedling, Sabeer 'No. 13-1', introduced into Israel from Egypt in 1931, has been tested since the early 1960's in various regions for tolerance of calcareous soils and saline conditions. It has done so well in sand with a medium (15%) lime content and highly saline irrigation water (over 600 ppm) that it has been adopted as the standard rootstock in commercial plantings in salty, limestone districts of Israel. Where the lime content is above 30%, iron chelates are added.
  • When planting, the fibrous stone or pit should be removed from the seed. The seed should be planted concave edge down and about 1 inch deep in any good potting soil. Germination may take two to three weeks; graftable seedlings of a quarter inch diameter take about six months. Once the seeds have germinated, the seedlings are carefully lifted and separated from one another.
  • Weak plants with twisted taproots or stems are not used. Only the healthy plants are planted in plastic containers no smaller than 17.5 x 15 x 40 cm. Well-drained, sandy soil should be used for filling the plastic bags.
  • This transplanting must be done at the right stage – 15 – 30 days after the seed has been planted in the bed, when they are in the fourth – to fifth – red – leaf stage.
  • If the seedlings are planted out after the young, red leaves have started turning green, a high mortality rate can be expected.
  • The rootstock is ready for grafting when it is about 45.0 cm tall and 1 cm thick at a height of approximately 25.0 cm. Rootstocks which are not ready to be grafted after one year should be discarded.
  • A reliable source of graft wood must be established, with a known history regarding production and quality, as well as diseases such as malformation and bacterial black spot.
  • The graft wood must be the youngest, ripe, round wood that is no longer grooved. Ripe, terminal growth, with a well-developed terminal bud showing the first signs of growth, is the best graft - wood. If this terminal bud is not yet ripe, wood of the previous growth flush, with a few lateral buds, may be used. Older wood should be avoided wherever possible.
  • Veneer or side veneer grafting and chip budding are the most successful methods of propagation.
• Most propagation occurs in winter, using rootstocks grown from the previous summer's production. Cleft grafting is also practiced.

**Clonal propagation of mango**

- The modified method of stool-layering is an easy technique for multiplying selected rootstocks in mango.
- The seedlings arising from the adventives embryos of nucellar origin are highly uniform.
- These can therefore be used as such for the vegetative multiplication of a poly-embryonic variety. If found suitable, they can also be utilized as standard rootstocks for some of the mono embryonic varieties.

**Dwarfing**

- Reduction in the size of mango trees would be a most desirable goal for the commercial and private planter. It would greatly assist harvesting and also would make it possible for the homeowner to maintain trees of different fruiting seasons in limited space.
- In India, double-grafting has been found to dwarf mango trees and induce early fruiting.
- Naturally dwarf hybrids such as 'Julie' have been developed. The poly-embryonic Indian cultivars, 'Olour' and 'Vellai Colamban', when used as rootstocks, have a dwarfing effect; so has the poly-embryonic 'Sabeer' in experiments in Israel and South Africa.
- In Peru, the poly embryonic 'Manzo de Ica', is used as rootstock; in Colombia, 'Hilaza' and 'Puerco'. 'Kaew' is utilized in Thailand.

**Advantages of Dwarf Mango**

1. High number of trees per hectare

   1. India-3m x 2.5 m (1,333 plants/ha),
2. Israel-3m x 5 m, 5 m x 8 m(200-600 plants/ha),
3. Thailand-200-600 plants/ha,
4. Australia-200-1000 plants/ha}

2. Easier management of trees:
   Pruning,
   1. Pests and Disease Monitoring,
   2. Minimal losses of fruits,
   3. Minimal damage and bruises,
   4. Easier bagging and harvesting,
   5. Efficiency in spraying

3-Date Palm (*Phoenix dactylifera* L.),

As the other fruits, few trees of date palm were found in the most orchards visited in spite of the fact that the whole of Somaliland country can be a Date palm forest; specially along the coastal areas. But all the Date palm trees observed were of poor stand, unhealthy growth, neglected, with few fronds, unknown cultivar and source.

At Bihin Duule village in Berbera we met an old man in his nineties whose name is Shide Ibrahim Roble. He told us that he was a sailor and between 1940-1955 he introduced so many offshoots by sea shipping from Oman, Yemen, Libya, Tunisia, Emirates, Bahrein, and Sudan. He planted these offshoots and evaluated the yields and quality of different varieties. He said he observed the most suitable cultivars were Musharig ones introduced from Sudan. In Sudan there are two date palm cultivars Mushrig Wad Laggia and Mushrig Wad Khatib. The two are semi-soft types. The people refer to Mr. Ali Shide Ibrahim as the Father Of Date Palms in the coastal areas.

Shide Ibrahim Roble
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There is a neglected Governmental orchard of date palms established before the civil war as a gift from the Iraqi Government planted in a dense spacing with objective of offshoots production to be supplied to the date palm growers in the Sahil region. Now all the trees are infected with so many fungal diseases such as: *Graphiola* leaf spot and Black scorch disease. So many seedlings have germinated from seeds and the orchard has become now as a Jungle.
At Gargaara village in the coast, we visited a promising date palm orchard and made a demonstration for the farmers on how to propagate high offshoots on the palm using plastic bags filled with sand as air layering philosophy.

In reference to the meteorological data and my experience of Date palm plantation at the Red sea coastal area in Sudan I recommend the following cultivars (table 8) to be adopted by Date palm growers in the coastal areas of Somaliland.

**Table (8): The characters of recommended Date palm cultivars**

<table>
<thead>
<tr>
<th>cultivar</th>
<th>Fruit characters</th>
<th>QUALITY</th>
<th>RIPENING</th>
<th>COLOR</th>
<th>SHAPE</th>
<th>TEXTURE</th>
<th>SIZE</th>
<th>DESIRABLE CHARACTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Deglet noor</td>
<td></td>
<td>Excellent</td>
<td>Late</td>
<td>Golden Brown</td>
<td>Oval-long</td>
<td>semi-dry, mild fruit</td>
<td>Medium</td>
<td>considered as number one for export to the European markets. The fruit is delicate and sensitive to dry condition for this reason I recommend to be planted only in the coastal areas.</td>
</tr>
<tr>
<td>2-Medjool or Meghool</td>
<td></td>
<td>Excellent</td>
<td>Medium</td>
<td>red</td>
<td>Oval-long</td>
<td>thick, soft skin</td>
<td>Medium - Large</td>
<td>They are sold as &quot;deluxe&quot; dates in the United States. Considered as number two in the export to European markets</td>
</tr>
<tr>
<td>3- Barhree</td>
<td></td>
<td>Excellent/High/super</td>
<td>Medium /late</td>
<td>Light amber to yellow (Khalal)</td>
<td>Broadly oval nearly cylindrical or rounded</td>
<td>Soft</td>
<td>Medium</td>
<td>High quality, heavy yield; with low tannin in Khalal stage. considered as number three in the export to the European markets</td>
</tr>
<tr>
<td>4-Hayani</td>
<td></td>
<td>Excellent</td>
<td>Medium</td>
<td>Dark brown</td>
<td>Oval-round</td>
<td>soft</td>
<td>Medium</td>
<td>Highly resistant to the saline water and gives high yield with excellent quality.</td>
</tr>
<tr>
<td>5- Khalass</td>
<td></td>
<td>Excellent</td>
<td>Medium</td>
<td>Yellow in Khalal</td>
<td>Oblong-oval</td>
<td>Soft</td>
<td>Medium with a very small perianth</td>
<td>Drought tolerant, even better than Khenezi</td>
</tr>
<tr>
<td>6- Sukkary,</td>
<td></td>
<td>Excellent</td>
<td>Medium</td>
<td>Brown</td>
<td>Heart shaped</td>
<td>Soft/ Semidry</td>
<td>Medium</td>
<td>A small seed</td>
</tr>
<tr>
<td>7- Khenezi,</td>
<td></td>
<td>Excellent</td>
<td>Medium /late</td>
<td>Yellow</td>
<td>Heart shaped</td>
<td>semi-dry</td>
<td>Medium</td>
<td>Tolerates high humidity.</td>
</tr>
<tr>
<td>8-Anbara</td>
<td></td>
<td>Excellent</td>
<td>Medium</td>
<td>Brown/Reddish</td>
<td>Oblong-oval</td>
<td>semi-dry</td>
<td>Big</td>
<td>They are sold as &quot;deluxe&quot; dates in the Saudia Arabia</td>
</tr>
<tr>
<td>9- Rziz</td>
<td></td>
<td>Excellent</td>
<td>Medium/ Late</td>
<td>Yellow</td>
<td>Oval</td>
<td>Soft</td>
<td>Small to medium</td>
<td>Second after Khlass</td>
</tr>
<tr>
<td>10-Nabt Saif</td>
<td></td>
<td>Excellent</td>
<td>Medium</td>
<td>Yellow</td>
<td>Oval-round</td>
<td>Soft</td>
<td>Medium</td>
<td>Highly prized variety but lower than Khlass.</td>
</tr>
<tr>
<td>11-Khadrawi</td>
<td></td>
<td>Good</td>
<td>Medium /early</td>
<td>Yellow-Green</td>
<td>Oval</td>
<td>Soft</td>
<td>Medium</td>
<td>Tolerates high humidity.</td>
</tr>
<tr>
<td>12-Sultana</td>
<td></td>
<td>Excellent</td>
<td>Medium /late</td>
<td>Yellow</td>
<td>Oval-round</td>
<td>Soft</td>
<td>Medium</td>
<td>A very rare variety</td>
</tr>
<tr>
<td>13- Mishrig Wad Laggia</td>
<td></td>
<td>Very good</td>
<td>Early</td>
<td>Yellow</td>
<td>Oblong-oval</td>
<td>semi-dry</td>
<td>Medium</td>
<td>Tolerates high humidity. Highly resistant to the saline water and gives high yield with excellent quality.</td>
</tr>
</tbody>
</table>
On- Farm Trials

Specifications of the Mango trial

Cultivars:

The seven recommended Mango cultivars (Tommy Atkins, Keitt, Kent, Haden, Elphonse, Abusamaka –Baida, Taimour) are to be budded on Sabeer 'No. 13-1', root stock. I also suggest that all the plant materials introduced from Kenya or Sudan as a 3 years-age seedlings are to be budded on Sabeer 'No. 13-1', root stock growing in artificial media in container of plastic bags.

Stations: Berbera, Borama and Hargeisa

Materials &Methods

Design of the experiment and acreage need

- RCB –Three replications, with four trees per plot, twelve seedlings from each cultivar needed i.e. 588 m2 for the experiment.
- Period of the Experiment:-Data are to be collected for a period of three years continuously; then we can recommend the promising/best performing cultivars under certain agro climatic zone. Then we can demonstrate to the growers and train them on the optimum cultural practices of mango production.

Specifications of Date palm trial

Cultivars

The thirteen recommended date palm cultivars are: Deglet noor, Medjool, Barhree, Hayani, Khalass, Sukkary, Khenezi, Anbara, Rziz, Nabt Saif, Sultana, Khadrawi Mishrig Wad-Laggay..

I, suggest the above are to be introduced from Sudan, because of absence of red weevils, as tissue culture offshoots of 3 years old, grown in artificial media in containers of plastic bags.

Stations of the on farm trials: Berbera, Borama and Hargeisa
Materials & Methods

Design of the experiment and acreage need

- RCB – Three replications, with four trees per plot, fifty two offshoots from each cultivar are needed i.e. 7644m² for the experiment
- Period of the Experiment: Data are to be collected for three years continuously; then we can recommend the promising/best-performing cultivars under certain agro climatic zone. Then demonstration and training to the growers on the optimum cultural practices of date palm production can be conducted.

