1. INTRODUCTION

Before 1960, table grapes were imported from the United States and Australia to Thailand, incurring high costs. At that time more than one hundred varieties were also introduced for testing from the United States and other countries. It was found that grapes can be adapted and grown well in the country. In 1956, Professor Pavin Punsri and his colleagues of the Department of Horticulture, Kasetsart University, Bangkok, tried to study and solve the problems of grape culture. The grape industry in Thailand has been a success since this time. The initial commercial table grape production areas were located in the Central Plain region at Nakhon Pathom, Ratchaburi, Samut Sakhon and Samut Songkhram provinces, which are near Bangkok. At present, the grape industry has expanded to the Northern, Northeastern and the Western regions.

The climatic and soil features of the grape growing areas are described below. In the Central Plain area the range of temperature, average rainfall/year, range of relative humidity and altitude are 25-30° C, 1300-1450 mm, 60-90 percent and 2-3 m, respectively. The soil is of a clayey type and drainage is often very poor in this region. It is, therefore, necessary to improve the drainage system by using the ‘ditch and dyke system’ which involves constructing raised beds alternating with ditches. The soil pH is about 5-5.5. Lime and manure are also needed to improve chemical and physical properties of these soils. The water sources in the Central Plain come from rivers and canals. In the Northern region the range of temperature, average annual rainfall, range of relative humidity and altitude are 10-20° C, 1400-1500 mm, 60-90 percent and 1200 m, respectively. The soil is a clay loam type and well drained with a soil pH of about 4-5. The water source comes from reservoirs that have been constructed for irrigation. In the Northeastern part of the country the range of temperature, average rainfall/year, range of relative humidity and altitude are 19-30° C, 1200-1300 mm, 60-90 percent and 450 m., respectively. The soil is a clay loam type with a pH of about 3.5-5, while the water sources also come from reservoirs.

2. PRESENT STATUS OF GRAPE CULTIVATION IN THE COUNTRY

The production status of grapes in Thailand in 1998 is shown in Table 1.

At present, there are about 2,717 hectares producing 31,677 tonnes/year with an average yield of about 15 t/ha. The main areas of grape production are located in the Central Plain area at Ratchaburi, Samut Sakhon and Nakhon Pathom, which mainly produce table grapes. However, some private firms use these table grapes for wine making. In the Northeastern region, growers grow both table and wine grapes. There are two wineries at Loei and Nakhon Ratchasima provinces. In the Northern region, the growers produce table grapes in Chiang Mai and Nan provinces and wine grapes in Phichit province. In these
northern parts of Thailand, grape varieties were introduced into the highlands under the auspices of the Royal Project in 1981. Research work aims to improve the living conditions of hill tribes and use grape as a substitute crop for opium poppy. Results indicated that the varieties Beauty Seedless, Ruby Seedless and Early Muscat gave good growth, production and quality. Extension activities are currently being continued.

Data on the production of table and wine grapes are presented in Table 2. The main varieties for table grapes are white Malaga and Cardinal, which produced about 27,556.7 and 4,043.9 tonnes, respectively. These two varieties are mainly used for table grapes as well as for wine making. Other less important varieties are Kyoho, Beauty Seedless, Early Muscat and Carolina Black Rose. The major varieties of wine grapes are Chenin blanc and Shiraz, which produced a premium, table white wine and a red wine, respectively.

3. PRODUCTION OF PLANTING MATERIAL

There are no Government nurseries to produce grape planting materials. However, the growers can buy the planting material from private nurseries, which are situated in the grape growing areas.

Grapes are commercially propagated by asexual methods. The common practices of propagating are by marcotting (air layering), marcotting followed by budding, or raising cuttings and subsequently budding onto these rooted cuttings. The methods of marcotting - budding and cutting - budding techniques are accepted by nurserymen and growers.

Solonis x othello 1613 is the only rootstock which is used for table and wine grape varieties. It is vigorous, nematode and phylloxera resistant, drought and waterlogging resistant, less resistant to lime, while at the same time it roots and grafts easily.
Table 1. Production Status of Grape in Thailand in 1998

<table>
<thead>
<tr>
<th>Province</th>
<th>Total (^\dagger) Planted Area (ha)</th>
<th>Total Production (tonnes)</th>
<th>Average Yield (t/ha)</th>
<th>Table Grape (ha)</th>
<th>Wine Grape (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Kingdom</td>
<td>2,717.9</td>
<td>31,677.1</td>
<td>15.2</td>
<td>2,377.5</td>
<td>340.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(87.4%)</td>
<td>(12.6%)</td>
</tr>
<tr>
<td><strong>Northern Region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chiang Mai</td>
<td>8.0</td>
<td>0</td>
<td>0</td>
<td>8.0</td>
<td>-</td>
</tr>
<tr>
<td>Nan</td>
<td>11.5</td>
<td>22.5</td>
<td>9.4</td>
<td>11.5</td>
<td>-</td>
</tr>
<tr>
<td>Phichit</td>
<td>6.4</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>6.4</td>
</tr>
<tr>
<td>Total</td>
<td>25.9</td>
<td>22.5</td>
<td>-</td>
<td>19.5</td>
<td>6.4</td>
</tr>
<tr>
<td><strong>Northeastern Region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nakhon Phanom</td>
<td>2.4</td>
<td>0</td>
<td>0</td>
<td>2.4</td>
<td>-</td>
</tr>
<tr>
<td>Nakhon</td>
<td>90.2</td>
<td>1,045.0</td>
<td>14.5</td>
<td>18.2</td>
<td>72</td>
</tr>
<tr>
<td>Ratchasima</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buriram</td>
<td>13.3</td>
<td>52.2</td>
<td>16.3</td>
<td>13.3</td>
<td>-</td>
</tr>
<tr>
<td>Loei</td>
<td>224.0</td>
<td>2,800.0</td>
<td>12.5</td>
<td>112.0</td>
<td>112.0</td>
</tr>
<tr>
<td>Si Sa Ket</td>
<td>2.4</td>
<td>0</td>
<td>0</td>
<td>2.4</td>
<td>-</td>
</tr>
<tr>
<td>Surin</td>
<td>2.2</td>
<td>0</td>
<td>0</td>
<td>2.2</td>
<td>-</td>
</tr>
<tr>
<td>Ubon Ratchathani</td>
<td>3.7</td>
<td>0</td>
<td>0</td>
<td>3.7</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>338.2</td>
<td>3,897.2</td>
<td>-</td>
<td>154.4</td>
<td>184.0</td>
</tr>
<tr>
<td><strong>Central and Western Regions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saraburi</td>
<td>39.7</td>
<td>49.0</td>
<td>17.0</td>
<td>39.7</td>
<td>-</td>
</tr>
<tr>
<td>Ang Thong</td>
<td>5.1</td>
<td>108.0</td>
<td>25.0</td>
<td>5.1</td>
<td>-</td>
</tr>
<tr>
<td>Ratchaburi</td>
<td>1,427.8</td>
<td>16,894.5</td>
<td>17.0</td>
<td>1,339.8</td>
<td>88.0 *</td>
</tr>
<tr>
<td>Samut Songkhram</td>
<td>3.2</td>
<td>20.0</td>
<td>6.3</td>
<td>3.2</td>
<td>-</td>
</tr>
<tr>
<td>Samut Sakhon</td>
<td>647.7</td>
<td>9,525.5</td>
<td>15.7</td>
<td>587.7</td>
<td>60.0 *</td>
</tr>
<tr>
<td>Nakhon Pathom</td>
<td>92.2</td>
<td>1,160.4</td>
<td>23.7</td>
<td>90.2</td>
<td>2.0 *</td>
</tr>
<tr>
<td>Suphan Buri</td>
<td>12.2</td>
<td>0</td>
<td>0</td>
<td>12.2</td>
<td>-</td>
</tr>
<tr>
<td>Kanchanaburi</td>
<td>125.9</td>
<td>0</td>
<td>0</td>
<td>125.9</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>2,353.8</td>
<td>27,757.0</td>
<td>-</td>
<td>2,203.8</td>
<td>150.0</td>
</tr>
</tbody>
</table>

