TECHNICAL COOPERATION

between
SOCIALIST ETHIOPIA
and
FEDERAL REPUBLIC OF GERMANY

HORTICULTURAL DEVELOPMENT PROGRAMME

VITICULTURE

Ethiopia - Federal Republic of Germany
Horticultural Development Project
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Germany Agency for Technical Co-operation
FINAL REPORT OF CONSULTANCY
ON VITICULTURE
IN ETHIOPIA
UNDER CONTRACT 77-2040.2 - 01 - 200
BETWEEN HDD/GTZ AND
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Davis
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1.0 Introduction


The basic objectives are to increase and diversify the food supply and supplement the present meagre diet. Processed food have been unavailable because of import restrictions, so an agro-industrial complex is about completed near Marti Jeju, which is centrally located in several thousand hectares of cleared semi arid land now brought under irrigation. Processing of tomatoes and citrus began in the fall of 1983. The expected benefits are already apparent in the increase in gainful employment and better living standards of the local population. The exports to foreign countries are expected to provide a more favorable trade balance. In view of the successful development of grape culture in several tropical countries including Ethiopia, the expansion of vineyards was also included as a promising branch of horticultural development.

The extension of grape production into the semi arid regions opens up new opportunities. Fruit ripening and harvest can be programmed for any time of the year by altering the time of pruning and the frequency and amount of irrigation. Fresh fruit can be produced to satisfy market needs, especially for out-of-season supply of the large markets in temperate zones. The grape is a fruit producing a large number of processed products. The growth cycle is reduced from 12 to 4 to 8 months, resulting in greater production.

However, successful viticulture in tropical countries is highly dependent on the choice of variety and special cultural practices unique to the tropics. Management and trained personnel familiar with such practices are essential to success.
1. Location of vineyard areas visited (see map).

<table>
<thead>
<tr>
<th>Map No.</th>
<th>Area</th>
<th>From Addis Ababa</th>
<th>Elevation m</th>
<th>Annual Rainfall mm</th>
<th>Nearest Climatic Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Guder</td>
<td>137 km W</td>
<td>1900-2000</td>
<td>750-800</td>
<td>Ambo, Chart 1</td>
</tr>
<tr>
<td>2</td>
<td>Dukem</td>
<td>35 km SE</td>
<td>1900</td>
<td>866</td>
<td>Debre Zeit, Chart 2</td>
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<tr>
<td>3</td>
<td>Zwai</td>
<td>165 km S</td>
<td>1640</td>
<td>648</td>
<td>Zwai, Chart 3</td>
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<tr>
<td>4</td>
<td>Nura-Era</td>
<td>170 km SE</td>
<td>950-1000</td>
<td>543</td>
<td>Metehara, Chart 4</td>
</tr>
<tr>
<td>5</td>
<td>Merti-Jeju</td>
<td>185 km SE</td>
<td>1100</td>
<td>543</td>
<td>Metehara</td>
</tr>
</tbody>
</table>
1. Guder area

In 1968-69, 15 hectares of vineyard were reported at Guder mostly 5-10 years old, and the remainder 30 years old except for a few vineyards planted in 1967. Number of vines not in production was about 20 to 25 thousand. Various varieties were in mixed culture, with table grapes predominating. The vineyards remaining today were taken over for a State Farm, but difficulties arose about use of irrigation water and it is to be allotted to peasant farmers.

There are now about 4 hectares of producing vineyard about 30 years old, principally the black variety and less than 10% white varieties. The vertical three wire trellis is used and the vines are pruned to long spurs of 4 to 6 buds, in late August. Harvest usually occurs in mid February into March. Many vines showed wilting of leaves. Apparently no irrigation has been given this season. The vines were relatively free of powdery mildew and the grapes were beginning to colour. Bermuda grass sod covered the area.

Several hectares of young vines were planted a few years ago and made very poor growth and should not have been trained up. Only a small rosette of growth has formed at the upper top of the vine. The major portion of the planting had not received water and weed growth smothered out the vines. One section was revived and trellised, now being trained up the stake. Between the rows, intercropping of tomatoes and peppers showed rather poor growth, but the vines were growing well with the additional water. These young vineyards illustrate the impossibility of establishing and training young vines without sufficient irrigation and weed control. With a small additional amount of water the old block of vines would be a respectable vineyard, with cultivation and weed control, it would undoubtedly produce well without irrigation. In this valley with a sloping vineyard area and hemmed in by mountains, the wind is very dry and undoubtedly helps to keep fungus attack to a minimum. It appears that mature vineyards in this general region can produce fruit with a high sugar content and good acid balance for wine production. Under these dry conditions table grapes would not be advised. The chief impediment to expansion is lack of irrigation water during the dry season. The red clay soils seem to fix both P and K and minor element deficiencies are also present. The peasant farmers lack resources and have little knowledge of grape growing. The group plantings of 10 hectares are in poor condition and headed for failure.
2. Dukem area

In 1969 the vineyards occupied 13 hectares, planted with varieties imported from Greece. In planting, holes 0.8 meter square were dug and 20 to 30 tons of manure-based fertilizer was applied on each hectare. Cultivation was done twice, at the beginning and end of the rainy season. No irrigation was practiced, the vines began producing in the third year and gave normal crops in the fourth, grape yield approached 10 kg per vine.

Today this 13 hectare block is still in place and called the Dukem I. vineyard, now 16 years old. It is planted 2.0 x 2.5 m, on 4-wire vertical trellis. This vineyard continues to be in good growth and over the years has produced reasonable crops. The chief problem is a mixture of varieties, many female vines that are unfruitful. This season a late attack of powdery mildew has affected some of the crop. Sale of much of the fruit is on roadside to people who travel from Addis Ababa. Prices this period range from 1.5 to 1.75 Birr/kg (1 Birr = 0.50 US Dollar). Harvest is now scheduled to being about February 5 and will extend for almost a month. Now a State Farm, the care and management are the best of any area visited. Cultivation and a better trellising and leaf removal system would open up the fruit to air circulation and sunlight and improve the yield. This vineyard illustrates more than any other visited, that with proper care satisfactory yields and good quality fruit can be expected over a long life span. There is little question that large vineyard expansion in this area is justified. Some irrigation during the first 2 years in the dry season to establish the vines until the root system reaches some depth is advised. Cultivation and weed control need attention. Yields of 9 tons/hectare reported in 1976. Part of the vineyard lied in a depression where frost is a hazard.

The Dukem II. vineyard consists of 5 hectares, now 12 years old. The stand of vines is incomplete and unfortunately the main variety is female and unfruitful. This vineyard has been very slow to develop and reach bearing age, because of the neglect of cultivation and lack of water in the first year or two after planting. The vines remaining are now making better growth. Only one crop per year is produced.

A new planting of 10 hectares was anticipated but insufficient water for the young vines (watered by tank truck) reduced this to two hectares. Vines that at this time should have a half meter or more of growth have only
short shoots. The region is ideally suited for the construction of small check dams in the ravines. The compacted clay soil would form a tight seal. Runoff during the rainy season could be entrapped in small reservoirs and used in the dry season. The areas would have to be fenced to keep out farm animals. Gravity flow to lower areas for supplying water during the dry season would be feasible. In other cases, ground water could be tapped and pumped from wells, as at Debre Zeit College.