Citrus Bud-wood Virus-Free Certification Program

Before setting any citrus variety trial, we suggest to establish Citrus Bud-wood Virus-Free Certification Program at Hargeisa because of the high invasion of all citrus plantations with: Cackexia or Excortics, Xyloporosis and, different types of Psorosis (Scaly bark, Blind Pocket, Crinkly leaf, Concave gumme, Gummy bark); in addition to Greening, Stubborn, Citrus canker and Phytophthora gummosis. All these viruses, virus-like or viroids, Micoplasma, bacterial and fungal diseases were heavy infestation of all citrus plantations in the country. A certified virus and virus free bud wood of all Citrus species and recommended cultivars (Tables 2,3,4,5,6,7) must be reintroduced from reliable sources e.g. French Citrus Experiment Station at San Ginliano, Corsica.

The set-up of this program is not difficult: it needs a piece of land, its preparation and the selection of root stocks.

Selection of root stocks:

1. Stock for indexing for virus infection.

   Certain varieties of citrus are especially reacting to a given virus, and hence are used for purpose of testing for the presence of that virus. Depending upon the time required for the test, the tested varieties may be grown in the field. Test varieties in common use are as follows:

   A. Psorosis – Pine apple, sweet orange (Florida) or Willow leaf mandarin.
   B. Cachexia (Xyloporosis) – Orlando tangelo (Florida) nothing else has proven as satisfactory.
   C. Exocortis – Etrog citron, Rangpurlime, Poncirus trifoliate is most widely used but is slow in reaction.
D. Tristeza—West Indian lime or Mexican lime

2. Stocks for field Trials: mentioned above

3. Sources of bud-wood or scions.

In order to get under way as quickly possible, nucellar bud wood, of proven trueness to horticultural type, and productiveness, and indexed and known to be virus-free can be ordered from reliable sources e.g. French Citrus Experiment Station at San Ginliano, Corsica or Florida and California. Without making formal inquiry, it is impossible to know exactly what is available, but I suggest requesting nucellar bud wood of the following lines (The age of the parent tree, and any data available on productiveness should be requested).

A. Recommended cultivars of Navel orange (Frost Navel Orange, Gillette N.O., Parent N.O., and Sukkary N.O.)
B. Recommended cultivars of Valencia orange (Frost Valencia, Butler, Nouri 16 and Hamlin)
C. Recommended cultivars of Mandarin (Wilking, Karra, Honey and Temple)
D. Recommended cultivars of Grape fruit (Red Blush, Frost march and Miami)
E. Recommended cultivars of lemon (Cascade YL Eureka, Cook YL Eureka, Rosenberger Seedling Eureka, and Santa Barbara YL Eureka)
F. Recommended cultivars of lime (Bearss lime, Tahity lime, Improved (Saad) and Improved (Ashraf).

Recommendations for Bud-wood virus-Free Certification program

- A National citrus bud wood certification programme should be established in Somaliland for the benefit of all nursery workers and growers. A number of collections of healthy germplasm, under the control of government institutions, should be established in each important citrus area of the country to provide new, superior propagative material. Nucellar and old-line clones should be kept separate in the programme, with a clear indication of their nature. A permanent inter institutional committee should be set up to supervise continually the execution of this programme and to guarantee long-term support.
- Well-equipped laboratories for shoot-tip grafting should be established in Hargeisa to provide local scientists with the necessary tools to free local citrus varieties from intracellular pathogens.
- Appropriate installations and facilities should be established for a full indexing programme for virus and virus-like pathogens. It would be preferable
to have these facilities concentrated in one or two centers only, to which propagative material could be brought for indexing.

- The citrus improvement programme should be expanded to include comparison trials between old-line and nucellar clones of commercial citrus varieties.
- New rootstock trials should be established to serve as a basis for a program of diversification away from the use of Rough lemon rootstock, as a safeguard against the threat of tristeza virus. Trifoliate selections and hybrids should be introduced under strict phytosanitary supervision and tested for performance as rootstocks for oranges, mandarins, Grape fruit, lime and lemon under different environmental conditions of each area.
- A nationwide identification and suppression program should be conducted to locate and eradicate all possible sources of stubborn and tristeza virus in citrus orchards.
- Quarantine regulations should be strictly enforced to prohibit any plant importation into the country by private growers. At the same time, a post-entry quarantine station under government control should be established to provide safe introduction of new citrus varieties and rootstocks. Somaliland citrus research workers should be encouraged to attend international meetings and leading citrus centers to learn at firsthand about new developments in crop improvement and protection. Financial support should be given to scientists to enable them to participate in such programs and in the international exchange of knowledge.
- Somaliland, in association with all coastal and African countries, should cooperate in a joint effort to prevent the introduction and diffusion of new pathogens into the region, particularly those of greening disease, tristeza virus, citrus canker and blight. In particular, all those concerned with the citrus industry must be made fully aware of the major threat presented by greening disease. If both the greening bacterium and its vectors become established in the country, large-scale destruction of Somaliland citrus orchards will follow.
- Unless an alternative rootstock is recommended as a result of citrus rootstock/section investigation studies (Troyer or Carrizo or Cleopatra mandarin/ for all Citrus spp. except Citrus macrophylla or Volkameriana for lemon and lime) should continue to be the standard citrus rootstock in Somaliland.
- Propagation on Rough lemon rootstock should be prohibited

Observations on the cultural practices survey

Introduction
This survey covered Arabsio, Dararweine, Malluugta, Borama, Garbodadar and Berbera between 10/05 -22/05/2012 with the company of Mohamed Warsame, Field Agricultural
Coordinator FAO Hargesia office, Ibrahim Omar Kahin, Head of Crop Production and Protection Dept. The survey has been undertaken to describe the general situation and to try to formulate answers to existing problems of fruit trees in the area.

**The major obstacle:**

In adequacy supply of horticultural inputs such as certified seeds, seedlings, Fertilizers, pesticides, fungicides, herbicides and other horticultural equipments. Also lack of qualified extension personnel, lead to total neglect cultural practices and crop management is very poor and farmers lack improved conventional production and protection skills to attain improved and sustainable levels of production (qualitatively and quantitatively)

**Acreage**

The smallness of the orchard size planted with so many species of fruits of unknown, poor cultivars from unknown sources eg. Mandarin, Guava, lime, Zizyphus, Papaya, mango, Castor Apple and Date palm in the same area with no spacing. In all surveyed orchard it was not possible to find ten trees from the same cultivar or even species in one place. Some trees in this cocktail can be a host plant to serious insectpests to other species. For example Zizyphus and Guava trees are host for the fruit fly which inflicts serious damage on Mango trees.

**Spacing**

Most of the visited orchards are characterized by irregular spacing without any system in place. In California the spacing had changed from 6.6x6.6 meters to 6.6x3.3 meters; also in South Africa, Egypt and Israel they tend to use dense spacing, e.g. 3x5 meters for the mango.

**Pruning program**

No pruning practices followed in all visited orchards which resulted in dense vegetative cover with the lower branches touching the soil. This normally increases the infection by *Citrus melanose*, *phytophthera* and *Diplodia*) and close heart of the trees which affect the yield and fruit quality. Proper pruning program must be adopted. So many stems are left to grow from the ground surface. Only one single stem should be allowed to grow to 75 cm high, then select three branches 25-30 cm, then select two branches from each to build the tree canopy.
Irrigation

It is well known that the growth of the fruit tree greatly depends on the soil water; therefore the management of the moisture in the soil is particularly necessitated for the increase of the tree production and improvement of the quantity and the quality of fruits. In all surveyed orchards, we observed high quantity of water applied to the trees compared to the countries which have the same conditions and metrological data. The irrigation method by Flooding by large basins system of irrigation results in spread of foot-rot gummosis in citrus caused by *phytophthora* spp. and *Botryodiplodia theobromae*; and Anthracnose in mango. No precaution is taken to avoid the irrigation water from getting into direct contact with tree trunk. The recommendation is to use double rings or rings and blind blocks method as shown in the photo.
Salt burn was seen in some orchards on Mango leaves at Daraweine village, and other areas I think it is a result of saline irrigation water because there are no salinity symptoms seen on the soil. From my experience if they use grafted mango on Sabeer 'No. 13-1'root stocks and add 300 g of elemental sulfur yearly as a routine fertilizer program to reduce soil or water pH, also to increase uptake of all micro nutrients, and as well activate the beneficial soil micro organisms,, they may overcome this salinity problem.

**Fertilizer program**

There is no fertilizer application program applied in the entire visited orchards. This is the main factor contributing to the low yield of fruit production. Micro and macronutrients deficiency symptoms were observed on mango, citrus and date palm leaves. If I have soil analysis and Irrigation water pH, I can easy design simple and perfect fertilizer program partially to increase the yield and growers income. Also the main constraint facing the fruit growers is the inadequacy supply of agricultural equipment and inputs. There are no private or governmental suppliers, even for the pesticides, fungicides, herbicides and seeds and other plant materials like offshoots or fruit seedlings. Generally I, can recommend these basic fertilizer program for the main areas.

**Table (9) : Recommended Fertilizer Program for the Citrus Trees**

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Element</th>
<th>Mg</th>
<th>K</th>
<th>P</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under Bearing 2-5 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100-65 g</td>
<td>250-200 g</td>
<td>250-200 g</td>
<td>400-200 g</td>
</tr>
<tr>
<td>Bearing trees Above 6 years</td>
<td></td>
<td>220-150 g</td>
<td>500-300 g</td>
<td>600-300 g</td>
<td>800 1000 g</td>
</tr>
</tbody>
</table>

**Table (10): Recommended Fertilizer Program for the Date palm**

<table>
<thead>
<tr>
<th>Off shoots Age</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 6 years</td>
<td>525g</td>
</tr>
<tr>
<td>6-4 years</td>
<td>262g</td>
</tr>
<tr>
<td>Less than 4 years</td>
<td>65g</td>
</tr>
<tr>
<td>138g</td>
<td>138g</td>
</tr>
<tr>
<td>540g</td>
<td>540g</td>
</tr>
<tr>
<td>45g</td>
<td>K</td>
</tr>
</tbody>
</table>
**Recommended Fertilizer Program for the Mango**

A. After the second year from planting the mango seedling I advice to add to it 100 g of ammonium sulphate then increase yearly with 50 g.

B. In the case of 5 years age (Bearing or under Bearing tree) advice is to apply 250 g of Ammonium sulphate every month (During April/May, May/June, June/July)+ 250 g KSo4 in June/July

C. Generally, the most important nutrient for the mango tree is the Potassium and it is preferable to add as the Potassium sulphate. Yearly the tree needs 500g of KSo4 added into two doses. Also it needs 0.5-1.05kg Nitrogen/year according to the tree size and the soil type.

D. In the case of the micronutrients, it is preferable to add in the form of Sulphate as 3g/liter of water in the case of MgSo4 and ZnSo4 or as1g/liter of water in case of Mg or Zn Chelate. While the Iron or Fe is added as FEEDHA, Iron Chelate 38 as 70 g/tree/year.

**Pests**

**Table (11): The following pests were found to cause damage for citrus**

<table>
<thead>
<tr>
<th>Observations control</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Pests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folimat insecticide</td>
<td><em>Papilio demodocus larvae</em></td>
<td>Papilio,</td>
<td>1</td>
</tr>
<tr>
<td>or any systemic insecticide</td>
<td></td>
<td>Citrus Butter fly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The citrus leaf miner (Phylloclinitiscitrella) helps</td>
<td><em>Phylloclinitis citrella</em> Stnt</td>
<td>Citrus leaf miner</td>
<td>2</td>
</tr>
</tbody>
</table>
to increase the susceptibility of citrus trees to citrus canker infection. Leaves damaged by citrus leaf miner become more sensitive to canker infection because leaf miner wounds allow easy penetration of the canker bacteria into the leaf tissue. Spray with Malathion 57% 22 cm³/Gallon of water.