Source: Department of Agriculture Extension
Remark: \(^\dagger\) Nonbearing, includes planting
* Estimated planted area by amount of processing used.
### Table 2. Production Statistics for Table Grape and Processing Varieties in 1998

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Total Production (tonnes)</th>
<th>Table Grape (tonnes)</th>
<th>Wine Grape (tonnes)</th>
<th>Wine Cooler (tonnes)</th>
<th>Others&lt;sup&gt;1/&lt;/sup&gt; (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Malaga</td>
<td>27,556.7</td>
<td>25,956.7</td>
<td>100*</td>
<td>1,500*</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Cardinal</td>
<td>4,043.9</td>
<td>3,293.9</td>
<td>50*</td>
<td>700*</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Kyuho</td>
<td>22.5</td>
<td>22.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Beauty Seedless</td>
<td>53.0*</td>
<td>53.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chenin blanc</td>
<td>150.0*</td>
<td>-</td>
<td>150*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shiraz</td>
<td>100.0*</td>
<td>-</td>
<td>100*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Other Varieties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eary Muscat</td>
<td>8.0*</td>
<td>8.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Carolina Black Rose</td>
<td>10.0*</td>
<td>10.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>31,944.1</td>
<td>29,344.1</td>
<td>400</td>
<td>2,200</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Source: Department of Agriculture Extension  
Remark: * Personal communication  
<sup>1/</sup> Fruit salad, Juice

### 4. ESTABLISHMENT OF VINEYARDS

In the Central Plain vines are grown on raised beds (about 6 m wide) in areas that have a high watertable or are waterlogged. The beds alternate with the ditches (about 1 m wide and 1 m deep) which provide for irrigation as well as for drainage. The water is also used for mixing with fungicide and insecticide for spraying. The vines are usually grown at the centre of the bed, about 2 m apart or at the two edges of the raised beds. The number of vines per hectare varies from 550 to 1,100 vines.

In the upland areas where a high watertable does not pose a problem raised beds are not necessary. Land preparation and digging planting holes should be done after the rainy season. The size of the hole is usually 0.5 x 0.5 x 0.5 m (width x length x depth). The spacing is about 1.5 - 2 x 3.5 - 4 m with the number of vines planted at 1,250-1,875 density per hectare. Soil in the planting holes is allowed to dry for one month before planting. Manure or compost should be mixed with the soil and filled up in each hole. The suitable schedule for planting is in January or February.

### 5. CARE AND MANAGEMENT OF VINEYARDS

**Support**

Grapevines cannot be grown satisfactorily without some support. There were many kinds of training systems during the early years of grape culture in Thailand. At the present, the arbor system is preferred to a trellis. The height of the arbor is about 1.5 m above the
ground level. The top is about 2-3 m wide. However, the training systems are dependent on the varieties of grapes, climate, and objectives of the growers.

Training and Pruning

In training a vine, the canes are spread out evenly to cover the area of the arbor, with no definite or regular training design. When the vine is 10 to 12 months old, the mature canes are pruned in order to force out the buds.

Fertilizer Application

Grapevines can adapt themselves to a wide range of soil fertility conditions. However, fertilizers are necessary for vigorous growth, high yield and to give better quality fruits. The main areas of grape culture in Thailand have clay soil types and were formerly rice fields. These soils need a large amount of organic matter and, therefore, manure is used a great deal. Complete fertilizers are usually applied to grapevines in the following manner:

- During the early growth phase of young vines obtained by budding, grafting or marcotting or before the first pruning, ammonium sulphate, urea or complete fertilizer (15:15:15) at the rate of 200-300 g/plant are usually applied every month.

- One to two months before the regular pruning period, fertilizer (9:25:25) at the rate of 200-300 g/plant is applied to promote flower bud development.

- Two weeks after fruit set, complete fertilizer (15:15:15) at the rate of 200-300 g/plant is applied to facilitate fruit growth and development.

- During the beginning of fruit softening or during colour change about one month before harvesting, complete fertilizer (13:13:21 or 12:12:17:2 or 9:25:25) at the rate of 200-300 g/plant should be applied to enhance fruit quality.

Weeding

In the Central Plain area, weeds are usually controlled by hand hoeing and application of herbicides. The herbicide used is grammoxone, which destroys the green parts of the weeds as the farmers prefer clean cultivation. In the uplands, weeds are controlled by hand hoeing, ploughing and using herbicides.

Irrigation

Water source and supply are important for the vineyards. Reservoir and groundwater tube wells are suitable for surface irrigation. Pipeline systems and hose irrigation would be practical and more economical for the farmers. However, mulching with rice straw is also very necessary during the dry season. In the Central Plain areas, the vines are grown on raised beds alternating with the ditches, which can provide the water supply needed for the vines.
Insects and Diseases

Insect problems are not that serious but diseases such as downy mildew, powdery mildew, anthracnose, bitter rot and fruit rot are quite harmful.

**Insects:** There are several kinds of insects that attack leaves, flower and berries e.g. leaf hopper, leaf roller, thrips and mites. The insecticides used for control are carbaryl, methomyl, carbosulfan, and dicofol, etc.

**Diseases:** The important diseases of grapes are described below:

a) **Downy Mildew:** The fungus (*Plasmopara viticola*) thrives best and becomes most destructive during still, cool and moist weather. Although primarily a foliage disease, the fungus also attacks flower clusters. The fungicides used for control of downy mildew are Zineb, Maneb, Captan, Mancozeb and Metalaxyl.

b) **Powdery Mildew:** The causal fungus (*Oidium tuckeri*) unlike most other diseases of grapes, which are favoured by moist conditions, thrives best in a dry climate. It attacks during berry growth and these developing berries will crack later. For the control of powdery mildew, the vines are sprayed with wettable sulphur.

c) **Anthracnose:** The causal fungus (*Gloeosporium ampelophagum*) attacks all parts of vines. The fungal attack is usually serious during the rainy season. For the control of anthracnose, the vines are sprayed with Mancozeb, carbendazim or benomyl.

d) **Dead Arm:** The fungus (*Melanconium fuligineum*) attacks during fruit maturity, particularly during 2-3 weeks before harvesting. The affected canes will die and the fruit will soften and shrink. For the control of this fungus a spraying of copper fungicide or difenoconazole is given to all parts of the vines.

e) **Berry Rots:** There are several fungi which will attack the berries and fruit clusters during fruit maturity such as Blue mold (*Penicillium* spp.), Rhizopus rot (*Rhizopus* spp.), Ripe rot (*Collectotrichum gloeosporioides*), Bitter rot (*Greeneria uvicola*) and Botrytis bunch rot (*Botrytis cinerea*). The fungal attack is usually serious during the rainy season. The control of these fungi is by spraying common systemic fungicides.