3. Zwai Farm

Zwai is located in the Rift Valley bordered by large lakes. Lake Zwai to the north offers an excellent source of water for irrigation. This is one of the southern areas selected for large scale farming, consisting of fairly level land cleared of native vegetation. The cultivated areas are noted for corn production without irrigation. The total area to be developed is 2,000 hectares. A vineyard of 10 hectares was planted with mixed local varieties in 1979 and has produced crop. In mid January 8 tons of the black "Tekur" were delivered to the winery in Addis Ababa, with 18 percent sugar and 1.1 total acidity as tartaric. The wine maker considered the shipment to lack sufficient maturity. Picking could have been delayed, but birds were beginning to decimate the crop. No selective picking was practiced and some immature clusters were included. Two crops per year are possible.

An additional 10.5 hectares were planted in 1980, 26 hectares in 1981 and 45.5 hectares in 1982. Much of this acreage was lost or temporarily abandoned because the irrigation delivery canal from the lake was poorly constructed. Seepage breaks developed, raising the water table in one section of trellised vines. The lack of trellis materials, particularly posts of Eucalyptus that are not very durable and yet expensive were not acquired. The vines of some acreage are still growing well. Some acreage can be salvaged by constructing a simple trellis 1 m in height, using pickets of Eucalyptus of small diameter to support a high tensile wire on the top. The vines should be cut back and trained as cordons by the "step" method.

Where water could be delivered, the growth of young vines has been excellent. The lack of trellising supports is critical and concrete posts should prove the only solution. The use of live tree trunks as an only alternative might be tried in a small planting. Fruitless mulberry and selected poplar clones from the Roe Valley in Italy are perhaps the best
choice. After reaching a satisfactory trunk diameter, the trees must be kept topped continuously to prevent shading of the vines. Clipping could offer an additional source of firewood, always in demand.

The arrested development of this farm is an example of good planning but a failure to first provide the supporting structures in working condition before planting, namely a good irrigation system and trellis materials on hand. A distribution system of underground concrete pipe, at least for the main canal seems the best solution.

4. Nura Era and Merti Jeju

These two areas are on either side of the Awash River, which is tapped by gravity flow thru open ditches to the farm area. Clearing of the semi arid land has given an area of 3,425 hectares for planting. Citrus is the main fruit crop.

To develop the grape production area, 14.4 hectares of local varieties were planted in 1982, 20 hectares of the same in 1982 and 5.5 hectares of certified varieties from California and France. Two crops should be produced per year. Pruning is now set for January and June, first crop harvest in the dry season in November - December, the second crop in May, early enough to escape the heavy rainy season. With more experience, pruning dates and irrigation will probably be adjusted to fit length of vegetative cycle and the desired date of harvest when the fruit would be in demand.

Merti Jeju is the area devoted to foundation plantings of new importations. It also serves as testing blocks before wide scale increase to plant large acreages.

2.0 Climate

Climatic date have been obtained from stations located closest to the viticultural regions (2). Graphs of the rainfall and mean maximum and mean minimum temperatures are included herewith, Charts 1 to 4.

2.1. Temperature

The mean temperature decreases rapidly with altitude and determines the length of the growth cycle. The maximum temperatures begin to rise in the periods of low cloudiness and absence of rainfall
and continue to rise steadily until a maximum is reached in June before the main rainy season. The minimum temperatures follow an opposite trend when the lowest temperatures reached for the year occur in December, and the sky is clear and bright. There is rapid radiation loss from the ground to the sky, so it is usual to be overly warm when the sun is up, but one feels the need of two woolen blankets on the bed at night. This large diurnal variation in temperature promotes ripening of the vine and its fruit, decreasing respiration of accumulated photosynthates, and promoting dormancy of the vine. At elevations of approximately 2000 - 2280 m local killing frosts may occur in depressions where the cold air settles. A frost killed vine in parts of nursery rows at the Debre Zeit Agricultural College when the cuttings had formed shoots a few centimeters long in December. A vineyard block in full leaf some 40 cm higher showed no damage. Vineyard sites at the elevations mentioned should be on sloping land where there is good air drainage. Frosts have not been recorded in the Rift Valley State Farms of Nura Era and Merti nor at Zwai.

The mean annual temperature at Nura Era (Metehara data) is 24.6°C compared to Zwai with 19.2°C. Two growth cycles and crops are possible for Nura Era, but Zwai may mature only a single crop. At least only short cycle varieties should be tried for two crops per year.

Chilling weather aids in breaking dormancy of the compound buds (eyes). Thus at Guder a larger number of buds burst than at Nura Era. Comparable vines at the two locations were not available to verify this observation. However at elevations above 2400 m, where bud dormancy ceases to be a problem, average temperatures and insolation are probably too low to initiate many inflorescences or ripen the fruit and vine before frost.

2.2. Rainfall and Irrigation

The dry season extends from October through May. Beginning in late January cloudy skies become increasingly frequent and night temperatures become warmer. During May and June light rain showers become more frequent until July and August, the heavy rainy season. By the middle of September the rains taper off, the beginning of the dry season. The driest month in all localities studied is December, which averages less than 6 mm.
After initial establishment, grapevines can be successfully grown without additional rainfall in the zones 1600 to 2200 m where the rainfall reaches 800 mm per annum or more, providing proper cultivation and weed control are used — now sadly neglected.

In the southern areas, there is adequate water of good quality for irrigation. Careful application and delivery of water must be improved and drainage of excess provided for.

Rainfall that persists during the blossoming period causes heavy losses, not only because of pollination difficulties but also from downy mildew, powdery mildew, anthracnose and Botrytis that destroys all or a part of the flower cluster. Losses from Botrytis may be very destructive if rain occurs with gusty winds, the lacerations of young leaves form points of mold entrance and the vineyard can be completely defoliated as well. It is well nigh impossible to protect against fungus invasion because the fungicides are washed off the vine. Here the need for systemic fungicides is evident.

Ordinarily the critical blossoming period and the period of harvest to maturity are those that should be programmed for the driest periods. Overhead arbors or bowers offer some protection of the leaf canopy and the clusters should be free hanging and not enclosed by leaves or tendrils. Care must be taken by deshooting or topping to leave "windows" in the canopy to provide sunlight and aeration. Overhead arbors with dense canopies that completely shade the area below soon become unfruitful.

The vineyard of 13 ha planted at Dukam has now spanned a period of about 18 years, relying solely on the natural rainfall of 866 mm (34.1 in). Local residents attest that the present growth is typical for this time of year. The black clay soil, called "cotton soil" covers thousands of hectares and is residual on a basement rock of basalt that is fractured into large blocks. The deeper soils have accumulated and washed into the lower depressions. Despite the gently rolling topography of the land and different depths of soil, scattered Eucalyptus trees grow at similar rates and do not vary in size as much as expected. It is probably the reserve water in the rocky subsoil that is the equalizing factor. The relative development of the native Acacia and the planted Eucalyptus can offer us some guide of possible vineyard expansion into dry lands seems possible.
A difficulty is that much of the plateau at this altitude is dissected into pockets of cultivated cereals, the land dissected by rock outcroppings or boulders steeply too frequently over the surface to allow mechanical cultivation. Large expanses of gradually sloping land should be obtained.

During the early life of the vineyard, spraying for diseases and insect control must have been limited if it was done at all. At the present time the vineyard is completely infested with Bermuda grass. The only cultivation done after the rainy season is to use a three pronged fork - at two man operation - to sink in and turn clods that are twice as long as a man's head. To balance one's self in walking over this terrain is not easy. One section of the vineyard had not received cultivation. This was compared with the area cultivated once per year in the manner described.