Fermon Trap (Methyl Eugenol + Malathion 57% in ratio of 9:1) or Citronella oil + water in ratio of 2:1 or biological control by Bacillus thuringiensis or Metarhizium anisopliae

<table>
<thead>
<tr>
<th>Fruit Fly</th>
<th>Citrus bud mite is primarily a pest of coastal lemons but Eriophyes sheldoni Citrus Bud mites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceratitis capitata</td>
<td></td>
</tr>
<tr>
<td>Citrus red mite</td>
<td></td>
</tr>
<tr>
<td>Panonychus citri</td>
<td></td>
</tr>
</tbody>
</table>

On leaves, citrus red mite feeding results in a pale stippling visible primarily on the upper surface of the leaf. In severe infestations, the stippling enlarges to dry necrotic areas (commonly called mesophyll collapse). Eventually, leaves may drop and twigs dieback. Stippling or silvering also occurs on green fruit but usually disappears when fruit change color. If large populations feed on nearly mature fruit, the silvering may persist. High populations can also cause fruit sunburn if hot weather is occurring. Low levels of citrus red mite can cause a blasting or burning of foliage and leaf drop in coastal another areas of Somaliland.
has also been found in interior regions of Somaliland. The mites feed inside the buds, killing them or causing a rosette-like growth of the subsequent foliage and distortion of flowers and fruit, which may or may not reduce yield and/or fruit quality.

The rust mite feeds on the outside exposed surface of fruit that is 0.5 inch (1.3 cm) or larger. Feeding destroys rind cells and the surface becomes silvery on lemons, rust brown on mature oranges, or black on green oranges. Rust mite damage is similar to broad mite damage, except that somewhat larger fruit are affected. Most rust mite damage occurs from late spring to late summer.

| **Phyllocoptrut a oleivora** | Citrus Rust Mite (Silver Mite) |
| **Coccus** | Scale insects |
| **Coccus hesperidum** |
| **Coccus viridis** |

Scale insects severe infestations of scales (*Coccus* spp.) on navel sweet orange fruit and twigs have been seen in so many area. This scale problem was even more important in 1983. *Coccus hesperidum* (soft brown scale) and *Coccus viridis* (soft green scale) have been reported in Somalia.

Control measures could be started by removing and burning destroyed offshoots. In case of a slight attack, it is recommended to clean the offshoot of soil canals and spray it with a termite killer (Dursban or Hostathion). It is also advised to turn over the surrounding soil to about 50 cm deep in order to destroy termites.
these canals and treat them with a nematicide product (which will certainly kill all termite species).

### Table (12): The following pests were found to cause damage for date palm

<table>
<thead>
<tr>
<th>Observations and control</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral oils+ Malathion57% insecticide</td>
<td>Parlatoria blanchardii Targ</td>
<td>White scale 1</td>
</tr>
<tr>
<td>Vertimic Fungicide, 3 sprayers /season washing all the canopy and stem</td>
<td>Oligonychus afragisticus McGregor, O. pratensis</td>
<td>Red spider mite 2</td>
</tr>
<tr>
<td>Furedan insecticide 60 g/soil application</td>
<td>Phonopate fahraeus frontalis, fahraeus</td>
<td>Frond Borer 3</td>
</tr>
<tr>
<td>Furedan insecticide 60 g/soil application</td>
<td>Jebusaea hammerschmidtii Reiche</td>
<td>Stem Borer 4</td>
</tr>
<tr>
<td>Actara insecticide or any piercing sucking insecticide</td>
<td>Battrachedra amydraula</td>
<td>LesserDate Moth or Hmira 5</td>
</tr>
<tr>
<td>As Hmira</td>
<td>Arenipes sabella Haps</td>
<td>BiggerDate Moth 6</td>
</tr>
<tr>
<td>Nimagore</td>
<td>Meloidogyne spp</td>
<td>Nematodes 7</td>
</tr>
</tbody>
</table>

In case of a slight attack, it is recommended to clean the offshoot of soil canals and spray it with a termite killer (Dursban or Hostathion). It is also advised to turn over the surrounding soil to about 50 cm deep in order to destroy these canals and treat them with a nematicide product (which will certainly kill all termite species).
### Table (13): The following pests were found to cause damage for Mango

<table>
<thead>
<tr>
<th>Observations and control</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folimat or any systemic insecticide / Furedan 60 g/soil application</td>
<td><em>Monolepta australis</em></td>
<td>Red shoulder leaf beetle</td>
</tr>
<tr>
<td>Folimat insecticide or any systemic insecticide</td>
<td><em>Penicillaria jocosatrix</em></td>
<td>Large mango tip borer</td>
</tr>
<tr>
<td>Furedan 60 g/soil application</td>
<td><em>Spulerina isonoma</em></td>
<td>Mango stem miner</td>
</tr>
<tr>
<td>Fermon Trap {Methyl Eugino} + Malathion 57% in ratio of 9:1 or Citronella oil + water in ratio of 2:1 or biological control by <em>Bacillus thuringiensis</em> or <em>Metarhizium anisopliae</em></td>
<td><em>Bactrocera tryoni</em> and <em>B. jarvisi</em></td>
<td>Fruit fly</td>
</tr>
<tr>
<td>Folimat insecticide or any systemic insecticide</td>
<td><em>Planococcus citri</em></td>
<td>Mealy bugs</td>
</tr>
<tr>
<td>Vertimic Fungicide 3 sprayers /season washing all the canopy and stem</td>
<td><em>Cisaberoptus kenyae</em></td>
<td>Mango leaf coating mites</td>
</tr>
<tr>
<td>Folimat or any systemic insecticide</td>
<td><em>Pseudaulacaspis nr. cockerelli</em> and <em>Aulacaspis tubercularis</em></td>
<td>False Mango scale</td>
</tr>
<tr>
<td>Actara insecticide</td>
<td><em>Selenothrips rubrocinctus</em></td>
<td>Red banded thrips</td>
</tr>
<tr>
<td>As in Date palm</td>
<td><em>Microcerotermes diversus</em></td>
<td>Termites</td>
</tr>
</tbody>
</table>

### Diseases

**Common observed diseases of citrus**

**Citrus canker:** *Xanthomonas axonopodis.*

Canker lesions develop along the tunnels of citrus leaf miners; all above-ground tissues of citrus trees are susceptible to infection by citrus canker when young. Cankers symptoms can appear on fruit, leaves and stems, and vary in their appearance depending on the age and severity of the infection. Severe infections can cause defoliation, stem dieback, fruit drop, general tree decline and result in very unappealing fruit. Trees with persistent, severe infections can become weak and unproductive.
**Citrus greening**

The diagnosis of greening in the orchard visited is based on field symptoms include yellow, sparse foliage with zinc-deficiency patterns off-season flowering, fruit of various sizes with aborted seeds; and leaves with severe leaf mottling and vein corking.

**Melanose - *Diaporthe citri***
This disease typically affects more mature trees or plants that have a canopy of foliage that hangs close to the ground. Mulch trees with a feeding mulch such as Lucerne. This will help to prevent spores splashing up onto the foliage when it rains. Lift the lower branches so that foliage is well clear of the soil. Spray trees with copper-based compounds after all fruits have been harvested, thoroughly wetting the foliage, trunk and branches. Repeat applications each year until no further evidence of disease exists. Improve general tree health with additional organic nutrients and water.

**Cachexia-xyloporosis**

On practically all mandarin trees encountered Cackexia-xyloporosis symptoms; namely the presence of gum impregnations in the bark, pegs on the cambial side of the bark, and stem pitting, that is, pits in the wood matching the pegs on the bark. Gum impregnations in the bark of susceptible species are easily seen by scratching the trunk with a knife at the bud-union to remove the outer layer of bark. Bud-union creases Sweet orange trees grafted on rough lemon often show bud-union over growth which called crease, a sign of incompatibility between the rootstock and the scion. In certain cases it has been shown that bud-union crease is a graft-transmissible disease. Symptoms of it have been seen in many orchards of the Hargeisa region. Practically all Sweet orange trees on rough lemon that were seen showed bud-union crease.
Scaly bark (Psorosis)

Scaly bark Psorosis, or Psorosis A, is a graft-transmissible, virus-like disease. Symptoms of it were seen on all sweet orange trees grafted on Rough lemon rootstock.

Concave gum / Blind pocket
Concave depressions typical of concave gum were seen on most of the trunks of navel sweet orange trees and mandarin trees on rough lemon rootstock.

**Gummy bark of sweet orange**

![Gummy bark of sweet orange](image)

Of all virus and virus-like diseases of citrus, gummy bark of sweet orange is probably the most conspicuous disease of citrus in Somaliland. The symptoms of gummy bark on sweet orange are similar to those of Cackexia on mandarin.

**Woody gall:**

Galls on trunk, branches and root were observed on all citrus species
Impietratura

Impietratura is an infectious disease affecting, sweet orange, mandarins and lemon. Affected fruit is hard, like stone - hence the name Impietratura - and there are gum pockets in the albedo. Mild Impietratura-like symptoms, i.e. gum in the albedo, have been seen on several occasions in Somaliland on navel sweet orange. Boron deficiency also results in the presence of gum in the albedo, further work is required to assess the presence of the Impietratura agent in the country.

Cristacortis

Cristacortis affects many citrus species. The disease is characterized by conspicuous pegs on the cambial side of the bark with corresponding pits in the wood. In cristacortis there are no gum impregnations in the bark. Cristacortis-like symptoms have been seen on sour orange carrying a mandarin top.
Stubborn (Micoplasma) disease

Vinca rose/Host plant of Stubborn Growing in Hargeisa FAO office

Stubborn-like symptoms, including bushy growth, off-season flowering and Navel closure, were seen on Navel sweet orange. Trees are stunted, with small, cupped leaves that also display mottle. Fruit peel is thick and coarse at the peduncular end but thin and smooth at the stylar end. Seeds are aborted and the fruit axis is curved, giving lopsided fruit also blue batches in albedo and small gum particles on the fruit pith.

Twig Die Back:

A severe dying back was observed on branches of almost all fruits species and varieties.
**Phytophthora foot rot**

Several cases of foot rot due to poor cultural practices were observed on mandarin and sweet orange trees on Rough lemon.

**Rio Grande gummosis**

Severe Rio Grande gummosis with abundant gum exudations was seen on sweet orange.

**Salt toxicity**

Salt burn in the Malluugta area, Rough lemon seedlings in the nursery showed severe salt toxicity symptoms. The irrigation water often has high chloride content, sometimes reaching 700 mg/l this will lead to secondary salinization of the soil.
Black scorch, also called Medjnoon disease, is caused by Ceratocystis paradoxa (Hohn) which is the perfect form of Thielaviopsis paradoxa.