Special Practices for Improving Grape Quality

There are some special practices to improve the yield and quality of grapes such as:

- Improving bud break or bud burst is achieved by treating canes with hydrogen cyanamide.
- Cluster elongation, cluster loosening, berry enlargement and seedlessness are induced by treating with gibberellic acid (GA).
- Increasing fruit colouration can be achieved by ethrel (2-chloroethylphosphonic acid) application.
- Rain and bird damage can be controlled by using a plastic roof and bagging of bunches.
6. HARVESTING AND YIELDS

Thailand has a tropical climate, which seems to stimulate the growth of grapes immensely. The first crop can be expected only 14 to 16 months after planting. The harvest can be timed at will because planting and pruning can be done at anytime of the year. The buds of the canes can be forced to sprout at any time of the year by pruning and consequently, two to three crops can be harvested from an individual vine in a year. In practice, however, the growers prune their vines twice a year and get two crops, one in the rainy season (May to October) and the other crop in the drought season (November to April). The latter crop is superior due to higher sugar content and better appearance. In the Central Plain area, grapes are grown under the ditch and dyke system. The pruning can also be done at any time of the year. However, in this intensive culture system disadvantages can be expected as the vines have a short life span of only 7 to 10 years. In general, the crop is inferior in quality during the rainy season and vineyard management is also quite intensive.

In White Malaga, which is a late variety, growers can have two harvests a year per vine or five harvests per vine every two years. The average yield is 15-20 kg per harvest. With Cardinal, a very early variety, one can have even three to four harvests a year per vine. The average yield of a vine is 12-15 kg per harvest.

7. MARKETING

Marketing of grapes in Thailand is not organized as there is no organization or association for marketing of this crop. Hence, the sequence of marketing is usually from the growers to middlemen (1 or 2) who transport to markets from which the produce is retailed to consumers. Most of table grapes are for domestic consumption. The export of table grapes is only a small amount (Table 3). The price of table grapes depends on the variety, quality, season and demand. The average farm price of old varieties like white Malaga and Cardinal is about 30-37 baht/kg, while that of the new variety of seedless grapes is about 100-150 baht/kg.

Table 3. Quantity and Value of Grape Exports (1993-1997)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grapes</td>
<td>40</td>
<td>861</td>
<td>34</td>
<td>707</td>
<td>31</td>
<td>545</td>
<td>22</td>
<td>509</td>
<td>38</td>
<td>839</td>
</tr>
</tbody>
</table>

Source: Office of Agricultural Economics
Remark: Quantity: metric tonnes
Value: 1,000 baht

The data in Table 4 and 5 show the quantity and value of table grapes and wine imports. The quantity and value of table grapes and wine have increased since 1993 up to the present time.
Table 4. Quantity and Value of Grape Imports (1993-1997)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
</tr>
<tr>
<td>Grape Fresh</td>
<td>1,633</td>
<td>131.7</td>
<td>2,326</td>
<td>177.4</td>
<td>2,318</td>
</tr>
<tr>
<td>Grape Dried</td>
<td>81</td>
<td>4.9</td>
<td>53</td>
<td>2.5</td>
<td>79</td>
</tr>
<tr>
<td>Total</td>
<td>1,714</td>
<td>136.6</td>
<td>2,379</td>
<td>179.9</td>
<td>2,397</td>
</tr>
</tbody>
</table>

Source: Office of Agricultural Economics
Remark: Quantity: metric tonnes
Value: 1,000 baht

Table 5. Quantity and Value of Wine Imports (1993-1997)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
</tr>
<tr>
<td>Champagne (1000 litres)</td>
<td>157</td>
<td>30.9</td>
<td>189</td>
<td>25.92</td>
<td>396</td>
</tr>
<tr>
<td>Wines (1000 litres)</td>
<td>111</td>
<td>10.1</td>
<td>114</td>
<td>11.8</td>
<td>193</td>
</tr>
<tr>
<td>Other wines (1000 litres)</td>
<td>1,824</td>
<td>141.5</td>
<td>1,907</td>
<td>169.9</td>
<td>3,657</td>
</tr>
<tr>
<td>Total</td>
<td>2,092</td>
<td>182.5</td>
<td>2,210</td>
<td>207.6</td>
<td>4,246</td>
</tr>
</tbody>
</table>

Source: Office of Agricultural Economics
Remark: Quantity: 1,000 litres
Value: 1,000 baht

8. POTENTIAL FOR GRAPE PRODUCTION DEVELOPMENT

In the past, table grapes were imported from foreign countries at great cost. Since 1960, grape growers have succeeded in producing grapes locally and even have exported to foreign markets. In 1987, however, new varieties of good quality table grapes continued to be imported in increased quantity and value (Table 4) although the imported table grapes were expensive. Both table and wine grapes have a very good potential as a horticultural fruit crop, although it requires an intensive crop management. Nevertheless, it is a lucrative enterprise for farmers. The data of Table 5 shows the quantity and value of wine imports which is of great interest to the private commercial sector. At the present time, grape growing areas have expanded to many new provinces.

9. CONSTRAINTS IN GRAPE PRODUCTION DEVELOPMENT

Thailand is located within the tropical climatic belt characterized by a hot climate, high rainfall and humidity. However, the vines can be adapted to grow well. Although the fruit produced in the dry season is of very good quality, the production, productivity and quality of grapes is far below that of sub-tropical climatic regions. Grape production can be useful for local consumption and export to some countries in the Region. The advantage of grape production in the country is that growers can predict the harvesting time of the year by pruning, and the vines can be harvested two to three times a year.
There are several constraints to be considered that affects the development of the grape industry in Thailand.

- In the Central Plain or lowland areas, the growers have to construct raised beds or dykes alternating with ditches. The growers allow too much over-cropping, often harvesting two-three times a year. The vines, therefore, have a short life-span of about 7-10 years under this intensive cropping system.

- The temperature, rainfall and high humidity are limiting factors that affect produce quality.

- The growers spray a lot of fungicides and insecticides to protect their crops without considering residual effects of the chemicals. The growers learn their grape cultivation from nearby grape growers and they also use these potent chemicals on the advice of the chemical suppliers.

- High initial investment, especially high cost of new good varieties, trellising, constructing reservoirs and irrigation systems, agricultural tools, framework for plastic roofs to protect from the rain, high cost of insecticides, fungicides and fertilizers are constraints to the expansion of the grape industry.

- Lack of knowledge on diseases and pest control measures and quality control technologies.