3.0 Soils

In the vineyard areas visited, the soils are predominantly adobe or clay loams. At moderate elevations, such as Debre Zeit or Dukem the soils are of residual origin, formed on ancient lava flows of basaltic rock. These black clay soils are on rolling and dissected slopes that have been heavily eroded and the deeper soils are in the lower prockets, with the higher elevations showing outcrops of lava rock. These black soils vary greatly in depth and are often locally called "cotton soils". When wet they become very sticky and slippery and almost impossible to cultivate. During the dry season these soils contract into large blocks of very hard texture, separated by cracks often 2 or 3 cm wide and to depths of 40 cm or more. Despite the clay texture the soils are well drained because of the slopes and subsoil rocks that are highly fractured, from which the vine roots probably extract considerable moisture late in the dry season.

Cultivation by tractor is limited to a short time when the moisture is at a level when the soil crumbles. When planting young vines at Dukem, several light irrigations must be given in the middle of the dry season in a shallow basin around the vine, covered with a straw mulch to prevent cracking of the soil.

As higher elevations are reached, near 2000 m and above, a dark red clay loam predominates, having much the same physical characteristics of the cotton soil. At the Guder area, the vineyards are in a transition zone, where both soil types intermix. The red soils seem deficient in available phosphorus, potash, zinc and magnesium.
In the Zwai area the soils are deep, well drained and sandier and light in color. Corn is produced successfully without irrigation. These soils do not crack extensively and grapevines root easily and develop vigorous young vines if irrigated during the dry season. This should be a preferred site for propagation of a nursery to produce rootings.

The deep clay loams of Nura Era are more easily worked than the black soils of mid altitudes. They often have angular rock fragments intermixed and appear to be well drained, though they have stratified layers and would benefit by deep ploughing.

4.0 Yields and Growth Cycle

No accurate records are available on the production of grapes. The few vineyards are irregular in outline and the hectarage is not easily measured. There are mixed variety plantings, some yielding much below normal. (see section of varieties). Over the years no regular care has been afforded and disease and insect control is just developing. Losses due to bird damage are often high. As many as five percent of the vines in some vineyards are missing. Periods of political unrest and land appropriation left some small plantings untended or abandoned. All of the older plantings were mostly nonirrigated or received only partial watering during the long dry season. Carpets of Bermuda grass completely cover the surface and compete seriously with the vines for moisture.

However, some estimates of expected yield are possible from the performance of the best individual vines. Some vines of the black variety at Guder this season have from 0 to 30 fruit clusters per vine and estimated weight is over 30 pounds. These yields compare favorably with the temperate zone vineyards. Obviously with improved cultural practices average yields can be greatly increased, especially if the vineyards are continuously cared for from the time of establishment. In recent years, occasional vines have been planted as overhead arbors alongside dwellings in the villages, especially to the west of Addis Ababa and around Debre Zeit. Here the vines can be fenced in with branches gleaned from the nearby Eucalyptus forests and protected from grazing animals. The early foliage usually falls because of downy mildew, but the vines retain a healthy canopy during the dry season. Much of the fruit is ruined by powdery mildew, but some may mature a useful harvest without any protective treatments. This trend of vine planting could be much stimulated if disease resistant vines were available, since the owners cannot afford even the simplest chemicals or equipment.
Priming and irrigation needs will depend on the desired maturity of the fruit and the growth cycle of the particular variety. The present cycles now adopted for the mid-altitude and low altitude areas are given in Charts 1 to 4, showing their relationship to the temperature and rainfall of the particular region. This is a useful guide in eventually setting a proper program.

5.0 Varieties

The choice of proper varieties is the most critical factor in determining the success or failure of tropical viticulture. Relatively few of the thousands available have been tried. Most failures have been due to low and sporadic yields, largely attributed to the protracted dormancy of the compound buds (eyes). Varieties differ somewhat in their onset and degree of dormancy. Cultural methods such as pruning or treating with chemicals can alleviate this problem. Use of calcium cyanamide and several derivative compounds appear promising in Israel (3) and California (4).

Varieties differ inherently in bud (eye) fertility over an extremely wide range of environmental conditions. In this respect the fertility of the basal buds 1 and 2 are most significant, to avoid long cane pruning. Many of the important commercial table grape varieties have low fertility, especially Emperor and Thompson Seedless. Some wine grapes have fruitful basal buds. Just how much yield the bud produces depends on the number of fruit clusters (1 to 3) per shoot and their weight. Quality of the fruit must be taken into consideration, as well as the vigor and disease and insect resistance of the vine in its particular tropical habitat.

Varieties that have a short vegetative cycle and mature their fruit early are important in the tropics, since it is possible to schedule the flowering and especially the fruit ripening period to escape the main rainy seasons. The period necessary for protective spraying is also shortened. The Perlette is an important variety in Northern India because harvest is just before the monsoon, which ruins the crop of the later Thompson Seedless. In Thailand the potential crop can be lost if the flowering occurs during protracted rains. A short cycle is obviously more important yet if two cropping cycles are possible. No late maturing varieties (long cycle) have been successful in the tropics.

Vigorous varieties with strong and rapidly growing arched shoots are more apt to stimulate growth of the active buds into lateral shoots, although there is also an inherent difference between varieties. In building and
maintaining the framework of the vine, the promotion of laterals where needed bypasses the dormant compound buds. Thus sterile shoots can be put into service by promoting lateral growth to produce fruit in the next fruiting cycle. The laterals often have great fruiting potential because there are more fruit buds per unit length and the compound buds, though smaller than those on the primary, are later in going into prolonged dormancy.

In some varieties the laterals exhibit another unique property in differentiating inflorescences as they grow. This gives rise to the so-called second crop in the temperate zones, which is often not harvested because it fails to mature with the onset of cool autumn weather. In the tropics this additional crop can be satisfactory and remunerative. The secondary laterals in turn may produce tertiary laterals that are also fruitful, leading to an almost everbearing habit. This is a characteristic of the Centennial Seedless. With successive production of laterals, the growth of each new one is decreased and the culsters correspondingly smaller.

Several local varieties are grown south and west of Addis Ababa in isolated vineyards. Although acquiring local names, it is likely they are of recent introduction, dating from the Italian occupation and adopted by the native population, much like expresso coffee, mordela and pasta have enriched the cuisine.

The most common and best adapted is called Tekur=black. For some years it has been considered to have the best potential for table wine. The yield is low but consistent. The fruit ripens fairly early, harvest for winery use occurred this year in January from the Zwai State Farm. The clusters are well filled with medium sized ellipsoidal berries. The coloring is quite uniform and at full maturity is jet black. The sugar and acid balance is very good. I have identified this variety as the 'Sangiovese', the principal component of Chianti wine in the Tuscany region of Italy.

After the Tekur the most widely planted variety is the 'Kai Dubia', favorite because it produces numerous clusters from compound buds (eyes) 1 and 2. Vineyard II at Dukem is planted solidly with this variety, with the exception of scattered single vines of about four or five other varieties intermixed, estimated at less than three percent. Unfortunately under conditions of the vineyard II, the variety has been described as "shattering" since at maturity only a few large seeded berries are formed, sometimes none. The berries that do form are "shot" berries, round seedless
berries 6 to 8 mm in diameter. In April of 1980 Schäfer (1) noted the extreme "shatter" of this same block of vines and attributed it to severe magnesium deficiency. However in vineyard I and in plantings at Nura Era, the variety site is quite well and is productive. It appears from my examination that the variety has sterile pollen (a female variety) that requires cross pollination to produce the normal large seeded berries. If its qualities are such to continue its use, it should be planted in alternate rows with Tekur or a heavy blossoming variety to provide pollen. Even then some risk of securing adequate cross-pollination such as dry, windy weather and similar blossoming times would be necessary.