Black scorch has been observed on date palm in all date growing areas of the world. Symptoms are usually expressed in four distinct forms: black scorch on the leaves, inflorescence blight, heart or trunk rot and bud rot on palms of all ages. Infections are all characterized by partial to complete necrosis of the tissues. Typical lesions are dark brown to black, hard, carbonaceous, and, as a mass, give the petioles, fruit strands and fruit stalks a scorched, charcoal-like appearance

Good sanitation is the first step in the control of black scorch. The affected fronds, leaf bases and inflorescences should be pruned, collected and immediately burned. The pruning cuts and surrounding tissues should be protected by spraying with Bordeaux mixture, lime-sulphur solution, copper sulphate lime mixture, dichlone, thiram or any new copper-based fungicides. Under a severe attack, affected palms are to be removed and burnt.
Graphiola leaf spot is caused by *Graphiola phoenicis* (Moug) Poit., which is a smut fungus. It develops sub-epidermal, in small spots on both sides of the pinnae leaves, on the rachis and on the leaf base. It is observed on date palm of Bihin duule and Gargaara Control measures include leaf pruning coupled with treatment with Bordeaux mixture or any large spectrum fungicide (mancozeb, cupric hydroxide, cupric hydroxide + maneb, or copper oxychloride + maneb + zineb; 3 to 4 applications on a 15-day schedule after, sporulation, have been recommended). Genetic tolerance has been found in some varieties (Barhee, Adbad, Rahman, Gizaz, Iteema, Khastawy, Jouzi and Tadala).
Belâat disease is caused by *Phytophthora sp.* similar to *P. palmivora*, also it observed at Bihin duule and Gargaara orchard. Spraying with maneb or Bordeaux mixture at the rate of 8 litres/palm could control the disease at its early stages. Offshoots of affected palms usually remain healthy.
Common observed diseases of mango

**Anthracnose** *Colletotrichum gloeosporioides*

*Mango malformation:* There are two types of Malformation:

1. Inflorescence Malformation  *Fusarium mangiferae,*
2. Vegetative Malformation  *F. sterilhyphosum*
False Mango scale *Pseudaulacaspis nr. cockerelli*1 & *Aulacaspis tubercularis*2

Stem end rot, *Botryodiploidea theobroma*
Nutritional Disorder

Boron Toxicity
Zinc deficiency:

Salt injury
Mango leaf Coating Mites *Cisaberoptus kenyae*

Grey leaf spot (*Pestalotiopsis mangiferae)*
Alternaria Disease

Red shoulder leaf Beetle *Monolepta australis*
The most important cultural techniques and the economic analysis of the potential of date palm production in Somaliland

Dates are comprehensive nutritional substance that contain most of the basic components of carbohydrates, protein, vitamins and minerals salts (table 14). If somebody takes ten dates a day (approximately 100gm), it will supply the human body with all its daily needs of Manganese, Copper, Sulfur, half his needs of Iron and a quarter of his needs of Calcium and Potassium. Since dates contain the Phosphorus element that plays a major role in the construction of bone and teeth, dates are considered very important for feeding the brain nerves cells. Dates also play role in forming heredity substances. The potassium element helps in bringing about a clear mind and ability to concentrate and think in addition to balancing water contents of body. Dates are considered the richest nutritional substances, as it supplies the human body with the calories necessary for movement and activities due to it is high contents of sugars which reach about 80% calculated on the basis of weight of fresh dates. When dates calories value are compared with other food and fruit taken by the individual, we find that dates rank at the top (table 15). Every 100 gm of cooked rice gives 180 calories, and the same quantity of bread gives 225 calories, and mutton meat (fat free) gives 224 calories, while we find that one kg of dates suffice the individuals need of daily energy, which estimated about 3000 calories per day.

Table 14: Nutritional components of dates

<table>
<thead>
<tr>
<th>Components</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>22.5-24.5%</td>
</tr>
<tr>
<td>Protein</td>
<td>2.3-5.6%</td>
</tr>
<tr>
<td>Energy</td>
<td>247 Calories</td>
</tr>
<tr>
<td>Glucose</td>
<td>44-88%</td>
</tr>
<tr>
<td>Raw fiber</td>
<td>6.5-11.5%</td>
</tr>
<tr>
<td>Ash</td>
<td>1.9gm</td>
</tr>
<tr>
<td>Calcium</td>
<td>59gm</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>63gm</td>
</tr>
<tr>
<td>Iron</td>
<td>3gm</td>
</tr>
<tr>
<td>Sodium</td>
<td>1gm</td>
</tr>
<tr>
<td>Potassium</td>
<td>5.9%</td>
</tr>
<tr>
<td>Fat</td>
<td>0.2-0.5%</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>50Intl.unit</td>
</tr>
<tr>
<td>Thiamine</td>
<td>0.09mg</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.10mg</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td>Niacin</td>
<td>2.2mg</td>
</tr>
</tbody>
</table>

Table 15: Comparison between dates and other Fruits and food calories value (per 100 gm of fruits).

<table>
<thead>
<tr>
<th>Food Commodity</th>
<th>Energy (calculated in calories)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dried dates (14% humidity)</td>
<td>233</td>
</tr>
<tr>
<td>Half-dried dates</td>
<td>156</td>
</tr>
<tr>
<td>Dates without seeds</td>
<td>274</td>
</tr>
<tr>
<td>Apple</td>
<td>49</td>
</tr>
<tr>
<td>Figs</td>
<td>75</td>
</tr>
<tr>
<td>Grapes</td>
<td>67</td>
</tr>
<tr>
<td>Mango</td>
<td>40</td>
</tr>
<tr>
<td>Apricot</td>
<td>47</td>
</tr>
<tr>
<td>Oranges</td>
<td>33</td>
</tr>
<tr>
<td>Grape-Fruit</td>
<td>32</td>
</tr>
<tr>
<td>Acid Lime</td>
<td>18</td>
</tr>
<tr>
<td>Water melon</td>
<td>13</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>17</td>
</tr>
<tr>
<td>Bananas</td>
<td>60</td>
</tr>
<tr>
<td>Pine Apple</td>
<td>30</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>43</td>
</tr>
<tr>
<td>Dates (Dibs)</td>
<td>386</td>
</tr>
<tr>
<td>Grape molasses</td>
<td>258</td>
</tr>
<tr>
<td>Cooked Rice</td>
<td>180</td>
</tr>
<tr>
<td>Bread</td>
<td>225</td>
</tr>
<tr>
<td>Mouton (Fat free)</td>
<td>224</td>
</tr>
</tbody>
</table>
The economic analysis of the most cultural techniques’ to improve the yield of date palm production.

Somaliland can be a very productive country on dates. The following chapter gives a general idea on the economic analysis and the cost of establishment of a modern date palm orchard of one hectare (Table 19), operational costs for 10m years (Table 20), the cost of building and equipment of packing house (Table 21) compared to the yield of the recommended cultivars (Table 18).

**Varieties**

Date varieties can be grouped into three types: soft, semi-dry and dry (or bread) dates. Soft type dates have a soft flesh, high moisture content and relatively low sugar content. Semi-dry varieties have a firm flesh, fairly low moisture content and high sugar content. Dry dates have high sugar content, very low moisture content, and a dry, hard flesh. In the relatively humid areas like Somaliland, I recommend only semi-dry and soft varieties such as the recommended varieties in Table (8).

**Propagation:**

Recognized varieties are propagated vegetatively by offshoots (Conventional or Tissue culture) to guarantee trueness to type. Also all the recommended varieties propagated by Tissue culture except Mishrig wadlaggai which is propagated conventionally. The Tissue culture off shoots (three years old, planted in artificial media in plastic container 30x40cm) its price in Khartoum, Sudan is about US $30.

![Three years Tissue culture off shoots](image1)

![New Imported tissue culture off shoots](image2)

**Figure (34)**

**Traditional method of Propagation:**
The offshoots are separated with minimum root damage and planted in a nursery at one meter distance between the offshoots. A year later, surviving offshoots are transplanted to the permanent site.

Tin or container Method: This is done for varieties which are difficult to root. A tin or plastic bag filled with a mixture of sand, silt and compost in equal ratios is fixed around the bottom of the offshoot. The soil is kept moist until the appearance of enough roots to successfully separate the offshoot from the mother tree.

Buried method: This is a new method of propagation where the offshoot, whether small or large, is completely buried in sand and frequently irrigated. After 6 months the offshoot is dug up and transplanted.
Land preparation

When establishing a new date plantation, certain actions need to be implemented to ensure the long term success of the plantation. One of these actions involves the initial land preparation which should be done prior to transplanting of the plant material (offshoots or tissue culture-derived plants).

The purpose of land preparation is to provide the necessary soil conditions which will enhance the successful establishment of the young offshoots or the tissue culture plants received from the nursery. Considering the nature of the date palm, one cannot "save" on this operation and hope for long term sustainability of the plantation.

The aim is to enable the date grower to plan and structure the implementation process in advance, ensuring the successful establishment of the date plantation. Planning forms part of the initial preparation and will help to limiting unnecessary stoppages during the implementation phase.

The critical factors to consider during this planning exercise are summarized as follows:

- Availability and quality of irrigation water;
- Field selection;
- Mechanical actions to be implemented;
- Chemical needs for pre-plant soil improvement;
- Tools and equipment needed for date cultivation;
- Labour needs;
- Irrigation design and installation;
- Leaching schedule;
- Hole preparation;
- Financial requirements and
- Time schedule.

1. Field selection

The area selected for the establishment of the date plantation can influence the cost of land preparation to the extent that it may not be viable to proceed with the development at all. I, need to highlight the critical areas to be considered when selecting the land for the establishment of a new date plantation.

Availability of water

Although not always realized, the date palm requires a rather large quantity of water for sustainable growth. Critical factors regarding water for irrigation purposes are:
(i) the sustainability of the water source,
(ii) the quantity of water available for irrigation,
(iii) the distance to the field, and
(iv) the quality of the water.

**Soil depth:**

In time date palms grow very tall and become top heavy especially during the fruit bearing stage. They therefore need sufficient room for proper root development to support the palms. Besides the importance of root development, soil depth also influences drainage and leaching possibilities. Any obstructive layers must be evaluated to determine whether they will influence root development and whether they can be corrected.

**Soil quality:**

Date palms can grow and produce in different types of soil in both hot arid and semi-arid regions. Adaptation could go from a very sandy to a heavy clay soil. The soil quality is related to its drainage capacity mainly when soils are salty or the irrigation water is characterized with a high salt content. Sandy soils are common in most date plantations of the old world. Rare cases of clay soils (i.e. Basra-Iraq) with drainage systems are found allowing the culture of date palms. The optimum soil conditions are found where water can penetrate to at least 2 m deep.

When evaluating the soil quality, attention must be given to:

(i) the soil texture which will influence the water retention capacity, and
(ii) the nutrient content to determine the corrective measures necessary for soil improvement.

**Soil salinity or acidity**

Plant growth is influenced by either saline or acid soil conditions which, in the end, will result in a loss of potential yield.

Saline and alkaline soils are common in date plantations and are characterized by a high concentration of soluble salts, and exchangeable sodium, respectively. Soluble salts present in these soils belong to cations: sodium, calcium and magnesium and to chloride and sulphate anions.

Saline soils have an electric conductivity (EC) of their saturated extract higher than 4 mmhos/cm at 25°C, with a sodium absorption rate less than 15 and a pH generally less than 8.5. Saline soils can be recognized by the presence of a white layer on the surface of
the soil resulting from the high salt concentration which may harm the growth and development of date palm.

Alkaline soils are characterized by an EC of their saturated extract less than 4 mmhos/cm at 25°C with a sodium absorption rate higher than 15, and a pH higher than 8.5. Alkaline soils do contain harmful quantities of alkalis with the hydroxyl group - OH, especially NaOH. These types of soil are usually difficult to correct coupled with a low production resulting from low content of calcium and nitrogen. However, it is recommended to eliminate the excess of sodium by the addition of acidifying agents (gypsum, sulphate of iron or elemental sulphur).

Saline and alkaline soils are usually the result of:

(i) An increase of the underground level caused by excessive drought situations (high evaporation);
(ii) The use of high salt content water, and
(iii) Very poor drainage system.