- Inadequacy of sufficient Government policy support for the grape industry.

10. GOVERNMENT POLICIES AND PLANS FOR RESEARCH AND DEVELOPMENT OF GRAPES

The priority of the important economic fruit crops are considered by the Committee of the Horticulture Research Institute under the Department of Agriculture, Ministry of Agriculture and Cooperatives. The grape crop has been given the lowest priority among fruit crops. There are some plans for wine and table grape production development in 1977-2001 and the period of the next ten years beyond 2001. The aim is to study all aspects of production. In the past, there were only a few research papers on grapes. However, the Department of Horticulture, Faculty of Agriculture, Kasetsart University, has tried to study and carry out research on table and wine grapes since 1960 up to the present time.

11. CONCLUDING REMARKS

The grape industry in Thailand has progressed greatly since 1960. The main areas are located in the Central Plain, which is diversifying into the rice growing lands. The major grape varieties are White Malaga and Cardinal, which are used for table grape and wine making. At present, the grape industry has expanded to Northern, Northeastern and the Western regions. The total planted area of 2,717 hectares produces 31,677 tonnes/year and the average yield is about 15 t/ha. Of the total grape production, 87.4 percent is used as table grapes and 12.6 percent for wine production, respectively. Vineyard management is quite intensive and often costly to growers. There are many diseases and insect problems. Grape
growing, however, is a highly remunerative enterprise as the crop is easily marketable. The grape industry development should be supported by the Government through the cooperation of the researchers and the growers. Considering the increasing demand and the ingenuity of local farmers, the grape industry has much potential for further expansion in the years to come.

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GRAPE PRODUCTION IN VIET NAM

Le Quang Quyen, Vu Xuan Long, et al. *

1. INTRODUCTION

In Viet Nam, grapevines can be seen everywhere. For a long time, the people in Hanoi Capital have grown grapevines around their houses for ornamental purposes and for shade; but these grapevine trellises have produced small berries and bunches with very sour taste and low food value. Grapes are now grown commercially only in the South. Their quality is not really ideal but is not inferior to other fruits (Vu Cong Hau, 1997).

In other parts of the world viticulture has existed for thousands of years, but in Viet Nam it has just begun to be developed in recent years. Since its economic value is superior to that of other crop plants, areas under grapes in Viet Nam have quickly increased since the early 1990’s when only table grapes were the main article of commerce from grape cultivation.

The research work on grapes in Viet Nam has mainly been carried out by the Cotton Research Centre, which has a Food and Fruit Crops Department serving local agriculture. To understand more about the viticulture situation in Viet Nam and help the vine growers to solve production problems in varieties and techniques, since 1989 the Cotton Research Centre (an agricultural scientific research organization of the Government based in Ninh Thuan province) has carried out research on some urgent problems for the development of viticulture.

2. PRESENT STATUS OF GRAPE CULTIVATION

Major Vine Growing Regions

Growing grapes for commercial purposes began in the late 1970’s in the North of former Thuan Hai province (including Ninh Thuan province and Tuy Phong District of Binh Thuan province). In Northern provinces such as Bac Giang, Ha Tay, Hai Duong, Quang Ninh and Vinh Phuc, vines have begun to be planted on a small scale for experimentation. Hence, the research work has only been carried out in the vine growing region of Ninh Thuan province.

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Area Under Grapes

The statistical data on the areas under grapevines in Viet Nam are presented in Table 1.

Table 1. Areas under Grapevines in Viet Nam in Recent Years

<table>
<thead>
<tr>
<th>Provinces</th>
<th>Areas under Grapevines (hectares)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. In the North:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Bac Giang</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Ha Tay</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Hai Duong</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. Quang Ninh</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5. Vinh Phuc</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B. In the South:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Binh Thuan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Ninh Thuan</td>
<td>26</td>
<td>306</td>
</tr>
<tr>
<td>Total (hectares)</td>
<td>26</td>
<td>306</td>
</tr>
</tbody>
</table>

The data show that grapes have mainly been grown in Ninh Thuan and Binh Thuan provinces. Today, the areas under grapevines are mainly located in Ninh Thuan province (occupying 90 percent of the total area) and in Binh Thuan province (occupying 9 percent of the total area under grapes in the whole country).

Up to now, statistical figures on the production of grapes in Viet Nam have not been given by the State Statistical Department because the area under grapes is very small in comparison to other crops.

Variety Information

In the middle of 1980’s, the four grape varieties that were popular in former Thuan Hai province were Muscat blanc, Alden, Ribbier and Cardinal (Vu Xuan Long et al, 1992). In the 1990’s, only the Cardinal variety became popular. This variety has some advantages such as high yield potential, difficult separation from pedicels, and short growing duration in comparison with Muscat blanc, Alden and Ribbier varieties. Duration of each cropping cycle is about 85-95 days from pruning to harvesting, with one month resting of vines before pruning again. Such a cycle needs about four months duration and three harvests per year can be possible.

Viet Nam did not introduce any new grape varieties for nearly 30 years. Hence, both producers and consumers have not been able to select other varieties at will and they have had to depend on the Cardinal variety to meet their urgent needs for local consumption.

Climatic Conditions in Grape Growing Regions

The rainfall in the Northern grape growing regions is much higher than that of Ninh Thuan. Annual rainfall in these provinces varies from 1,500 to 1,900 mm (Appendix 1). High rainfall is the main impediment that caused areas under grapes in the North not to
increase but to be reduced, which was also based on experimental studies carried out for some years.

Ninh Thuan is a dry region with a mean temperature of 24-28°C, a low relative humidity of 72-85 percent, high sunshine hours per month ranging between 130-287 hours, an annual average rainfall of 750-900 mm, and a lesser number of rainy days per year (Appendix 2). These climatic conditions are fairly favourable for the growth and development of grapes.

**Soil Conditions in Ninh Thuan Grape Region**

The results from a survey on the nutrition status in the soil of 800 hectares in Ninh Thuan showed that the soil conditions were very suitable for the growth and development of grapes, which included neutral to low acidity, high availability of phosphorous and potassium, and medium level humus content.

### 3. PRODUCTION OF PLANTING MATERIAL

Many years ago, there were no Government or private nurseries producing planting material of grapes in Viet Nam. Hence, farmers had to produce planting material of grapes for themselves by using cuttings and a few by layering.

Today, there are three organizations that have been tasked to produce planting material of grapes for farmers, namely the Cotton Research Centre, Ninh Thuan Domestic Animal and Crop Breeding Centre and Binh Thuan Socio-Economic Development Centre. All of them are researching on rootstocks to identify suitable planting materials for different soil and climatic conditions of the various grape growing regions. Besides, the Cotton Research Centre is conducting studies to propagate grapes by the in vitro method.

### 4. ESTABLISHMENT OF VINEYARDS

**Land Preparation**

Some operations that need to be carried out before planting include deep plowing and harrowing to improve good porosity and aeration of the soil. The land is then divided into plots following the general gradient of the land to facilitate appropriate irrigation and drainage layout. This is followed by fine leveling of the surface of each plot, digging holes, and filling with a mixture of topsoil, phosphate fertilizer and lime (if necessary) before commencement of planting.