Another use of the variety in solid block plantings can be suggested. Since small seedless berries are produced, there could be much increased in size by several sprays of gibberellin, one at 20 ppm at berry set, 2 - 3 mm diameter, followed by a second spray about 2 weeks later at 40 ppm. Only the clusters need be sprayed. By this means the fruit would be salable as a seedless table (the bright red color is very attractive) or also dried for raisin production.

Another variety likely a female is 'Nechul', a white oval variety described as an "alternate bearer" and not recommended for increase.

A very productive white variety is "Nech Debul Bul", with large clusters of good quality, ripening after the Tekur. Although quite susceptible to powdery mildew, control can be accomplished.

I have recommended that particularly healthy and fruitful vines of the most promising local varieties for expansion, notably "Tekur" and the white just mentioned should be marked by painting the trunks. Cuttings should be taken and bundled and kept separately planted under number in the nursery. When planted in the field the descendants from each vine are together in the row. Improvement in the variety is possible by this method of clonal selection. Future propagations can continue from the best descendants in each region.

New Variety Collection from California and France
Merti State Farm

This variety collection consists of single rows of trellised vines of the principal commercial table and wine grapes introduced from California. A few varieties were also obtained from French sources. The cuttings were first propagated in the nursery row and then planted as rooted....
vines at the present site. With the exception of Merlot from California, all of the varieties have made excellent growth and have been trained to a low cordon on a vertical trellis. The first few rows were now being pruned and very long canes were left, even up to 2 m in length to form the horizontal trunk. Where lateral growth was strong enough, a few scattered spurs of one or two buds were retained. I pointed out that these long cordons would show bud break and predominant shoot growth at the terminal ends and it would be difficult to establish a uniform spur system, but rather long grape would develop. The arms of the cordon should be shortened to 10 to 20 cm, extending the horizontal by leaving an end core 3 or 4 nodes long each growth cycle.

I checked this planting for variety identification and noted the following errors: Row labelled 'Merlot' from France was actually Grenache. One vine only in this row is Merlot.

The Ribier (Alphonse Lavallée), Chenin blanc, and French Colombard have very healthy and abundant foliage. Grenache shows symptoms of severe magnesium deficiency.

This plot should supply valuable information on the performance of some widely planted varieties as indicators for future trends. Data should be recorded on growth performance and bud fruitfulness, irrigation and fertilizer applications, budding out, flowering, fruit maturity and composition. Sugar content, acidity and pH of the juice would be indicative of processing use and scheduling time of harvest.
Varieties recommended for trial and found useful in some tropical countries.

**Table Grapes**

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Merits</th>
<th>Color</th>
<th>Demerits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anab-e-Shahi</td>
<td>India</td>
<td>Very vigorous, large clusters and berries</td>
<td>W</td>
<td>Only fair quality</td>
</tr>
<tr>
<td>Italia</td>
<td>Italy</td>
<td>Attractive, light muscat flavor</td>
<td>W</td>
<td>Low sugar, skin bruises</td>
</tr>
<tr>
<td>Cardinal</td>
<td>California</td>
<td>Vigorous, early maturity</td>
<td>R</td>
<td>Berries crack in rains</td>
</tr>
<tr>
<td>Queen</td>
<td>California</td>
<td>Very fruitful</td>
<td>R</td>
<td>Low sugar</td>
</tr>
<tr>
<td>Muscat Hamburg</td>
<td>France?</td>
<td>Very fruitful, excellent flavor</td>
<td>B</td>
<td>Weak vine, irregular ripening</td>
</tr>
<tr>
<td>White Malaga*</td>
<td>Thailand</td>
<td>Fruit keeps well</td>
<td>W</td>
<td>Yield often low</td>
</tr>
<tr>
<td>Danugue</td>
<td>France</td>
<td>Large cluster, need thinning</td>
<td>B</td>
<td>Good resistance to rain</td>
</tr>
<tr>
<td>Ribier (Alphonse Lavallée)</td>
<td>France?</td>
<td>Attractive large berries, low sugar</td>
<td>B</td>
<td>Cracks badly in rain</td>
</tr>
</tbody>
</table>

*Unknown variety erroneously named*
Experience with wine varieties is more uncertain and limited because the quality of the fruit is dependent on its composition and the balance preferred for a particular type of wine, principally the sugar, acids, phenols and flavouring materials.

### Wine Varieties

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Merits</th>
<th>Color</th>
<th>Demerits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merlot</td>
<td>France</td>
<td>Resistant fruit of good flavor</td>
<td>B</td>
<td>Sometimes lacks vigor</td>
</tr>
<tr>
<td>Tempranillo</td>
<td>Spain</td>
<td>High yield, early maturity</td>
<td>B</td>
<td>Spoilage bad in rains</td>
</tr>
<tr>
<td>Carignane</td>
<td>Spain</td>
<td>Very productive</td>
<td>B</td>
<td>Low sugar and color</td>
</tr>
<tr>
<td>Tannat</td>
<td>France</td>
<td>Fruit very resistant</td>
<td>B</td>
<td>Adds good color and tannin</td>
</tr>
<tr>
<td>Verdelho</td>
<td>Madiera</td>
<td>Very productive, some disease tolerance</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Sangiovese</td>
<td>Italy</td>
<td>Productive, good quality</td>
<td>B</td>
<td>None serious</td>
</tr>
<tr>
<td>Petit Verdot</td>
<td>France</td>
<td>Very productive</td>
<td>B</td>
<td>Low sugar, good color</td>
</tr>
<tr>
<td>Trebbiano</td>
<td>Italy</td>
<td>Fruit resistant, vine vigorous</td>
<td>W</td>
<td>Low sugar, thin wine</td>
</tr>
<tr>
<td>Sauvignon blanc</td>
<td>France</td>
<td>Very vigorous, early maturity</td>
<td>W</td>
<td>Very small clusters</td>
</tr>
<tr>
<td>Chenin blanc</td>
<td>France</td>
<td>Very productive</td>
<td>W</td>
<td>Heavy fruit rot in rainy periods</td>
</tr>
<tr>
<td>Rubired</td>
<td>California</td>
<td>Very productive, tolerant to powdery mildew</td>
<td>B</td>
<td>Excellent for color</td>
</tr>
<tr>
<td>Carnelian*</td>
<td>California</td>
<td>Greache type, but good color</td>
<td>B</td>
<td>Highly flavored wine</td>
</tr>
<tr>
<td>Carmine*</td>
<td>California</td>
<td>High cabernet flavour, some tolerance to downy mildew</td>
<td>B</td>
<td>Well balanced wine</td>
</tr>
<tr>
<td>Centurion*</td>
<td>California</td>
<td>Highly productive, very high sugar</td>
<td>B</td>
<td>Some berry shatter</td>
</tr>
<tr>
<td>Symphony*</td>
<td>California</td>
<td>Very heavy production with short spurs</td>
<td>B</td>
<td>Muscat flavored dry wine</td>
</tr>
</tbody>
</table>

*These varieties hold U.S. Plant Patents (see under Seedless Raisin Grapes)
### Seedless Raisin Grapes*