Where date palm grows in climates of little rain, but great heat and much evaporation, irrigation or flood water evaporates quickly, and its salts are left on the surface of the soil.

The negative influences of saline conditions are:

(i) High concentration of soluble salts;
(ii) High soil pH;
(iii) poor drainage and aeration; and
(iv) The negative effect of sodium on the plant metabolism.

According to so many scientists the date palm is more salt tolerant than any other fruit crop. It will survive in soils containing 3 % soluble salts; when this content goes above 6 %, the date palm will not grow. Also so many scientists reports the crop tolerance and leaching requirements of some important crops, including date palms (Table 39). It is clear from these results, that it is possible to irrigate date palms with water of a salinity of up to 3.5 mmhos/cm with no reduction in yield, provided that a leaching requirement of 7 % is provided for. A ten (10) % reduction in yield is obtained when irrigation water is of 5.3 mmhos/cm salt content and with a leaching requirement of 11 %.

Soil acidity contributes towards negative plant growth and is mainly due to:

(i) The toxic levels of certain elements (aluminium, manganese);
(ii) The deficiency of certain elements (calcium, magnesium, molybdenum);
(iii) The low availability of phosphorous; and
(iv) A drop in the efficiency of fertilizer and water usage because of poor root development.

**Physical land preparation**

Once a suitable area for establishing the plantation is selected and the planning operation is finalized, the actual preparation can be activated. These activities are divided to structure and pace the implementation process in order to be ready for planting at the most suitable time, according to the specific regional climatic conditions.

**Mechanical field preparation**

The mechanical or initial soil preparation concerns mainly the preparation of a field for further detailed preparation such as irrigation system installation, hole preparation, etc. Actions, if applicable to the area, include:

(i) debushing/bush clearing;
(ii) removal of stones and rocks;
(iii) ripping; and
(iv) leveling of the soil.

**Irrigation system installation**

The type of irrigation system to be used will be determined by the availability of water, topographical and soil conditions. When the initial soil preparation is completed, the installation of the required irrigation system will be implemented according to the site condition.

**Soil improvement**

The scheduling of the soil improvement programme will depend on the date grower, as certain applications could be combined with the initial actions of soil preparation. Due to the long waiting period, planting to first production, it is a trend to establish date plantations on new soils, with the exception of areas where date palm is used for intercropping.

If new soils are considered, the soil improvement programme will mostly deal with:

(i) The application of organic matter; and/or
(ii) The elimination of soil salinity.

**Organic material**

In general, most soils are poor in organic matter content and the improvement of this situation plays an important role in soil fertility. Some of the advantages of a higher humus content in the soil are summarized as follows:
* Enhances crumb formation which improves the respiration of the roots;
* Increases the water infiltration rate;
* Increases the water holding capacity;
* Reduces soil compaction and crust formation; and
* Limits the harmful effects of alkalinity and improves the leaching of salts.

**Salinity**

In an attempt to reclaim salt affected soil, consideration should be given to:

(i) The type of salinity/alkalinity,
(ii) The drainage possibilities of the soil profile,
(iii) The origin or the source of salts,
(iv) The quality of irrigation water and
(v) The leaching of salts from the soil.

If the source of salts is identified as drainage water from higher lying areas, a cut-off canal may be sufficient to eliminate this source of "salt" supply.

Poor drainage normally goes hand in hand with soil salinity problems and therefore the improvement of the drainage potential should be addressed before any leaching programme is implemented. A soil cover (mulching) and the application of organic material will improve the water infiltration resulting in improved drainage (excluding soils with obstructive layers).

In saline soils (soluble salts present as chlorides, sulphates and/or carbonates of calcium, sodium or magnesium), only leaching will be necessary to drain the excess salts. In the case of alkaline and/or saline-alkaline soils, sodium can be replaced through the application of gypsum or acidifying agents like elemental sulphur. Once the sodium has been replaced, a programme should be followed to leach it out. When the irrigation water is of poor quality, proper drainage and over irrigation, without the development of a water table, is very important.

**Hole or pit preparation**

The actual digging of the hole is one of the last actions before planting takes place, but it must be emphasized that this is not the final preparation for the planting operation itself. This is the point where the required inputs such as gypsum and organic materials are worked into the soil and a start is made with the leaching programme. The reason why the leaching is only applied at this stage is because of the relatively small area that is occupied by the date palm. If the total area had to be leached, it would become very costly with little or no benefit in the long run.

It is recommended that a hole of 1 m³ be prepared and that the soil from the hole be mixed with the organic material and gypsum or elemental sulphur. The soil mix is then put back into the hole, where after the site is clearly marked for positioning of the small
date palm plants. At this stage, once the hole has been prepared and closed, it is irrigated and a leaching programme implemented. The water supply will then enhance the leaching of excessive salts and contribute to the fermentation process of the organic material. Subsequent irrigation, several times (2 to 3) before planting, will also allow the mixed soil to settle in the hole. In most soils, the early and rapid growth of the date plant is better when the holes are prepared one to two months before planting. Well-rotted manure can also be used in holes prepared and irrigated shortly before planting, but extreme care must be taken to put the manure (and fertilizers) deep enough to allow a layer of soil at least 15 to 20 cm thick to be placed between the manure and the roots of the date plant.

**Planting operation**

This is probably the most critical phase in the establishment of a new date plantation. Mistakes at this point may lead to a poor survival rate of offshoots or tissue culture-derived plants, regardless of the efforts put in during the preparation phases. The aim is to assist the date grower to execute the planting operation in a way that will ensure a high transplanting survival rate in the newly established plantation. The planting operation is divided into different activities which will be discussed separately.

**Plant spacing**

It is difficult to prescribe a definite plant spacing but there are specific factors influencing the spacing such as:

* to allow for sufficient sunlight when palms are tall;
* to allow for sufficient working space within the plantation; and
* to provide sufficient space for root development.

Previously, the general assumption for a commercial date plantation was to use a plant spacing of 10 m × 10 m (100 palms/ha). It has, however, changed over time and a plant spacing of 9 m × 9 m (121 palms/ha; Israel) or 10 m × 8 m (125 palms/ha; Namibia), is used in modern plantations.

As an example of different spacing used with date palm, Table 40 illustrates the distance apart, the square unit to each palm and the number of palms in each spacing.
TABLE 15

Comparative table of spacing distances (Palms planted at the corners of squares)

<table>
<thead>
<tr>
<th>Distance Apart (m)</th>
<th>Square Units to each palm (m)</th>
<th>No of Palms in Each (Hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.06</td>
<td>101</td>
<td>100</td>
</tr>
<tr>
<td>9.14</td>
<td>84</td>
<td>119</td>
</tr>
<tr>
<td>8.83</td>
<td>78</td>
<td>129</td>
</tr>
<tr>
<td>8.53</td>
<td>73</td>
<td>137</td>
</tr>
<tr>
<td>8.23</td>
<td>68</td>
<td>148</td>
</tr>
<tr>
<td>7.92</td>
<td>63</td>
<td>159</td>
</tr>
<tr>
<td>7.62</td>
<td>58</td>
<td>172</td>
</tr>
<tr>
<td>7.32</td>
<td>54</td>
<td>185</td>
</tr>
<tr>
<td>7.01</td>
<td>49</td>
<td>204</td>
</tr>
<tr>
<td>6.71</td>
<td>45</td>
<td>222</td>
</tr>
<tr>
<td>6.40</td>
<td>41</td>
<td>244</td>
</tr>
<tr>
<td>6.10</td>
<td>37</td>
<td>270</td>
</tr>
<tr>
<td>5.79</td>
<td>34</td>
<td>294</td>
</tr>
<tr>
<td>5.49</td>
<td>30</td>
<td>333</td>
</tr>
</tbody>
</table>

Source: Dowson, 1982.

The planting density also depends on ecological factors (mainly humidity) and on varieties. In general, commercial plantations use 10 m × 10 m, 9 m × 9 m or 10 m × 8 m, for all varieties except for Khadrawy (dwarf variety with a small canopy) which could be planted at a higher density. The tendency to plant more closely is found when the prevailing wind is dry and extremely hot and strong. The 10 × 10 is desired in areas where humidity during the date ripening period (Coachella valley-USA, Elche-Spain and Coast of Libya (Zliten)) is high (Dowson, 1982); This wider spacing is to allow sun and wind to counteract the humidity's influence. According to Nixon (1933), wide spacing is also recommended whenever there is considerable danger of rain damage to dates during the ripening season. Accordingly, I, recommend using 7x7m, because the Barhee cultivar has the longest frond than other recommended cultivars which reach 7 meters long. There for the calculation or the estimation will be 204 palm/hectare.

Time of planting

The critical factor is to transplant the young tissue culture date palms or offshoots at that time of the year that will ensure a good survival rate and proper establishment before the beginning of a "hard" season. Because of the following reasons:
* Very high summer temperatures,
* Strong, dry winds during August-January, and
* Sand storms during the summer.

**Planting time and depth**

Planting should always be initiated early in the morning to limit stress on the date plantlets and also to allow sufficient time for adaptation (from the plastic bag to the soil). Bags are to be removed with care and the plant, with most of its surrounding substrate, to be planted carefully. Planting is probably the area where most people make the vital mistake of planting the plant too deep. If a date plant is planted too shallow, its roots will desiccate and die.

The golden rule is to ensure that the greater diameter of the bulb of the plant is at the same level as the soil surface after transplanting and to ensure that water does not go over the top of the date plant.

**Basin preparation**

Immediately after transplanting, a basin is prepared around the palm to prevent run-off and to ensure a sufficient supply of water to the plant. When using a micro irrigation system, it is recommended to have a basin of approximately 3 m in diameter and 20 to 30 cm deep. The basin should have a slight downward slope towards the plant to allow the water to reach the root system of the young plant.

**Irrigation**

Immediately after transplanting, the palm should be irrigated to limit transplant stress. Once the plantation is established, a frequent irrigation schedule is to be followed to allow sufficient water supply to the young date palm.