**Planting Season**

In Ninh Thuan and Binh Thuan provinces, the farmers usually plant grapes at the end of the rainy season and at the beginning of the dry season. The most suitable planting time is in December and January.
Spacing

Grapes are planted at a spacing of 2.5 x 2.0 m, which gives a density of about 2,000 plants per hectare. In Ninh Thuan and Binh Thuan grape growing regions, the farmers have only used the overhead arbor system for training vines. The height of the trellis depends on the convenience of the worker.

5. CARE AND MANAGEMENT OF VINEYARDS

5.1 Training and Pruning of Plants

Training

In Viet Nam, vine branches are trained into a cobweb-like design. When vines climb to the top of the trellis (about 2-3 months after planting), the tops of main stems are cut in order to promote 2-3 main arms or branches. After 1-1.5 months, the tops of these arms are pruned back to induce 2-3 secondary branches, and canes are spaced at convenient distances along the secondary branches to achieve the required network. Ninh Thuan farmers have a habit of pruning bearing canes for the first harvest after allowing vines to grow for about 8-10 months.

It is necessary to tie branches to the trellis and pluck unwanted axillary buds in time before the blooming period. Vine branches are usually tied along the horizontal plane on the surface of the trellis for better flowering. Plucking axillary buds is regularly done in order to create good conditions for growth and development of the main branches.

Pruning

Vines in Ninh Thuan can be induced to produce at any time of the year (2.5-3 harvests a year), so grape pruning time is possible all the year round. A grape season lasts about 4 months, and 25-30 days after each harvest vines are pruned again for the next crop. The 8-month old branches are usually pruned in winter-spring for the first crop and every 4 months thereafter. Pruning positions on the canes are from the eighth to the twelfth nodes for the strong branches, and from the fourth to the sixth nodes for the weak canes.

5.2 Application of fertilizers

The results from a survey on fertilizer use are presented in Table 2.

<table>
<thead>
<tr>
<th>Kinds of Fertilizers</th>
<th>Total (kg/hectare/crop)</th>
<th>Percentages of Weights on Different Stages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before Pruning</td>
</tr>
<tr>
<td>1. Humus</td>
<td>25.300 ± 7.850</td>
<td>100</td>
</tr>
<tr>
<td>2. N</td>
<td>539 ± 68</td>
<td>54.76</td>
</tr>
<tr>
<td>3. P₂O₅</td>
<td>339 ± 56</td>
<td>65.30</td>
</tr>
<tr>
<td>4. K₂O</td>
<td>288 ± 73</td>
<td>45.25</td>
</tr>
</tbody>
</table>
Application of nitrogenous fertilizer was mainly carried out before pruning (55 percent N), from pruning to flowering stage (26 percent), and 19 percent at berry enlarging stage.

Almost all phosphorous fertilizer was given before pruning, the rest was applied at the bud, flower and berry enlarging stages in the form of mixed fertilizers. However, it was observed that fertilizing nearly 25 percent of the total amount of phosphorous fertilizer in the berry growing stage was rather high.

Potassium fertilizer used for grapes before pruning was 45 percent and 44 percent for the berry enlargement and colour break stages.

5.3 Weeding

Average vineyard size of each household is very small, usually about 0.1-0.4 hectares. Hence, controlling weeds is only carried out by hand. In recent years, roundup herbicide has begun to be used. At present, the Cotton Research Centre has been carrying out some research on polyethylene film mulching as a measure for control of weeds in grapes.

The results from the survey on farming techniques showed that 70 percent of vine growing households turned up the soil at least once per crop and others did it once per year. Turning up the soil is often carried out after the last harvest together with the incorporation of organic and inorganic fertilizers before the next pruning.

5.4 Supplementary Irrigation

According to Ninh Thuan farmers, irrigation and fertilization are the main inputs for ensuring high grape productivity and quality. Irrigation is only necessary in the dry season but not important in the wet season. Farmers have often used the flooding method of irrigation on the surface of grape beds. The quantity of water and the irrigation frequency together with inorganic fertilizer application are the most important practices of all the field operations. Vineyards are usually irrigated according to a 10-15 day schedule, but in sandy soils it is shorter, usually about 5-7 day intervals.

5.5 Insects and Diseases

Insects

Vines are attacked by some destructive insects such as mealy bug (*Ferrisiana virgata*), thrips (*Thrips sp.*), red spider mites (*Eotraniclus carpini*), and yellow spider mites etc. These pests usually exist on vines and cause great damage in dry seasons.

The main kind of chewing pest is the army worm (*Spodoptera exigua*). It bites young leaves, buds and flowers. It occurs and causes serious damage in dry seasons.

Diseases

Grapes are infected by several diseases that are economically important.
Downy mildew disease caused by *Plasmopara viticola* fungus infects mostly young and fully grown leaves. The population dynamics and damage caused by this pest indicate that the disease is persistent in vineyards and causes damage all the year round, especially in the rainy season (May to November).

Bunch rot disease caused by *Diplodia natalensis* fungus infects the peduncles of bunches at flowering and young berry stages. Hence, it is very difficult to control this disease when vines are infected which causes serious losses to grape yields. Population dynamics and nature of damage indicate that this disease seems to occur nearly all the year round, especially in the rainy season (May to November).

Powdery mildew disease caused by *Uncinula necator* fungus infects berries and old branches. Population dynamics and damage show that this disease exists in vineyards and develops and causes damage all the year round, especially in dry seasons (December to April).

Rust disease is caused by *Kuehneola vitis* fungus, which infects fully grown leaves. This disease often develops and debilitates vines only in the rainy seasons (June to November).

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Infected Part</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diseases:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Downy mildew</td>
<td><em>Plasmopara viticola</em></td>
<td>Young and full leaves</td>
</tr>
<tr>
<td>Bunch rot</td>
<td><em>Diplodia natalensis</em></td>
<td>Peduncles of bunches</td>
</tr>
<tr>
<td>Powdery mildew</td>
<td><em>Uncinula necator</em></td>
<td>Berries and old branches</td>
</tr>
<tr>
<td>Rust</td>
<td><em>Kuehneola vitis</em></td>
<td>Full and old leaves</td>
</tr>
<tr>
<td><strong>Pests:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Army worm</td>
<td><em>Spodoptera exigua</em></td>
<td>Leaves, squares and flowers</td>
</tr>
<tr>
<td>Mealy bug</td>
<td><em>Ferrisiana virgata</em></td>
<td>Branches</td>
</tr>
<tr>
<td>Thrips</td>
<td><em>Thrips sp.</em></td>
<td>Leaves, Berries, Branches</td>
</tr>
<tr>
<td><strong>Spider mites:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red spider mites</td>
<td><em>Eotraniclus carpini</em></td>
<td>Leaves</td>
</tr>
<tr>
<td>Yellow spider mites</td>
<td><em>Unknown</em></td>
<td>Leaves</td>
</tr>
<tr>
<td><strong>Nematodes:</strong></td>
<td><em>Unknown</em></td>
<td>Roots</td>
</tr>
</tbody>
</table>

**Table 3. Some kinds of Pests and Diseases Recorded on Grapevines in Viet Nam**

**Pest and Disease Management**

As mentioned above, the Cardinal variety in Ninh Thuan has degenerated and possesses weak pest resistance. Moreover, haphazard pruning at any time of the year without any organized cropping system always causes conditions favourable for pests and diseases to develop and cause damage. Hence, controlling them becomes one of the important factors that affect the yield and economic effectiveness in viticulture programmes.