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Merits</th>
<th>Color</th>
<th>Demerits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thompson Seedless</td>
<td>Iran</td>
<td>High quality, thin skin</td>
<td>W</td>
<td>Long pruning, needs high insolation</td>
</tr>
<tr>
<td>Perlette</td>
<td>California</td>
<td>Very early, tender fruitful on spurs</td>
<td>W</td>
<td>Low sugar, needs berry thinning</td>
</tr>
<tr>
<td>Dawn*</td>
<td>California</td>
<td>Skin more resistant than Perlette</td>
<td>W</td>
<td>Vine lacks vigor</td>
</tr>
<tr>
<td>Fiesta</td>
<td>California</td>
<td>Earlier than Thompson Seedless</td>
<td>W</td>
<td>Needs long pruning</td>
</tr>
<tr>
<td>Himrod</td>
<td>New York</td>
<td>Vine tolerant to mildew</td>
<td>W</td>
<td>Berries drop at maturity</td>
</tr>
<tr>
<td>Centennial*</td>
<td>California</td>
<td>Largest seedless berry, excellent raisins.</td>
<td></td>
<td>Berry shatter, susceptible to powdery mildew</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Earlier than Thompson. Everbearing habit.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*These varieties carry U.S. Plant Patents and the sale of plants would have to be licensed by the Regents of the University of California. Write to Mr. Rober Fissell, Associate Plant Patent Officer, University Hall, Berkeley, California.
6.0 Propagation and nurseries

To expand plantings in 1980-81 cuttings were selected from the oldest blocks in production, the Dukem I vineyard planted about 15 years ago and the oldest block at Guder planted about 1920. Cuttings were taken on mass at pruning time in August and September, without realizing there were a mixture of six to ten varieties in the blocks. However a single black variety predominated.

The first new vineyards planted in the Rift Valley were also mixed. I have advised grafting over the odd vines by top-grafting and replanting missing vines by layering. Demonstrations of both methods have been demonstrated several times in the vineyards so no details are necessary here.

I have suggested, and Mr. Zimmermann has already put into operation, a method to mark and select the best vines of each recommended variety just before harvest. All cuttings from each superior vine will be bundled together and receive a number. These will also be kept together in the nursery row and planted in the vineyard. This should improve the commercial vineyards and lay the basis for continued selection.

At this time, the method of cutting preparation and nursery planting are well understood and the planting at Debre Zeit illustrates the point. I believe the Zawai region would provide the best nursery location for large scale production. Emphasis must be to keep cuttings and rooting moist and present drying out. Storage of cuttings or rootings in large plastic bags in the range 2° to 7°C is desirable if the propagation material cannot be used within a couple of weeks. Temporary storage out-of-doors in a cool shady place in damp river sand is convenient near the site of planting. The bundles of cuttings or rootings are stood upside down and covered over completely until ready for use. Irrigation of the nursery should stop two months before pruning time to enable good maturation of the wood and some yellowing and shedding of the leaves. Irrigation can be resumed several days before digging to allow easier extraction of the rootings. Rootings should be sorted and any weak plants discarded.

Schafer (1) recommended cold storage of cuttings before nursery planting but this is usually unnecessary because dormancy of the buds is broken by the pruning wound. Zimmermann found no advantage in the chilling treatment in the nursery at Debre Zeit.
7.0 Planting preparation and site selection

New sites selected for table wine production are preferably located at elevations ranging from 1830 to 2130 m on the black adobe lands referred to as "cotton soil". This zone has relatively cool temperatures with a single growth cycle, and the main harvest is in February. The slopes with SW orientation appear more favorable and should be gradual enough to permit tractor cultivation. Low-lying pockets with poor air and water drainage are very subject to ground frost by entrapement of cold air.

Fencing is imperative to protect the planting from grazing animals.

During the early part of the dry season, the area selected should be cleared of brush and trees, then deep ploughed (30 cm or more). If noxious weeds are present, the land can be left fallow and recultivated during the dry season, which is the cheapest method of control.

7.1. Spacing of vines and trellising

Spacing of vines has followed from the earliest Italian plantings of 2.0 x 2.5 m. This has proven satisfactory in the oldest vineyards at Guder and Dukem, where no irrigation has been practiced and cultivation is by hand, using mattocks or forked hoes. Now that tractor cultivation is beginning at Dukem and in the newly established acreage, the spacing between rows should be widened to 3.0 m to allow tractor cultivation and furrow irrigation. In the new vineyards in production at Zwaı and Nura Era the old spacing was retained. The trellising system adopted for the first Zwaı vineyard follows a pattern used a half century ago.

This is a simple vertical trellis of 0.85 to 1.2 m in height, the bottom wire 20 to 25 cm above ground level the two upper wires spaced 30 to 35 cm apart. At the old Guder vineyard the vine was headed or branched laterally at the lower wire, then gradually extended outward from either side to the middle wire. The shoots were trained upward and tied individually to the top wire. As the shoot reached full diameter and had mature leaves, it was topped just above the tie. This produces a narrow cylindrical wall of foliage with the leaves on either side completely shading and obscuring the fruit clusters inside, specially with large-leaved vigorous vines typical of the Dukem I vineyard. Spray contact is thorough and complete on the outer facing leaves and canes, but the clusters and inner shoots are shielded from the spray and rest in shady and humid environment, promoting extensive attack of botrytis, downy mildew and powdery mildew.

The support for this trellis system consists of end poles of
Eucalyptus about 10 cm in diameter set in the ground about 40 cm deep. These should be leaned outward to about a 60° angle with the ground and secured with a wire attached to a dead-man buried at the extension of the row (a rock or concrete anchor) at a depth of 40 - 50 cm.

For 2 m vine spacing in the row intermediate poles of smaller diameter can be used by driving them alongside the vines at every 10 m. The three vines between poles can be trained up with a string or any cheap support available, bamboo, etc. Eucalyptus is the only present source of poles for trellising. Even when pressure treated they do not last more than 5 or 6 years and must be replaced. Concrete poles with wire reinforcement will have to be manufactured on the sites of vineyard expansion.

In the interim, for vineyards already planted and not trained up, a temporary solution to prevent loss and abandonment is the use of low trellis about 1 m in height which can be supported with short poles of smaller diameter, sawed square on the top and sharpened at the other end, making it easy to drive in the ground at least 35 cm deep. A single high tensile wire is stretched and stapled to the tops of the stakes, pulled taught and anchored at the end post as described above.

A cordon is established on the wire, doing so in stages as discussed and demonstrated in the field meetings. When the shoots grow upward they will have no support and will grow and arch outward or downward from the top of the trellis wire. Early topping of shoots and deshooting are necessary to keep vine growth off the ground. When other poles become available the trellis can easily be raised to its final form.

A low trellis using diagonal cordons is another solution, but it uses three wires instead of one. This however offers a better solution for cane pruning and yield increase (see diagram).

The use of overhead trellis 1.5 m x 3.0 m x 2.0 m high is recommended for warmer sites such as Zwaï and Nura Era, when concrete posts become available, as the best system to insure good yields and fruit quality. Overhead trellises are not advised for non-irrigated vineyard areas such as Debre Zeit, Dukem or Guder, because of the greater water demand of the greatly expanded leaf surface. However yield at the Dukem I vineyard could be increased by using a cross-arm at the head of the vine 40 cm wide with a wire on each side to expand the fruiting area.

I am not inclined to favor the suggestion of Schäfer (1) that head pruning be used for vineyards awaiting trellising. Head pruning
be used for vineyards awaiting trellising. Head pruning would require a substantial pole to hold the trunk upright. The dominant growth occurs terminally, which will rapidly extend the arms of the vine outward and will often split from the main trunk from the added weight of the crop.

Expansion of new vineyard acreage without the materials or experience of trellising is doomed to fail. Increasing citrus acreage is a relatively simple affair and well understood compared to grape culture in the tropics, which requires relatively sophisticated techniques, such as trellis support, special pruning methods, double cropping and persistent fungus disease control. At this stage of development, one hectare of vineyard properly developed and cared for is far more valuable and a source of reference than 100 hectares doomed to be abandoned.