The irrigation frequency is soil type dependant, but on very sandy soils it requires daily irrigation during the first summer. Heavy soils will require irrigation once a week, while in most soils, irrigation is required every second or third day. During the first six weeks, the date growers should inspect their planted date palms to verify that the surface soil does not dry and shrink away from the plant.
Table 16

Measured Irrigation Requirements per date palm tree

<table>
<thead>
<tr>
<th>Age of tree in year</th>
<th>Water consumption litres/day/tree</th>
<th>Water consumption in m³/tree/year</th>
<th>Water consumption in m³/ha 1/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flood Bubbler</td>
<td>Flood Bubbler</td>
<td>Flood Bubbler</td>
</tr>
<tr>
<td>1</td>
<td>70 50</td>
<td>26 18</td>
<td>3992 2852</td>
</tr>
<tr>
<td>2</td>
<td>100 70</td>
<td>37 26</td>
<td>5703 3992</td>
</tr>
<tr>
<td>3</td>
<td>150 105</td>
<td>55 38</td>
<td>8555 5988</td>
</tr>
<tr>
<td>4</td>
<td>200 140</td>
<td>73 51</td>
<td>11406 7984</td>
</tr>
<tr>
<td>5</td>
<td>250 180</td>
<td>91 66</td>
<td>14258 10266</td>
</tr>
<tr>
<td>6</td>
<td>275 193</td>
<td>100 70</td>
<td>15684 11007</td>
</tr>
<tr>
<td>7</td>
<td>300 210</td>
<td>110 77</td>
<td>17109 11977</td>
</tr>
<tr>
<td>8</td>
<td>340 238</td>
<td>124 87</td>
<td>19391 13573</td>
</tr>
<tr>
<td>9</td>
<td>375 263</td>
<td>137 96</td>
<td>21387 14999</td>
</tr>
<tr>
<td>10</td>
<td>410 287</td>
<td>150 105</td>
<td>23383 16368</td>
</tr>
</tbody>
</table>

* Calculated figures assuming tree spacing of 8 m x 8 m

**Source: Salih A. A. and Dawoud H. D., ARC Annual Report 2000 and Personal communication.

This study of Water use by date trees has been measured on a commercial farm in River Nile State in Sudan, situated on high terrace soils (Table ). (the plantation of 43,314 trees covers 315 ha.) Ten year old date palms under bubbler irrigation used 105 m³/year and under flood irrigation 150 m³/year. Access tubes and neutron probes were used to minimize deep percolation so these measurements closely approximate the consumptive use or crop water requirements of the trees. Between the rows of trees the soil was kept completely weed free. The treatment called “flood irrigation” was actually circular basins and the whole soil surface was not wetted. If contiguous basins were used and the trees were under-cropped with fodder or citrus the consumptive use would increase. With an ETo of around 3,000 mm per year, the use of 23,338 m³/year approximates to a crop factor Kc of about 0.8 so a crop factor for permanent crops of 0.9 to 0.95 seems reasonable.
**Factors influencing water requirements**

It is necessary to take certain aspects into consideration in order to calculate the volume of water required by a palm. The following aspects play a major role in this calculation:

a. Soil salinity: If the soil is saline, more water must be given to enable a leaching process for clearing the salt from the soil.

b. Temperature: The higher the temperature, the higher the rate of evaporation and the more water the plant needs.

c. Humidity: The lower the humidity level, the more water needed.

d. Wind (speed and occurrence): Higher constant wind speeds cause higher evaporation and thus higher water demands.

e. Cloud cover: More water is required during periods of less cloud cover.

It is worth mentioning that all above factors influence evapotranspiration, which strongly determines the water requirements.

**Different irrigation methods**

The following methods are of importance method of irrigation and each has its own advantages and disadvantages:

1- Flood irrigation

This irrigation method is the oldest method known, and is also the method most widely used in date palm culture. It has, however, advantages as well as disadvantages which are outlined below:

i. Advantages:

(1) Running costs are low;
(2) Easy to apply; and
(3) Initial costs are low if the area is fairly flat.

ii. Disadvantages:

(1) Difficult to achieve a high efficiency rate;
(2) Labor intensive;
(3) Irrigates areas in between where no palms are planted; and
(4) Not well suited for sandy soils.

2. Furrow and basin irrigation
It is basically a redesign of flood irrigation to eliminate some of the disadvantages listed above and thus make it more efficient.

i. Advantages:

(1) Running costs are low;
(2) Easy to apply; and
(3) Initial costs are low if the area is fairly flat,

ii. Disadvantages:

(1) Labour intensive; and
(2) Interferes with mechanical operations.

3- Sprinkler irrigation

This is the oldest modern irrigation method and was introduced to enhance efficiency and to enable automation.

i. Advantages:

(1) More efficient use of water is possible;
(2) Easy to schedule - manage;
(3) Less labor is needed; and
(4) Topography is not a limitation.

ii. Disadvantages:

(1) Expensive (installation);
(2) Running costs are high;
(3) Heavily influenced by wind and temperature (spray pattern and evaporation);
(4) Not well suited for small palms because water can enter from above into the growth point of the palm.

4- Micro irrigation

This method was more recently introduced and was developed in South Africa to irrigate mine dumps to prevent the wind from blowing the sand away. It was then adapted for irrigation of trees and other crops.

i. Advantages:

(1) More efficient use of water is possible;
(2) Running costs are lower than sprinkler irrigation (lower pressure needed);

(3) Easy to schedule - manage;

(4) Only areas that need water are irrigated;

(5) Topography is not a limitation;

(6) It is easy to automate;

(7) It is not labor intensive; and

(8) Several spray patterns are available to suit date palms (e.g. gaps in the spray pattern so as not to wet the growth point or the trunk of the palm.)

ii. Disadvantages:

(1) Installation costs are high;
(2) Needs clean water; and
(3) Influenced by wind and temperature (spray pattern and evaporation).

5- Drip irrigation

This is the latest irrigation method introduced and was developed in Israel where there is scarcity of water.

i. Advantages:

(1) More efficient use of water;
(2) Running costs are low;
(3) Easy to schedule/manage;
(4) Topography is not a limitation;
(5) Only the water needed by the palm is applied;
(6) Not influenced by wind;
(7) Easy to automate; and
(8) Not labor intensive.

ii. Disadvantages:

(1) Expensive (Installation);

(2) Requires very clean water; and

(3) Sometimes difficult to determine if the correct amount of water has been applied by the system, and when it becomes clear that it is too little, it may be too late.
Accordingly, in Somaliland I, recommend to use the conventional method of irrigation (except in the areas suffering from water deficit) but with minor modification as shown in the figure.

![Figure (37) Conventional method of irrigation](image)

**Protection**

Tissue culture-derived plants and young offshoots should be protected from harsh climatic conditions (sun and wind during the first summer and cold the following winter) and against some animals (rabbits, etc.). The use of a jute sacks wrapping, a shade net cover, or a tent of date leaves is recommended. The top is to be left open so that new growth may push out.

![Figure (38) sacks wrapping](image)

**Fertilization:**
In general, farmers do not realize the importance of following a date palm fertilization programme. This behavior is normally caused by one or more of the following factors:

1- Information, regarding date palm fertilization requirements, is not readily available.

2- Information may confuse farmers, because of the differences between literature/studies conducted by various scientists.

3- Farmers tend to assume that date palms do not require any nutrients, because of the general view that date palms can survive the toughest conditions.

The importance of a fertilization programme at and after transplanting is to provide in the nutrient needs of the young tissue culture plants or the offshoots, to ensure rapid growth in preparation for the first production season. An under-developed plant will not have the capacity to reach its production potential at an early stage.

The fertilizer programme starts in second year. Add 100 g urea in split doses of 50 g in March and October. Add 10 kg manure/tree in late June.

Third year: 200 g urea (split) + 15 kg manure/tree.

Fourth year: 400 g urea (split) + 20 kg manure/tree.

Fifth year: Beginning of fruiting adds 600 g urea +30 kg manure.

Sixth year on: Add 800 g urea, split between the flowering stage (February – April) and fruiting development stage (June – September).

For many reasons, it is recommended that organic manure be added as compost at a rate of 25 -100 kg per year per palm, according to the age of the plant.

**Organic fertilization strategies:**

In organic cultivation fertilization strategies are based on green manure and compost. This strategy doesn’t differ much from the traditional way of fertilizing date Palms. Animal manure was applied by digging a trench around the tree in order to bury the animal manure. Nitrogen was provided by intercropping of alfalfa (and other appropriate leguminous plants). Organic cultivation systems requires for a sufficient supply with composted organic materials (animal manure with other organic materials like straw and other organic waste material) on a regular basis. At least, every 4 years compost should be added to the date palm. For that reason the compost must be brought into the soil around the stem. Regular application of organic materials improves the water holding capacity and therefore the efficiency of irrigation.

**Pruning:**
In October, remove old leaves by shearing and make sure that leaf bases are removed close to trunk to prevent harboring of insects. Remove crowded offshoots leaving only a few ones for propagation.

Figure (39) Leaving only a few offshoots for propagation.

Pollination

*The very old and primitive pollination technique consisted of placing an entire male spathe in the crown of the female palm and leaving in the rest to wind pollination.

*The male / female ratio in modern plantation is 1/ 50 (2%).

Figure (40) Male spathe or male inflorescence
Pollination techniques: (by one of these methods)

* Dried pollen: this pollination technique is more economical and allows proper use of the pollen can apply by two different methods.

* Fresh male strands (Need special technique)

* Cotton pieces

* Mechanical pollination.

According to so many Experiments here in Sudan Date Palm mechanical pollination (from ground level) 3-4 times during the season using (1: 9) pollen / filler ratio increased the total yield and give excellent quality of M. W.Laggai, M. W Khatiab and Barhee date, under different condition .
Generally, under Sudanese condition, a ground level duster (two laborers) are capable to pollinate 200 palms within 6 hours, the device is to spray the whole female leaf canopy, just above the opened spathes per season every 4 – 7 days intervals increases the total yield and gives excellent quality of Barhee dates, under different condition.

**Pollination time**

To obtain high yield with excellent quality, pollination must be achieved within one to three days from female spathe cracking delaying pollination after sixth, ninth and twelfth days from female spathe cracking reduced by reducing the yield to about 25-50%.

During the pollination practices, date growers must be aware of:-

* Metazenia (Male female compatibility)

Metazenia, can be defined as the effect of pollen grains on date palm fruit quality, yield and maturity period. Compatibility is related with the fruit set percent after pollination and its genetic characteristics.

**Fruit Thinning Techniques**

Fruit thinning is commonly practiced in most date growing regions of the world in order to get the following improvements:-

* To avoid the alternancy phenomenon and to ensure adequate flowering for the next season

* To improve fruit size and texture which reflects in the price

* Ensure an early ripening.

Date fruit thinning may be realized at three levels
Reducing the number of bunching per palm

The mature palm of the most cultivars may bear 20-25 bunch / year, always we recommend removing the early and latest bunches and leave 15 –18 bunches / palm to obtain more uniform bunch sizes.

Reducing the number of strands per bunch

Mostly from the central part of the bunch (cut-off about 15 – 20 % from central strands)

Reducing the number of fruits per strands by:

Cut back ¼ the strand length

Removal of 50% of the fruit alternating from the strands.

The thinning practices recommendation for Somaliland date growers:-

*Cut back ¼ the strands length before pollination at the spathe opening

3-4 weeks later remove 25% or cut off ¼ the central strands

For thinning techniques I suggest more experimental work under Somaliland different condition.

Bagging female spadices

After pollination, immediately the recommendation is to cover the spathe by brown papery bags 40 × 60 cm² warped around the bunch and tied to the fruit stalk for four weeks was found to result in a significant increase in fruit set, yield and fruit dimensions Furthermore, growth of the pollinated carpels in the bagging treatment was faster that with the un bagged one .improved fruit set obtained on bagged inflorescences might not always be attributable to improved temperature conditions; it probably delays drying of the styles and permits the normal progress of the pollen tube into the ovule even at relatively low temperatures.
Bunch bending

At the sixth week from the pollination, all the bunches are pulled downwards through the leaves gently enough not to break any of the strands and the bunch fruit stalk is tied for support to the middle of one of the lower leaves to avoid breaking, this makes the bunch easily accessible for thinning, bagging and pesticide application.

With young palms, bunches are held off the ground by attaching the fruit stalk to one end of the wooden stack (with a fork shape called pole).
Bunch Cover

In various date growing areas (USA, Algeria, Tunisia, etc. in the northern hemisphere; and in Namibia, RSA in the southern hemisphere), rain could coincide with the ripening season and consequently causes severe loss of fruit. A sturdy light-brown craft-paper is used in the USA to cover and provide good protection of the bunch during the ripening season.

Protection is applied to the bunches in late kimri stage. Paper covers, wrapped around the bunch and tied to the fruits talk, could be used in combination with a pesticide programme because the lower part of the bunch is not covered. Covering bunches too early may lead to the sun burning of the outer young fruits, once the cover is removed.

With varieties such as Khadrawy and Hallawy having a relatively open crown, white paper covers have been found to cause less sunburn than brown paper covers. Medjool bunches are usually protected with a lightweight white cotton bag of which the upper portion is water-proof. Plastic bags are to be avoided because of sunburn and heat damage to the fruit as well as build up for humidity.