In the past, lime-sulphur, copper sulphate and bordeaux mixture were mainly used to control diseases of grapes. These chemicals were cheap but had to be sprayed many times per crop. When new foreign-made chemical fungicides and pesticides were used to control diseases and insects of grapes, some remarkable results were obtained including fewer
spraying times, long-lasting effect from each spraying, and lower labor costs. Since 1989, the Cotton Research Centre has screened many fungicides and recommended some of them to farmers, including Rovral, Rozin, Ridomil MZ, Ridomil combi, Score, Topas, Anvil, Antracol, Copperhydroxide, Tilt, Baycor, Curzate, and Bayfidan, etc.

For army worm (*Spodoptera exigua*), it has been found that it is very difficult to control this kind of pest with chemical insecticides. However, researchers found it easy to control army worm with a biological product, Nuclear Polyhedrosis Virus (NPVSe) made at the Cotton Research Centre.

Nematodes, such as the vine-damaging nematode, were mentioned by scientists of the Cotton Research Centre some years ago. However, this problem has not yet been studied due to lack of budget resources.

6. **HARVESTING AND YIELDS**

Grape yields are shown in Table 4.

### Table 4. Grape Yield (t/ha) Based on Different Age of Vines and Crops
(By Vu Xuan Long, et al. 1992)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>8.00</td>
<td>8.00</td>
</tr>
<tr>
<td>2</td>
<td>10.55 ± 4.75</td>
<td>2.67 ± 3.46</td>
<td>18.67 ± 4.71</td>
<td>31.89 ± 10.90</td>
</tr>
<tr>
<td>3</td>
<td>20.00 ± 11.32</td>
<td>8.10 ± 7.19</td>
<td>20.61 ± 5.87</td>
<td>40.71 ± 22.20</td>
</tr>
<tr>
<td>4</td>
<td>15.56 ± 4.45</td>
<td>8.70 ± 5.85</td>
<td>16.73 ± 3.29</td>
<td>41.33 ± 9.82</td>
</tr>
<tr>
<td>5</td>
<td>14.90 ± 4.70</td>
<td>10.24 ± 6.61</td>
<td>16.30 ± 2.98</td>
<td>41.44 ± 13.06</td>
</tr>
<tr>
<td>6</td>
<td>9.38 ± 3.74</td>
<td>6.13 ± 2.93</td>
<td>10.62 ± 4.08</td>
<td>26.12 ± 5.35</td>
</tr>
<tr>
<td>7</td>
<td>22.50</td>
<td>5.00</td>
<td>5.75</td>
<td>33.25</td>
</tr>
<tr>
<td>8</td>
<td>5.33</td>
<td>7.33</td>
<td>-</td>
<td>12.66</td>
</tr>
</tbody>
</table>

Average grape yield (metric tonnes/hectare/year) 29.43

From the data in Table 4, the following observations have been made:

- Grapes in Ninh Thuan age fast and become senescent due to severe exploitation of vines. Normally, the vine growers have to get rid of old vines for replanting after they are cropped for about 10 years. This seems to be a bad way of forcing culture (pruning and harvesting 2.5-3 times per year) and the vines consequently degenerate fast.

- The grape yield of the Autumn-Winter season is the lowest in a year, which is only about 50 percent in comparison with other seasons. The main reason for low productivity is that, in the pruning period of this season (in September and October), heavy and continuous rains often appear, which cause root rot and disadvantages for the blossoming process.

The results from a random investigation of 50 vineyards of different plant ages in 1995 and 1996 showed that mean grape productivity in Ninh Thuan was over 30 tonnes per
hectare/year. Planting grapes could bring a profit of over VND 100 million per hectare/year. Grape yield is high and stable in Winter to Spring or Spring to Summer seasons but low and unstable in Autumn to Winter (Appendix 3).

7. MARKETING

Up to now, most grapes produced in Ninh Thuan and Binh Thuan provinces have been consumed in the form of table grapes, and a small quantity of grapes with very poor quality are processed into local juice and wine. Grapes are transported everywhere in Viet Nam by dealers and middlemen.

At present, Viet Nam is importing 2 kinds of table grapes from abroad. Consumers are aware that they are produced in the United States, Australia or Thailand. Table grape prices are shown in Table 5.

Table 5. The Prices of some Kinds of Grapes at the Free Markets in Viet Nam (April 2000)

<table>
<thead>
<tr>
<th>Kind of Table Grapes</th>
<th>Place of Production</th>
<th>Wholesale Price (VND/kg)</th>
<th>Retail Price (VND/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A kind of table grape with very big berries, red colour, few seeds</td>
<td>Abroad</td>
<td>Unknown</td>
<td>90,000-110,000</td>
</tr>
<tr>
<td>2. A kind of table grape with big berries, green-yellow colour, seedless</td>
<td>Abroad</td>
<td>Unknown</td>
<td>60,000-80,000</td>
</tr>
<tr>
<td>3. Cardinal</td>
<td>Viet Nam</td>
<td>5,000-10,000</td>
<td>10,000-15,000</td>
</tr>
</tbody>
</table>

Note: Exchange Rate VND 14,000/USD

8. POTENTIAL FOR GRAPE PRODUCTION DEVELOPMENT

The potential for grape production development in Viet Nam, especially in Ninh Thuan and Binh Thuan provinces, is very good because of some salient factors that are linked to high demand for grapes. These are as follows:

- Consumer needs for grapes keep increasing.
- Market potential for grapes in Viet Nam is still very large for fresh grapes and processed products.
- The vine growing region of Ninh Thuan and Binh Thuan have relatively dry conditions with the lowest rainfall in the country.
- There is considerable wasteland on the hills and near the low mountains that can be utilized for expanding viticulture.
- The vine growers have a lot of experience on intensive cultivation of grapes.
- Both Government and local authorities are interested in the development of the grape industry.
9. CONSTRAINTS IN GRAPE PRODUCTION DEVELOPMENT

In 1998 and 1999, like other provinces in the centre of Viet Nam, Ninh Thuan was affected by natural disasters (storms and floods) that caused serious damage to viticulture. The total area under destroyed vineyards by storms and floods was 1,487 hectares (occupying more than 50 percent of areas under grapes at the beginning of 1998). Storms and floods weakened the crop that survived and it may take a long time for them to recover.

Due to the economic advantages of viticulture, some farmers have diversified from other crops to grow grapes, even in double-cropped rice fields or in the sandy soils near the coast. Hence, there were some vineyards established in unsuitable soils such as in sunken terrain which floods frequently, soils with high acid content, as well as in very infertile soils. In order to get reasonable harvests from such soils, farmers had to invest more in comparison to other areas.