8.0 Cultural operations

Although at present agricultural labor is very cheap and plentiful, one cannot dismiss the fact that large scale farming must turn more and more to mechanization for economic production. This is especially true of soil tillage and weed control in the heavy clay soils in Ethiopia which are difficult to work by hand mattock, but the problem is more difficult yet because they must be worked over a very short time period, when the soil is of the proper tilth. Hand cultivation without the use of herbicides is ineffective in eradicating perennial weeds like bermuda grass and cyperus. Fungicides needed on grapes must be applied in very short time, requiring motorized sprayers and dusters. These examples should suffice to promote the recommendation that large vineyard planting must be designed and planted for adoption of mechanized operations.

8.1. Irrigation

For the production of light table wines of good balance and quality, I have recommended the zones of "cotton soils", in the general elevation of 1830 to 2130 m. The desirable areas from the standpoint of vine growth and yield receive an annual rainfall of 700 to 900 mm, with only slight variations within a broad belt south and west of Addis Ababa. We have information that permanent vineyards can produce adequate crops without supplementing the natural rainfall, as witness the Dukem vineyard (over 18 years of age) and the plantings at Gouda of greater age. During the long dry seasons, the vines become stressed for moisture, and it appears that some supplementary irrigation during the
mid-dry season could increase both yield and fruit quality. However, if clean cultivation were practical during the dry season instead of leaving a sod of bermuda grass to compete for the moisture, the need for additional water would be minimized.

The most critical phase of moisture stress for vineyards in the heavy clay soils is in the first year or two after planting. At this time, the soil dries out, shrinks and cracks and the vine growth stops. Present practice is to mulch the soil surface with straw or refuse, which helps somewhat.

Tank trucks have been used to tap a local water supply and apply extra water in a basin around the vine. There are many small ravines that could serve as catchment dams during the rainy season to store some of the runoff for use during the dry period. They can be located above areas selected for vineyard development to provide gravity flow.

In the Rift Valley, there are permanent sources of good quality irrigation water delivered by surface diversion ditches by gravity flow. These have been poorly designed and traverse areas of porous subsoil which allows seepage into adjoining land and a rise in the water table that quickly asphyxiates the vine roots. At least the main distribution lines should be underground and constructed of steel or concrete pipe. Since there is no immediate shortage of water, furrow irrigation is adopted. However, uneven water application is a problem as the land is only rough leveled. If furrow irrigation is also adopted for new vineyard development, a better job of leveling is needed at the beginning. Unlike annually cropped fields, it is impossible to do leveling after the vineyard is established.

The Awash River carries a large burden of silt, which would require expensive settling basins and filters if drip irrigation were to be considered. Use of this water certainly adds to the spread of noxious weeds. A series of screens at the ditch intake would certainly reduce this problem.

As in most irrigation projects, adequate drainage is often overlooked. Attention must be directed to providing good drainage and not over-irrigate vineyard areas. Well-drained sloping lands are preferred.

In the hotter areas of the Rift Valley, two cycles of growth and cropping are feasible. Soon after the dormant pruning, a heavy
irrigation and fertilization are usual. When the fruit begins to color, the irrigation is withheld completely until time for the second pruning period. During the dry season, irrigation of mature vines every two to three weeks will usually be necessary.

8.2. Cultivation and weed control

In opening up virgin lands for vineyard establishment, every effort should be made to avoid the introduction of noxious weeds, which will shortly become a problem of concern. The solution is to utilize a settling basin reservoir near the point of intake from the stream and use underground concrete pipelines. Nylons or plastic screens can be interposed in the main field distribution ditches to prevent passage of plant parts and seeds. These should be cleaned periodically and the refuse burned. During the dry season leaving a shallow mulch by lightly discing the cover crop or using a rotovator would prevent weed growth.

Permanent open ditches in field distribution lines should be avoided as they are the main source of weed establishment. They can be kept clean by ploughing them up several times during the dry season or periodically sprayed with herbicide. Two of the most troublesome weeds in vineyards are Bermuda grass (cynodon) and nut sedge Cyperus spp. Bermuda grass can be controlled with cultivation at the beginning of the dry season. Infestation in line with the vine trunks can be controlled with glyphosate (Roundup) herbicide, but care must be taken not to get any on the green parts of the vine, spraying just after pruning is the best time for application. Young vines can be covered with a can to prevent spray contact.

Nut grass multiplies very rapidly in areas that are moist and is very difficult and costly to control. Although glyphosphate will keep it in check, treatment is expensive. There is as yet no satisfactory eradicant for this week in irrigated vineyards.

In preparing previously cropped land for vineyard development, it should be deep ploughed and left fallow during the dry season. If furrow irrigation is used, some leveling is desirable to provide good distribution of water.

The use of a leguminous cover in a band between the vine rows, planted just before the expected rainy season is an excellent way to
prevent erosion and maintain soil tilth and fertility. With the onset of the dry season remains of the crop refuse can be rotavated. Subterranean clover is especially good since it reseeds itself during the rainy season. Berseem (Egyptian) clover can also be cut several times during the cool rainy season and provides excellent fresh forage for farm animals.

8.3. Mineral nutrition and fertilization

The nutritional needs of different crops have not yet been explored in Ethiopia. Soil surveys and mopping of cultivated areas are non-existent. Under the circumstances the most appropriate measure of possible deficiencies or fertilizer needs for grapevines is petiole or leaf analyses. Soil analyses are less useful, because the soil may "fix" or hold the elements such as P or K in a form unavailable to the vine.

By observation of symptoms expressed in the leaves, the following deficiencies have been noted:

\[\begin{array}{ll}
\text{N} & \text{General in the Debre Zeit 3-year planting. Competition with the alfalfa cover crop is probably the cause. Corrected within 2 weeks with UREA.} \\
\text{Mg} & \text{The most widespread deficiency, found in all vineyards, but most severe in oldest planting at Nura Era project and in some varieties, particularly Grenache at Merti Vine Introduction Areas.} \\
\text{Zn} & \text{Typical symptoms on scattered vines in all areas, but, most serious at Guder on dark red clay soils. Also some at Zwai.} \\
\text{K} & \text{Borderline in both black cotton soils and heavy red soils.} \\
\text{P} & \text{Most evident in red clay soils at Guder; no evidence elsewhere.} \\
\text{B} & \text{No evidence of deficiency or toxicity.} \\
\text{No excess of salts have been observed, but it is likely they may become a problem, especially in the Rift Valley vineyards if over-irrigation takes place and poor drainage results.} \\
\end{array}\]

The government imports only UREA as a nitrogen source and diammonium phosphate.
The appearance of deficiency symptoms do not always mean corrective measures are needed. If good vine growth and production continue, the deficiency becomes academic. Some deficiencies become more apparent with the aging of the vine and heavier crop production. Heavy cropping vines more often develop K deficiency.

Practically all lands, both cultivated and in native bush, have been overgrazed for centuries. "During the dry season the straw and plant refuse is gathered in stacks and protected for later use. The fields and pasture land are gleaned repeatedly by herds of animals (goats, sheep, steers, burros and camels) that often migrate considerable distances for water and food. Animal manure is not available as fertilizer, but is gathered for fuel". Lack of organic matter in the soil should be compensated by composting waste materials with cattle manure when available, especially to add in the hole when field planting rooted vines.

Only two fertilizers are imported for use in Ethiopia, UREA and diammonium phosphate. In setting our new plantings at Zwai and Nura Era, usually 100 g of UREA and 200 g of phosphate are sprinkled in the irrigation basin around the vine, offset from the delivery furrow down the row.