Wet weather resulting from very high humidity and/or from rain will produce various levels of damage depending on the fruit ripening stage:
Immediately before the Khalal stage, minute superficial breaks, or checks in the fruit skin occur. The abundance of these checks and their types (transverse, longitudinal or irregular) vary in different varieties. When the checking is severe it is usually followed by a darkening and shriveling of the tip (black nose).

At the Khalal colour (yellow to red), checking no longer occurs and water will produce deeper and longer breaks or cracks (splitting phenomenon) in the skin and flesh beneath. Furthermore, humid weather during the Khalal stage also favours the attack by various fungi causing serious spoilage from rot.

At the Rutab stage, moisture no longer causes skin breakage, but the fruit absorbs moisture and becomes sticky, less attractive and more difficult to handle. High moisture content of the fruit will result in fermentation and souring that often results in heavy losses.

**Figure (46) Paper covers, wrapped around the bunch at rainy areas**

At the Tamar stage, high humidity and rain cause little damage to the fruit except when it is neglected. The timing of bunch protection from rain is usually when the fruit starts to acquire its Khalal colour. An early covering will increase checking and black nose because it reduces ventilation within the bunch. Although, the fruits escape damage by actual wetting, damage by excessive humidity increases.

**Protection from birds**

Birds of various species cause severe damage by eating on the fruit during the Rutab and Tamar stage. Parrots, besides eating the fruits while on the bunches (mostly at the Khalal stage), kick the fruit off the bunches with their legs, resulting in the loss of date fruits that fall to the ground.
Bird attacks are common in Sudan, Sahel countries and also in the southern hemisphere (Namibia, Republic of South Africa, for example). The most common birds causing damage to date fruit in Namibia and RSA are the Redbilled Quelea (*Quelea quelea*), Redheaded Finch (*Amadina erythrocephala*), Lesser Blue-Eared Starling (*Lamprotornis chloropterus*), and the Redeyed Bulbul (*Pycnonotus nigricans*). The Grey Lourie (*Corythaizoides concolor*), Rupell's Parrot (*Poicephalus rueppellii*), and the Rosyfaced Lovebird (*Agapornis roseicollis*).

When there is danger of severe bird or/and parrot damage, it is advised to initiate a bird control system. With the paper bags, the bunch should also be protected beneath with a good grade of porous cloth or netting that will exclude birds and insects, but at the same time not interfere seriously with ventilation of the fruit.

The importance of ventilation increases during the later stages of fruit growth and ripening as well as with the frequency of showers and periods of high humidity. If such conditions occur, it is advised to use a cover flared out and not extending down around the sides of the bunch. The thinning of central-strands of a bunch will promote better aeration of fruits. Rings or spreaders 15 to 30 cm in diameter, made usually of heavy wire, could be inserted in the centers to keep the bunches open as the fruit becomes full sized. Such accessory is mainly recommended with short-strands varieties, bearing fairly soft fruits. Those of a many-pointed star shape (or corrugated wire) remain in place better than circular ones and they must be inserted before the fruit reaches the Khalal stage.

**Protection from insects**

The bags retain the fruit and provide some protection from birds, but they do not hinder fruit-infesting insects. Unless only Khalal fruit is harvested, insects may damage more than 50 % of the Rutab fruit. Stored dates from such palms will show large infestation by living and dead insects.

*Figure (47) Jute covers wrapped around the bunch at the desert and dusty areas*
Physical exclusion of most insects by use of screen bags is a practical measure used in various localities in the Middle East. Moths and other insects larger than fruit beetles (Nitidulidae) are excluded. The bags are of flexible $18 \times 20$ mesh wire or shade net (80 % is recommended) and are 1.0 to 1.5 m$^2$, depending on the bunch size to be covered. It is closely tied to the fruits talk to ensure that rain water will not enter and also to prevent it from being blown away by wind. The best timing of its placement is mid-to-late chimri stage.

The date grower is advised to conduct proper insect control in the field, followed by prompt fumigation of fruits immediately after harvest. Packing house sanitation is closely related to field insect control. The packing facility should be insect-free to prevent re-infestation of fumigated fruit by "Dried fruit-infesting insects", flies, roaches and other pests.

Furthermore, the bags eliminate the need for pesticides on fruit and thus maintain biological control of Parlatoria scale and other insects.

**Leaf Pruning**

Is a desirable practice in order to improve date fruit quality and also enhance bearing capacity.

Removing the leaves up to about the point where the lower ends of most fruit bunches are exposed is highly recommended for adult full bearing palms.
The pruning advice for all the recommended cultivars to leave 10 leaves per bunch was most suitable treatment to obtain a high yield with good quality fruits.

**Dethorning:**

Another important pruning process is the removal of spines, also called thorns. It is advantageous to annually remove spines from the base of new leaves in order to facilitate pollination and handling of fruit bunches. Cut thorns themselves are a source of some danger, because they lodge in leaf bases on the soil where they persist as a hazard.

Date spines are usually removed from the new growth of fronds in the crown of the palm just before the pollination season to allow easy access to the date spathe as they emerge. If the palms have been dethorned the previous year, the new growth will be 2 or 3 rounds of fronds, each round developing 13 new leaves, a total of about 26 to 36 fronds to be dethroned. Such an operation will ensure a safe approach to the spathe for their pollination and also avoid any risk of injury to labourers during other technical practices (tying down, protection of bunches, harvesting, etc.)

It is common to use dethroning knives of various designs to remove these spines: a long sharp curved blade or pruning knife mounted on a wooden handle 30 to 45 cm long, or a sickle type blade with a sharp cutting edge

**Harvesting**

The colour of the dates indicates the right harvesting time. At the “Khalal” stage Dates are partially-ripe showing a yellow or red colour (depends on the variety). At this stage some dates are already harvested in spite of the fact that the moisture and tannin content is still very high. Most of the dates are harvested at the fully-ripe stage showing a colour. Furthermore, the sugar content is higher and/or moisture and tannin content is lower.

Harvesting is labor intensive as dates are handpicked. In intensive date Plantations cranes are used to lift up the workers. However, in most of the cases workers have to climb up the date palm in order to reach the fruit bunches. Preparation, transport and storage. After harvesting dates are sorted, washed in drinking water, air dried (45°C), again sorted and packed. Sorting of dates is done manually. While sorting workers can remove dates with any indication of infestation as well as other particles and Fruit Harvesting, Sorting, Washing, Drying, Sorting, Packing, Storage Air-drying should result with moisture content of 20% or below in order to prevent Incidence of molds and yeasts. Storage of dates depends on anticipated duration of Storage as well as on the variety of dates. The optimum storage temperature is 0°C which allows for a storage period of 6 up to 12 months. Semi-soft dates like Deglet Noor and Hallawy have a longer storage life than soft dates like Medjool and Barhi.

For longer storage durations it is possible to freeze the dates (-18°C). In case dates are stored for a short time temperature shall be below 13°C (prevent insects to cause feeding
damages and reproduction) and/or below 5°C (control of new insect Infestation). The humidity in storage rooms shall range between 70% and 75%. High moisture in combination with higher temperature levels increase enzymatic as well as non-enzymatic browning of dates. Dates with insect infestation have to be treated in order to maintain export quality.

Unlike conventional dates the use of methyl bromide and other chemical storage Pesticides is not allowed within management system for organic food. Alternatively, Disinfestations with 100% carbon dioxide for 1-2 days is recommended.

**Harvesting Conditions for the recommended cultivars**

**Soft type**

This type is a soft and delicate large fruit size with skin requiring careful treatment. The Harvest recommendation for this type is:-

Picking the fruits one by one at the beginning of ripening process at the stage of the transition from Khala to Rutab, the fruits which has variation on the palm will become too soft. Harvesting the bunches when reach Rutab stage, i.e. every bunch is harvested according to its state of ripeness after removing the ripped fruits from the bunch by shaking gently the bunch on a platform, the fruits are placed in shallow trays in a single layer.

**Semi dry type**

**Harvesting of the fruits on bunches:-**

The bunches are harvested when the most of the fruits are in the stage of Rutab, before they become Tamor with a few Khalal i.e. the fruit must be soft with a potential shelf life of several weeks. The bunches are removed carefully and placed in containers or in a net to protect them from pests or birds.

Harvesting is carried out in 3 – 5 rounds and intervals of 5 -7 days until all bunches have been cut of the palms.

**Barhee – (Exportable Variety)**

This variety is harvested and consumed at unripe yellow stage (Khalal) and internationally marketed on strands in card boxes, this way of marketing and consumption requires harvesting of the bunches in the stage of Khalal before it turns into Rutab. The harvesting of the bunch is carried out with special knifes, the heavy bunches (approximately 25kg) are carefully lowered to the ground and placed on clean platform or hung on special hanger.
**Harvesting loose fruits to be sold unattached – at Tamor stage**

The fruits in this method must subject to hydration treatment, usually it remain on the palm until all the fruits are at the same stage of ripeness and dryness. This method is recommended only under dry areas at the harvesting period for the semi dry cultivars. eg Mishrig Wad Laggia cultivar

**Field Sorting of Fruits**

The harvested fruits are transferred into containers (large plastic bins) for transport to the packing station, large wooden, plastic or cardboard cases of various sizes are also used, focusing on the need to prevent damage to the fruit especially to soft and sensitive fruits.

![Field cleaning, washing, grading and sorting](image)

**Figure (49) Field cleaning, washing, grading and sorting**

**Packing Recommendations according to the International Specifications**

After Sorting, grading, fumigation, washing, hydration and dehydration practices, the fruits are usually packed in cardboard boxes (some time in plastic boxes for additional protection and preservation of moisture, before being placed in the boxes) The usual weight is 5 kg.

The packing is done manually and much time is invested in arranging the dates in the boxes, the fruits are usually covered with glucose (Natural) to give it a shine appearance.

![Packing in cardboard boxes](image)

**Figure (50) Packing in cardboard boxes**
The date palm products and by products

Here only the products and by products made from the fruit itself are mentioned, other parts of the palm such as the trunk, the leaves and the male pollen are also used in various ways. The raw material used for the products usually consists of dates of lower quality with a low percentage of sugar, good quality fruits also may be used when a surplus of fruit is on the market.

Pitted pressed dates:

This is a very useful basic product both in producing and in importing countries (European countries, the USA and South Africa). The dates are pitted by hand or by machine, pressed into a mould and vacuum packed. Packing in this way and with the right amount of moisture (less than 20 %) preserves the stability of the product over time without refrigeration. If these rules are not adhered to, the product may be harmed by microbiological processes or through sugar crystallization. This product is used mainly as a filling for cakes and biscuits, especially during the Muslim Feast of Holy Ramadan.

Date paste: In order to preserve the stability of the products over time and prevent their going bad, specific rules must be followed during the date paste production stage. Brix must not be less than 65° and the acidity must not rise above pH 4.5. In this case the paste can remain in its natural state (without the need for preservatives). If the above conditions do not exist, the product must be pasteurized or sterilized. These pastes can be used as fillings for cakes (with the addition of various flavors, as required). The great advantage of these pastes is that their melting temperature is higher than that used in baking, so that the filling does not run out of the cake during baking.

Date syrup (sometimes called dibs or rub): Five production stages are involved: pretreatment, extraction of juice, clarification, concentration and filtration. The rules
with regard to brix and sourness must be strictly kept. The syrup is used to sweeten various foods.

Date products resulting from intensive processing: Sauces for steak or chutney: The dates serve as a source of sugar and to form the body of the sauce.