Heavy rains often occurred at the end of the year (August to November) together with high temperature, when some diseases develop very quickly. Large quantities of fungicides have to be used in this period.

Up to now, cultivation techniques for grapes have not been properly studied. Farmers have had to toil in their vineyards in order to gain experience for themselves. As a result, the harvests are unstable, uses of fertilizers are excessive and consequently, production tends to suffer.

10. GOVERNMENT POLICIES FOR VITICULTURE DEVELOPMENT

The Government of Viet Nam has issued several general policy directives for development of fruit crops all over the country, including grapes. These policies include encouraging farmers to change crop planting composition to diversify agriculture and farm products, providing loans to farmers at low interest rates, and constructing new water reservoirs as well as main channel systems for agricultural production. In recent years, Viet Nam Agriculture and Rural Development Ministry has made initial investments for research and agriculture extension including surveys on grape cultivation techniques for farmers, forming agro-extension models for planting new varieties, as well as IPM programmes. These investments are, however, too small in comparison with the grape growers' needs, especially on production techniques.

Since Ninh Thuan province was re-established in 1992, the provincial authorities have affirmed that the development of viticulture is one of the key tasks in its socio-economic programme. Hence, they have begun to show their concern for the development of viticulture by investing more for research on variety collections, surveying the suitable areas for grapes, and building wineries for processing, etc. However, these investments are still insufficient in comparison with production needs.
Research Work on Grapes in Viet Nam

Research on Vine Collections

There are four organizations in Viet Nam maintaining and researching on vine collections. These are the Cotton Research Centre, Hanoi Vegetable and Fruit Research Institute, Ninh Thuan Domestic Animal and Crops Breeding Centre and Binh Thuan Social and Economic Development Centre.

At the Cotton Research Centre these varietal studies carried out from 1994 to 2000 have included the collection and introduction of 61 accessions. Among them there are 12 domestically collected accessions and 49 accessions introduced from abroad (France, United States, Australia, India, Thailand, China and Germany) including 34 table grape accessions, 25 wine grape accessions and 3 rootstock varieties. Through the results of research on this collection, some specific promising accessions were identified and presented for further research. Table grape accessions selected are NH-01-08, NH-01-48 and NH-01-60; wine grape accessions selected are NH-02-04, NH-02-10 and NH-02-17 and the raisin grape accession is NH-01-11.

At Hanoi Vegetable and Fruit Research Institute, 5 accession wine grape collections introduced from France have been studied since 1995. As a result, Vilard noir accession has been identified as a variety having the highest productivity and the best quality (By Nguyen Quoc Hung, Tran The Tuc, Vu Manh Hai and Stephen Desmazieres, 1999). Besides, this Institute has just introduced some additional vine accessions. There are 28 accessions in the collection here at present, including 16 table grape and 12 wine grape accessions.

At Ninh Thuan Domestic Animal and Crop Breeding Centre, the grape collection mainly contained wine grape accessions introduced from Australia from 1995. In 1996, the Germans supplemented some table grape and rootstock accessions to this collection. Now, there are 33 accessions in the collection including 17 table grape accessions, 13 wine grape accessions and 3 rootstocks. From the result of the research on the vine collection, Black Queen table grape variety has been released for screening on an experimental and pilot production scale.

At Binh Thuan Social and Economic Development Centre (established by the Germans together with local authorities in Binh Thuan province) one of its tasks was to research on vine varieties for farmers in Tuy Phong district. Hence, up to now a 42 accession vine collection has been established here. Among them there are 32 table grape accessions, 5 wine grape accessions and 5 rootstocks. Today, this Centre has also released the Black Queen table grape variety for screening and pilot production on a small scale.

Research on Some Promising Table Grape Varieties

Initial results of studies on grape yield and quality in preliminary investigations showed that NH-01-48 table grape accession has more advantages than the Cardinal variety. Hence, this accession was selected for testing on a large scale. From these demonstrations carried out over several seasons, the following results were obtained:

The growth duration of NH-01-48 grape variety (from pruning to the last harvest) was about 25-30 days longer than that of the Cardinal variety. The NH-01-48 variety could
resist downy mildew, bunch rot and powdery mildew better than Cardinal variety. Finally, the yield of this new variety was higher than that of the Cardinal check variety.

NH-01-48 grape variety had better quality characteristics compared with Cardinal, which included higher sugar content, fewer seeds, and sweeter taste and aroma.

Research on Micro-element Mixtures

The Cotton Research Centre succeeded in studying several kinds of mixed foliar fertilizers from macro, semi-macro and micro fertilizers, called "Duong nho". Spraying "Duong nho" on grapes increased yield and sugar content. It also increased farmers profit from VND 3 to 5.76 million per hectare (Nguyen Huu Binh, Le Quang Quyen, Vu Xuan Long, et al. 1997). This product was recognized as a technical achievement and was released for trial on a large scale by the Scientific Commission of the Agriculture and Rural Development Ministry.

Research on Growth Regulators

Based on research on the effectiveness of some growth regulators for grapes, a yield-increasing product called LH1 was found for grapes. This product contained α-Naphtyl acetic acid, gibberellic acid and some micro-elements. Berry weight, bunch weight, number of the berries per bunch and yield increased when LH1 0.1 percent was used, which especially brought profit for farmers exceeding over VND 7 million per hectare (Vu Xuan Long, Nguyen Quang Thach, 1997).

Research on Cultivation Techniques for Grapes

Currently, the Cotton Research Centre has been carrying out some research on cultivation techniques for grapes which included research on polythene film mulching, vine planting using a ditch and dyke system of land reclamation in low-lying areas, grape bunch covering techniques, use of rootstock and grafting techniques, use of economical irrigation methods, and research on some methods of agricultural extension.

11. CONCLUSIONS

- In Viet Nam, grapes have mainly been grown in Ninh Thuan and Binh Thuan provinces. Today, the areas under grapevines are some 2,400 hectares in Ninh Thuan (occupying 90 percent) and 250 hectares in Binh Thuan (occupying 9 percent of the total areas under grapes in the country). In the North of Viet Nam, grapes are being planted on a small scale for experimentation.

- The climatic and soil conditions of Ninh Thuan province are very suitable for the growth and development of vines. It is in this region that grapevines can be pruned at any time of the year giving 2.5-3 harvests a year.

- At present, Cardinal is an unique variety popularly grown in Viet Nam. This variety has a high yield potential but not excellent berry quality and is especially weak in pest and disease resistance. Vines are mainly propagated by cuttings.
Ninh Thuan and Binh Thuan farmers have only used the overhead trellis system for vines. Grape planting time is mainly carried out in December and January every year. Popularly used plant density is some 2000 plants per hectare. The system of vine training is similar to a cobweb-like design. Pruning is done at any time of the year and irrigation is given usually every 10-15 days. Inter-cultivation is mainly done once per season together with the application of organic and inorganic fertilizers. Fertilizer doses used are rather high, most of which are given before the pruning stage.