On heavy clay soils such as as Dukem and Guder, it might be better to apply phosphate in a deep furrow for better absorption by roots, since fixation by the soil is suspected. The same might be true of potassium fertilizers.

8.4. Diseases and Pests

Great care has been exercised in importing propagation wood that comes from certified material in California and France. Extra precautions should be continued to bar importation of rooted grapevines in order to remain free of phylloxera. The silty clay soils common to the present and planned viticultural areas crack frequently and are of a type that would harbor phylloxera and allow rapid dissemination of the insect.

Downy mildew has been effectively controlled on State Farm plantings. The most troublesome disease observed was powdery mildew, which attacked in late season, just before the fruit was beginning to color. Abundant sporulation first occurred on the green nubbins of
unfertilized flowers or the small shot berries. Damage was most severe in the inner and shaded parts of the canopy. The white varieties had clusters completely covered with mycelium and berries shattered from the cluster, as well as splitting open and exposing the seeds. Despite the loss of fruit and spoilage, the leaves and canes showed no sign of infection. This apparently indicated control measures cannot be terminated so early but must be continued to the ripening stage. Fruit clusters exposed outside the foliage curtain were seldom infected. Leaf thinning around the clusters to admit air and light is recommended. Use of an expanded trellis can also alleviate the difficulty. Overhead trellising that develops too heavy a canopy and shades the fruit makes the problem worse. Large termite mounds are abundant in the corn fields at Zwai and in uncultivated land at Nura Era. The insects have been controlled before vineyard planting.

No other insects damaging the vines have been observed, other than a large wood-boring beetle that hollows out the trunk of older vines. Not yet identified, it appears only sporadically in the Dukem region. Mr. Jackson has mentioned a leaf-eating beetle in the Nura Era vineyard.

New fungicides are appearing more frequently on the market. Systemic fungicides such as "Bayleton" for powdery mildew control are especially useful because they are effective a longer period of time and are distributed within the plant and not washed off by rains. Similar systemics are being developed for downy mildew control. Testing of new compounds is of the utmost importance and such trials are well advanced at the Dukem area by Mr. Arthur Zimmermann, member of the German Voluntary Corps. The timing of spray applications has to be developed for each region. In the mid-altitude regions such as Debre Zeit and Dukem no spray protection for downy mildew is necessary in the long dry season. The absence of morning dew and prevalence of dry winds are protective factors. Topping of vine shoots to reduce the formation of young leaves subject to infection is a good practice.

8.5. Harvesting and transport

Table grapes require a great deal of attention in their harvest and transport, because the appearance of the displayed fruit is a large factor in consumer acceptance.
The maturity of table grapes ready for harvest can be judged by tasting a few berries from the best colored clusters. More precise measurements of sugar and total acidity can be made by sampling 200 berries at random and expressing the juice, employing the usual chemical determination. Harvest time is difficult to decide, since clusters ripen over a longer period and are at different degrees of ripeness, mostly the result of the asynchrony in bud burst. Several consecutive pickings will be necessary. Sub-standard fruit can be processed by by-products. Packing is often done directly in the field, laying the clusters in a wooden or cardboard lug box in a single layer holding a net weight on 10 kg if designed for export. Harvest should be done in the early morning and the packed and lidded boxes transferred to a precooling room. Precooling and shipment by refrigerated truck or other transport is essential to guarantee satisfactory condition of the fruit at destination. A further safeguard is the use of SO₂ gas generators (impregnated paper pads) that gradually release sulfur dioxide, preventing mold development in the fruit.

For wine production, the grape clusters are picked with curved knives or shears into plastic boxes or buckets in a once-over harvest. These are unloaded into a "gondola" or low tank trailer holding two or more tons of grapes. The trailer is pulled between vine rows as the pickers on either side progress down the row and empty their containers. The loaded gondola is towed directly to the processing plant on its own rubber tired wheels. It is unloaded into a receiving bin by a hoist that tips up one side of the gondola and empties it. A screw conveyor moves the grapes to a stemmer-crusher unit, thence to fermenting tanks. For long distance hauling, rectangular tanks when filled are loaded onto flat-bed transport trucks. These tanks are hinged on one side and can be dumped in a similar manner as the gondolas.

9.0 Marketing and Processing

The major advantage of table grape production in the tropical areas is the ability to produce a crop at most anytime of the year. By manipulating the time of pruning, choice of variety and water supply, harvest can be scheduled at a time when the market demand and price are at a peak. Temperate zone markets of the northern hemisphere are devoid of fresh grapes in January - February; world-wide the supply is practically nil in December. Prices are also very high during this month because of the many holidays. The consumer can often have fresh grapes available the year round.
The cycle of vine growth is shortened in the tropics. In areas with continuously high temperatures and insolation, two and occasionally three harvests can be obtained in a 12-month period. There are certain advantages in staggering the harvest when the fruit is processed for fresh juice, wine or other products, since a smaller installation can be utilized continuously.

In general, processing facilities are best located in the area of production, provided the utilities are available. The recently completed processing plant could be equipped to handle the preparation of grape juice and concentrate, as well as wine making and distillation of alcohol for the production of sweet wines and liquors. Light table wines in the cooler zones would continue to be made near Addis Ababa.

The Rift Valley is well located for export of fresh table grapes to Arabian gulf countries, by using shipping docks at Djibouti (connected by rail to Addis Ababa) or the port at Asmara.

9.1.1 Table grapes

The quality of table grapes (of any given variety) is largely determined by the cultural methods employed in the vineyard in a favorable growing environment. Complete and bright colors are preferred. Thus a reddish-black berry color signifies to the customer a black variety that has not reached full maturity. The fruit should be free of blemishes such as scars, bird pecks, cracked, discolored or spoiled berries. Compact clusters are difficult to arrange in a package and may have incipient deterioration inside the cluster. Certain manipulations during the growth and maturation of the fruit on the vine can improve appearance. In general, the clusters should hang free to avoid rubbing or abrasion by leaves or other vine parts. Removing leaves that shade the cluster often improves coloring and minimizes fungal attacks on the fruit, permitting better coverage of spray materials. It may be necessary to bag the fruit clusters at maturity, to shield them from birds and heavy rain.

Clusters of \( \frac{1}{2} \) to 1 lb. are preferable, so reduction in cluster size and compactness by thinning before or after berry set may be necessary. Growth regulators such as gibberellin are regularly used to increase the berry size of seedless varieties.

In general, fruit of high sugar content and moderate to low acidity is preferred. In tropical areas, the sugar tends to be lower and the acid higher than in the temperate zone table grape regions.
Temperate zone varieties that ripen early and produce high sugar content with a low acidity are most successful in the tropics. The balance between sugar and acid is an important relationship in palatability.

Seedless varieties have become increasingly important but most of these have poor fertility in basal eyes and must be cane pruned and are low yielding.

9.2. Wine Production

Formerly there were five wineries operating in Addis Ababa. Consolidation has occurred, and four now are branches of the parent Awash Winery. The Manager of the Ethiopian Beverage Corporation, Ato Getachew Ayele, received us cordially, first discussing problems of winery production, then touring the plant and finally ending with a tasting of the different wine types produced. An Italian trained enologist is the winemaker. Production of distilled spirits is separately under the aegis of the Ministry of Industrial Development.

The winery building dates back over 45 years and the building reflects the old Greek wineries familiar to the founder. The building rests on a hillside in a heavily populated suburban area. A dusty courtyard surrounds the building with a frenzy of small delivery trucks, either returning crates of empty bottles or loaded with cases for delivery. A unique salvage item are chianti fiaschi, still denoting to consumers a mark of quality, a holdover of the Italian occupation. The company hope to phase out the use of these bottles, as the straw covering is difficult to keep intact and clean; moreso to weave a new one.