Other types of products are extruded date pieces or diced dates. The dates are pressed through holes of 5 - 12 mm; the product is covered with dextrose or oat flour in order to prevent the little pieces from sticking to each other.

Alcohol: Alcoholic drinks can be produced by the fermentation of the dates.

Table 1:17

Yield estimation at Rutab stage of the recommended date palm cultivars

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>*Years (Yield in Kg / palm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1-Deglet noor</td>
<td>-</td>
</tr>
<tr>
<td>2-Medjool or Meghool</td>
<td>-</td>
</tr>
<tr>
<td>3- Barhree</td>
<td>--</td>
</tr>
<tr>
<td>4-Hayani</td>
<td>-</td>
</tr>
<tr>
<td>5- Khalass</td>
<td>-</td>
</tr>
<tr>
<td>6- Sukkary,</td>
<td>-</td>
</tr>
<tr>
<td>7- Khenezi,</td>
<td>-</td>
</tr>
<tr>
<td>8-Anbara</td>
<td>-</td>
</tr>
<tr>
<td>9- Rziz</td>
<td>-</td>
</tr>
<tr>
<td>10-Nabt Saif</td>
<td>-</td>
</tr>
<tr>
<td>11- Khadrawi</td>
<td>-</td>
</tr>
<tr>
<td>12-Sultana</td>
<td>-</td>
</tr>
<tr>
<td>13- Mishrig Wad Laggia</td>
<td>--</td>
</tr>
<tr>
<td>Average yield</td>
<td>-</td>
</tr>
</tbody>
</table>

* Estimated yield of new varieties of date palm compared with Mishrig Wad Laggia under West Omdurman condition- Dawoud H.D., ARC. Horticultural annual report of 2012
Table 18: Establishment costs per hectare for a modern date palm plantation (US dollars)

<table>
<thead>
<tr>
<th>Cost items</th>
<th>Cost in US dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Land Preparation- Hectare</td>
<td></td>
</tr>
<tr>
<td>*Cleaning and levelling</td>
<td>Cleaning of hectare</td>
</tr>
<tr>
<td>**Hole preparation</td>
<td>3$ × 204 hole</td>
</tr>
<tr>
<td>***sweet sand + Fill in the hole</td>
<td>1 m$^3$ of sand (.05$ × 204) hole</td>
</tr>
<tr>
<td>Total</td>
<td>822.2</td>
</tr>
<tr>
<td>2. Water Supply</td>
<td></td>
</tr>
<tr>
<td>On land irrigation system (conventional)</td>
<td>Basins+Canals+Well+Pump machine)</td>
</tr>
<tr>
<td>Total</td>
<td>300$</td>
</tr>
<tr>
<td>3. Offshoots cost</td>
<td></td>
</tr>
<tr>
<td>All the tissue culture offshoots</td>
<td>30$x×204=$</td>
</tr>
<tr>
<td>The conventional offshoots</td>
<td>20$x×204=$</td>
</tr>
<tr>
<td>Total</td>
<td>10200$</td>
</tr>
<tr>
<td>4. Fertilizer</td>
<td></td>
</tr>
<tr>
<td>Chemical (Elemental Sulphur)</td>
<td>0.5$x×204$</td>
</tr>
<tr>
<td>Organic</td>
<td>0.3$x×204$</td>
</tr>
<tr>
<td>Total</td>
<td>163.2$</td>
</tr>
<tr>
<td>5. Hardening of Plants (Jute Sacks)</td>
<td>0.2$x×204$</td>
</tr>
<tr>
<td>Total</td>
<td>40.8$</td>
</tr>
<tr>
<td>Establishment cost</td>
<td>11526.2</td>
</tr>
</tbody>
</table>

* For the first year of establishment

Table 19: Operational costs for a small date plantation (1) hectare (US dollars)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Pre harvest Costs</td>
<td></td>
</tr>
<tr>
<td>Establishment cost</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>30</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>----------------------</td>
<td>----</td>
</tr>
<tr>
<td>Labour *</td>
<td></td>
</tr>
<tr>
<td>Mechanization</td>
<td>-</td>
</tr>
<tr>
<td>Protection</td>
<td>-</td>
</tr>
<tr>
<td>Bags : Plastic</td>
<td>-</td>
</tr>
<tr>
<td>Shade nets</td>
<td>-</td>
</tr>
<tr>
<td>Pesticide</td>
<td>30</td>
</tr>
<tr>
<td>Sub Total (1)</td>
<td>15</td>
</tr>
<tr>
<td>Harvest Costs</td>
<td></td>
</tr>
<tr>
<td>Labour **</td>
<td></td>
</tr>
<tr>
<td>Mechanization</td>
<td></td>
</tr>
<tr>
<td>Packing Costs</td>
<td></td>
</tr>
<tr>
<td>Packing Material</td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td></td>
</tr>
<tr>
<td>Sub Total (2)</td>
<td>175</td>
</tr>
<tr>
<td>Marketing Cost</td>
<td>30</td>
</tr>
<tr>
<td>Cold storage Cost</td>
<td>60</td>
</tr>
<tr>
<td>Transport</td>
<td>15</td>
</tr>
<tr>
<td>Sub Total (3)</td>
<td>105</td>
</tr>
<tr>
<td>Total (1) + (2) + (3)</td>
<td></td>
</tr>
</tbody>
</table>

Labor*:- include weeding, pruning, pollination, thinning and overhand maintenance

Labor**:- Include sorting, cleaning, packing and packing house maintenance

Water *** cost of irrigation water
Table 20: Additional capital expenses: Building and equipment of packing house

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Cost in US Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Packing house / Shed Structure</td>
<td>39,000</td>
</tr>
<tr>
<td>Packing room, cold room etc.</td>
<td>30,000</td>
</tr>
<tr>
<td><strong>Implements:</strong></td>
<td></td>
</tr>
<tr>
<td>Tractor and trailer</td>
<td>29,000</td>
</tr>
<tr>
<td>Pick up</td>
<td>23,000</td>
</tr>
<tr>
<td>Equipment</td>
<td>3,500</td>
</tr>
<tr>
<td>Tools</td>
<td>1,200</td>
</tr>
<tr>
<td>Plastic crates for harvesting</td>
<td>800</td>
</tr>
<tr>
<td>Grading sorting line / table</td>
<td>4,500</td>
</tr>
<tr>
<td>Electronic scale</td>
<td>570</td>
</tr>
<tr>
<td>Press for pitted dated</td>
<td>650</td>
</tr>
<tr>
<td>Vacuum packer</td>
<td>1,200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>133,420</strong></td>
</tr>
</tbody>
</table>

Training the FFS facilitators in the TOT training at Ammoud University

Introduction

The training at Ammoud University took place between 13-15/5/2012 in a form of training workshop.

Objective of the training

The main objective of these training workshops is to increase the skills of the trainees with different methods of Mango, Citrus and Date palm cultural practices techniques for more qualitative and quantitative fruit production.

Content of the training program

The main topics of the training session are:

I. Propagation:
➢ Fundamentals of fruit propagation Techniques.
➢ Science of propagation
➢ Art of propagation
➢ Experience of propagation

II. Advantage & Disadvantage of Sexual (seed) & A sexual (vegetative) propagation

III. Tissue culture

IV. Mother plant
➢ Criteria for selection of mother plants
➢ Criteria for selection of rootstocks
➢ Dwarfing /semi-dwarfing in nature
➢ Protocols for propagation of different fruit crops

V. Mango propagation

VI. Raising of rootstocks

VII. Methods of propagation
VIII. Mono embryonic seeds (sexual Propagation)

IX. The compatibility between the rootstocks & scions

X. The advantages of different mango root stocks

XI. Softwood grafting

XII. Veneer grafting

XIII. Stone or epicotyls grafting

XIV. Care of nursery plants

XV. Plant Protection Measures

XVI. Standards for veneer grafting in mango

XVII. Standards of soft wood grafting in mango

XVIII. Poly embryonic seeds (A sexual Vegetative Propagation)

Different Methods of Vegetative Propagation
✓ Cuttings:
  - Soft or semi-hardwood cuttings
  - Hardwood cutting
  - Terminal cutting,
  - Mediate cutting
  - Basal cutting
  - Root cutting
  - Leaf cutting
  - Stem cutting

✓ Layering
  Healthy status of the Mango mother tree from nutrition, pests and disease point of view

✓ Rejuvenile practices for old and low quality mango trees by different methods of vegetative propagation

---

XIX. Citrus seedlings production

Preparation of scion {Criteria for selection of mother plants} (Bud wood)

XX. Age of the scion

XXI. Rootstock preparation {Criteria for selection of rootstocks}

XXII. Advantages of different root stocks
Raising of rootstocks
Age of the rootstock
Diameter of the rootstock
Standards of the planting material
Methods of propagation (Budding)
Height and condition of union
Scion/ rootstock diameter at the union
Webber selection
Care of nursery plants

XXIII. Plant Protection Measures

XXIV. Insect, Pests, Disease incidence (Fungal, Bacterial, Viral, etc.)

XXV. NURSERY PRACTICES TO RAISE DISEASE – FREE SEEDLINGS OF CITRUS

XXVI. Potting mixture:
✓ Soil solarization:
✓ Soil fumigation:
✓ Steam sterilization

XXVII. Selection of Root stock seeds

XXVIII. Role of rootstocks

XXIX. Rising of seedling in primary nursery

XXX. Transplanting of seedling in secondary nursery

XXXI. Selection of mother plants and bud wood

DIAGNOSIS OF VIRUS/VIRUS LIKE DISEASES

A. Serological diagnosis:
B. Bo-diagnosis:
C. Budding and maintenance of budding
D. Best time of budding of citrus in different part of country
E. Recommended rootstocks for different scions
F. Tips for raising disease- free nursery
G. Plant protection measures
Modernization of the conventional method of all cultural practices of fruit production

A. Planting method  
B. Fertilization  
C. Irrigation  
D. Pruning  
E. Harvesting

Training Methodology:

Training methods and tools used in the facilitation of each training sessions  

A. Brainstorming.  
B. PowerPoint presentation.  
C. Practical work in the nurseries to increase skills and knowledge in propagation techniques.

Need to promote professional and career development

Overall, there is a dire need to build and upgrade the technical capacity/knowledge of the personnel of the Horticulture Section at the Ministry of Agriculture, through training at graduate and post-graduate level. I can arrange for short-term training courses for one month at the Horticulture Research Center & Agricultural Research Corporation in Sudan. This training will focus on management, technical knowledge, skills of propagation, cultural practices and other technical knowledge of Mango, Citrus and date palm.

Moreover, a training on Plant Protection and Phytosanitary can be arranged as the ministry needs assistance in establishing and running of an effective Phytosanitary services. The ministry lacks the capacity to effectively introduce and carry out pest and disease control measures in the country. The citrus plantations in Somaliland, for example face extinction from wide spread of citrus canker and greening infestations. There is a new plantation of Date Palm offshoots at coastal area introduced from U.A.E and Saudi Arabia without any control measures. As we know the Red Palm Weevil *Rhynchophorus ferrugineus* has infected the entire Date palm plantation in Saudia Arabia and it is considered as an international quarantine pest.
I can also arrange with Plant Protection Department, Ministry of Agriculture Khartoum, Sudan, a short training course for 15 to 30 days at Khartoum Airport Phytosanitary section and other 15 days at Port Sudan Phytosanitary section.

**Update:** Contacts with both Horticulture Research Center & Agricultural Research Corporation and Plant Protection Department, Ministry of Agriculture Khartoum yielded their offering free training for one month for three trainees from Somaliland at each. Travel and accommodation costs to be covered by the trainees.
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