Production of wine is about 15 million liters per year, of which 1 million bottles are exported, mostly to neighboring African countries, wine imports from any outside country are prohibited.

Two general categories of wine, one for local consumption marketed in 750 ml, quart or liter bottles under the Sarris label, selling retail for $1.25 to $1.50 US. The export or premium grade wine of 250 ml retails for $2 US and is sold in hotels and restaurants frequented by tourists. The markup in price varies from place to place.

Since only a minuscule supply of wine grapes are produced, less than 50 tons in 1984, imports of cheap sub-standard raisins from Greece and Turkey provide the raw material, following a system long traditional in the Middle East. The mass of raisins are disintegrated and soaked
in warm water, then pumped into the concrete fermenting tanks or some fiber glass epoxy tanks. The usual rackings and filtration (frame plate) after bentonite. The wines are cold stabilized and then flash pasteurized before bottling. Benzoate of soda is added as a preservative. Modern machinery such as pumps, filters, refrigeration, etc. have been imported from Italy plus a few items from France.

The market demand for wine has outrun the supply and there is little room for expansion in the old quarters. By adding modern and new machinery without supporting services is not efficient. A new and modern winery built from the ground up should have high priority as grape production is expanded. The site determined should be considered in relation to the areas of production.

The production of white wines from imported raisins, heavily dosed with sulfur dioxide, produce colorless, watery wines. Caramel is added to provide both color and flavor.

There are four labels regularly used; advertised as "winners of international gold medals". Dukem for red wine, Abadir for rosé, Soave for white and Guder for red wine, indicating the locations from which the small vineyards are located.

The exception is Soave, an Italian appellation of origin. All are light bodied, slightly sweet wines of no distinctive character, although many years past the Guder wine had acquired some local reputation. Demand for white wine is outpacing the red, so two new white types are being introduced, Ambo and Holeta.

There are indications that more and better grapes are needed for wine production. The grapes grown in the mid altitude region, without irrigation crop and ripen more uniformly and attain high sugar content with good acid balance. Concerted efforts should be made to develop larger vineyards in this zone for quality wine production, particularly light table wines. Some better quality red wines could be produced if there was some incentive to age wines in oak barrels. No barrels of any quality are produced in the country and imports are at present not considered.

The major impetus at present is to produce more grapes for all purposes, so the hot southern regions bordering the Awash River are of more immediate interest. With proper manipulation, two crops per year can be produced, and the availability of large expanses of virgin soil
and a good supply of water for irrigation by gravity flow are available at all seasons. There is no compunction about using foreign apppellations for wines. Soave, Champagne and similar apppellations are regularly used.

In Ethiopia, as in all early countries bordering the Mediterranean, the Christian heritage was responsible for the introduction and maintenance of vineyards. In tropical countries this proved to be an impossible task. Wine was difficult to transport over unsettled and difficult terrain. Containers for storage were unavailable and high temperatures resulted in spoilage. The rules of ancient monasteries dot the landscape. However it is noteworthy that wine was not easily made, stored, nor transported, and the ancient Coptic and Orthodox sects accepted raisin juice as a legitimate substitute for wine in the celebration of the mass. The Catholic Communions in areas incapable of producing grapes or importing wines got permission to use imported raisins for wine making. Ethiopians look upon raisins as a special product of particular religious significance as well as a delectable item for festive occasions.

Production of raisins would be a desirable addition to the economy.

There are several alcoholic drinks made by peasant farmers in the countryside.

**Tala** - A crude type of beer. Small twigs and fresh leaves of buckthorn (Rhamnus sp) are crushed up and steeped in water, which extracts a bitter compound. To this is added a powder ground from roasted barley grain. This is fermented in a large bottle or earthenware jug. It may be kept for many weeks and kept restocked. The liquid is decanted off as needed.

**Tej** - Mead or honey wine is commonly made. Tumeric is added to give it a more attractive color. Honey has become expensive, so more sugar is used. When consumed it is a murky liquid with a pleasant taste and is consumed in large quantities with festive meals.

**Areke** - This is a stronger alcoholic drink, upto 35% made by distillation.

9.3. **Raisin production**

At Nura Era, some seedless varieties should produce and ripen sufficiently during the main production in late January to Mid
February for raisin production. Sun drying on paper trays out of doors is possible. The drying process requires about 3 to \(3\frac{1}{2}\) weeks. A raising processing equipment could best be added at the Merti plant. Before any such plans are made, production of seedless grapes must be well advanced.

9.4. **By-products**

Bottled fresh grape juice and concentrate would provide other outlets for surplus grapes. Wine vinegar is another item to consider.

10.0 **Recommendations**

1. Vineyards for the production of good quality wines can be developed in the black cotton soils in the zones from approximately 1600 to 2200 m. Established vines would need no irrigation.

2. The chief impediment in vineyard establishment in this region is the lack of irrigation water during the dry season for the first two years after planting.

3. Added water supply can be secured by the building of catchment dams in the ravines and depressions, as well as ground water pumping.

4. Cultivation and weed control are absolutely necessary in vineyards to conserve water for vine needs.

5. Leguminous cover crops should be planted in the rainy season a band about 1.8 m wide between vineyard rows to improve fertility, prevent erosion, and keep the soil in good tilth.

6. Cover crops should be rotavated or shallow disced and left on the soil surface as a mulch before the onset of the dry season to prevent weed growth.

7. Herbicide treatment along the vine row is recommended.

8. In the newly developed regions in the south, at Nura Era, Zwai and Merti two crops per year appears feasible.

9. In these areas overhead trellises are recommended.

10. Reliable and permanent water distribution systems with underground piping are advised. Expansion of planted acreage without a dependable water supply is unthinkable.

11. A serious shortage exists in the supply and availability of trellis materials. These must be made available long before planting increase.
12. Salvation of young plantings now in the ground can be achieved by using a low cordon, training the vines on a single wire.

13. Later conversion of low to high trellis can be achieved later when materials are available.

14. Trial and testing of varieties should be continued, those promising expanded to larger test vineyards.

15. Two varieties have proven well adapted, the black 'Tekur' = Sangionese and an unknown white variety. Expanded plantings of these are justified.

16. A few small well managed vineyards are necessary to train sufficient manpower to properly expand acreage and to apply the sophisticated methods needed in successful grape culture in tropical regions.

17. Workshops for vineyard managers and workers to achieve greater knowledge are needed, with practical application in the field.

18. Depredation of the fruit by birds is a serious problem and requires a concerted effort to use the newest techniques, especially to reduce the starling populations.

19. Production of table grapes for local consumption should be in high priority.

20. Possibility exists for export, especially in the period January - February.

21. Details on cultural methods have been given in a series of workshops.

22. As grape supplies increase, laws should be promulgated to guarantee production of wines of better quality.

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References cited


CHART 1

MEAN MAX.
19 YRS.

MEAN MIN.

RAINFALL
mm.

ANNUAL 912 mm.
13 YRS.

TEMP.

J F M A M J J A S O N D

AMBO 8.58N, 37.52E 2080 m.
CHART 2

Harvest
Pruning

Mean Max:
Mean Min:

Rainfall

Annual 866 mm
30 yrs.

J F M A M J J A S O N D

Debre Zeit 8°44'N 32°02'E 1900 m.
CHART 4

MEAN MAX.

MEAN MIN.

TEMP 
°F

150
120
90
60
30

ANNUAL 543 mm.
15 YRS.

METEHARA 8.52N, 39.59E 951 m.