Vines in Ninh Thuan are infected by four kinds of diseases: downy mildew, bunch rot, powdery mildew, and rust. Among them, downy mildew, bunch rot and rust diseases often develop and cause serious damage in the wet season, but powdery mildew occurs in dry weather. In addition, vines are attacked by army worm, thrips, mealy bug and spider mites. These insects and spider mites mainly cause damage in the dry season.

Vines in Ninh Thuan age soon because of intensive exploitation. Normally, vine growers have to get rid of old vines for replanting after about 10 years. Average grape yield in Ninh Thuan was estimated at about 30 tonnes per hectare a year. High grape yield is focused on Winter-Spring and Spring-Summer seasons but it is low and unstable in Autumn to Winter.

There are four organizations maintaining and researching on grape collections, which are the Cotton Research Centre, Hanoi Vegetable and Fruit Research Institute, Ninh Thuan Domestic Animal and Crops Breeding Centre, and Binh Thuan Socio-Economic Development Centre. The quantities of accessions in these collections are 61, 26, 33 and 42 respectively.

NH-01-48 table grape variety has more advantages than Cardinal variety in characters such as easy blossoming after pruning, high yield, high sugar content, delicious taste and good disease resistance.

Because Viet Nam is a poor country, the Government has not yet been able to invest much capital for the development of viticulture. Although leaders at all levels have begun to show their concerns for viticulture development and invested on grape research, these investments are too small in comparison with the grape growers' needs in the domains of basic and applied research techniques.

REFERENCES


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## APPENDICES

### Appendix 1. Average Annual Rainfall in some Vine growing Regions in Viet Nam

<table>
<thead>
<tr>
<th>Stations (Prov.,City)</th>
<th>Months</th>
<th>Total (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1. Lang (Hanoi)</td>
<td>18.6</td>
<td>26.2</td>
</tr>
<tr>
<td>2. Moc Chau (Son La)</td>
<td>14.8</td>
<td>21.2</td>
</tr>
<tr>
<td>3. Vinh Yen (Vinh Phuc)</td>
<td>19.4</td>
<td>24.1</td>
</tr>
<tr>
<td>4. My Duc (Ha Tay)</td>
<td>30.4</td>
<td>17.2</td>
</tr>
<tr>
<td>5. Nha Ho (Ninh Thuan)</td>
<td>7.7</td>
<td>2.4</td>
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### Appendix 2. Average Meteorological Data at Nha Ho Station (1979-1998).

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Sunshine hours/month</th>
<th>Rainfall (mm)</th>
<th>Rainy days/month</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Max.</td>
<td>Min.</td>
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<td></td>
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<tr>
<td>1</td>
<td>24.4</td>
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<tr>
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<table>
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<tr>
<th>Crops</th>
<th>Yield (kg/ha)</th>
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<th>Expenditure (1000 VND/ha)</th>
<th>Profit (1000 VND/ha)</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Materials</td>
<td>Labour</td>
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<tr>
<td>1. Spring-Summer 1995</td>
<td>12293.6</td>
<td>63184.17</td>
<td>16844.24</td>
<td>6900.07</td>
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<tr>
<td>2. Autumn-Winter 1995</td>
<td>7735.6</td>
<td>42885.78</td>
<td>16840.33</td>
<td>7021.20</td>
</tr>
<tr>
<td>3. Winter-Spring 1995-1996</td>
<td>12677.8</td>
<td>70063.95</td>
<td>16477.02</td>
<td>6852.29</td>
</tr>
<tr>
<td><strong>Total/year</strong></td>
<td><strong>32707.0</strong></td>
<td><strong>176133.90</strong></td>
<td><strong>50161.59</strong></td>
<td><strong>20773.56</strong></td>
</tr>
</tbody>
</table>

Note: Total income and expenditure at market prices in May, 1996.
CONCLUSIONS AND RECOMMENDATIONS

1. Grape is one of the most important fruit crops of the world and it contains many of the most valuable elements necessary for life. The crop has a wide adaptability, and grapes can be grown under temperate, sub-tropical and tropical climatic conditions and varied agro-ecological settings. The food, nutrition, medicinal and economic values of the crop could be of significant importance for the population of the Region. Therefore, the Consultation recommended that every effort should be made to realize the full agricultural potential of the crop.

2. Remarkable success has been achieved in grape production and productivity levels in certain countries of the Region (such as India and Australia), while in other countries the progress is very limited. The opportunities for further development of the grape industry appear to be very good. However, at the same time the problems to be addressed are many and serious. There is, therefore, a need for the various countries to consider taking appropriate action to address the existing problems to the extent possible.

3. The number of grape cultivars throughout the world is very large but in many countries in the tropical zone only a relatively small number of cultivars are present and have been evaluated for suitability to local climatic conditions. The introduction of many cultivars (table, wine and raisin) for field evaluation under local conditions was considered an important objective for the advancement of grape industries throughout the Region, in producing fresh and processed grape products of a quality which meets the requirements of specific markets. The opportunity exists for the field evaluation to occur through a collaborative effort involving interested countries, to address common problems whilst also addressing the individual needs of each country's industry. Some countries in the Region have many grape cultivars and could become a germplasm resource for other countries. Also developing linkages with cultivar-rich countries outside the Region would provide an additional supply of cultivars for evaluation of their suitability to local growing conditions.

4. Several countries in the Region have grape breeding programmes notably Japan, the Republic of Korea, Viet Nam, China and Australia. Currently each breeding programme is operating in isolation to achieve objectives specific to the industry in that country. There exists the opportunity for communication and information sharing between grapevine plant breeders in the Region as well as exchange of genetic material to enhance both the individual breeding programmes and quality of cultivars grown by the industry. However, the need to recognize breeder protection rights over their genetic material must be recognized and may make access to new grape cultivars too expensive for some countries. In both breeding and the evaluation of existing cultivars the attributes sought are high bud fruitfulness under tropical conditions, disease resistance, and productivity, despite increased vine vigor (e.g. Marroo Seedless).

5. All grape producing countries in the Region have one or more soil derived problems, notably phylloxera, nematodes, salinity, drought and adverse soil chemistry, which impinge upon successful grape production. Some countries in the Region have experience in the ability of rootstocks to tolerate adverse soil conditions
and the positive impact of rootstocks on fruit quality and vine fruit yield. These countries also have a large number of rootstocks whereas most countries in the Region have only a few. The introduction of many rootstocks into countries throughout the Region and their evaluation for suitability under local conditions to fulfil industry requirements was considered an important objective. Initially this could be achieved through collaboration between those countries with the diversity of grapevine rootstocks and those countries with production problems that potentially can be overcome through the use of appropriate rootstocks.

6. Grapevine plant material used in countries throughout the Region was either of unknown health status or known to be infected with specific micro-organisms (viruses, mycoplasmas, bacteria) which are detrimental to vine performance. A supply of grapevine plant material free of debilitating organisms is critical for the development of a successful grape industry. Techniques for determining the virus status (Elisa, PCR) and controlling debilitating organisms (hot water treatment) are available in several countries throughout the Region. It is feasible for these techniques to be transferred to other countries in the Region for further dissemination by local staff. In addition, grapevine material of a higher health status available in some countries could be introduced to those countries in the Region requiring improved plant material.

7. Several production issues were highlighted as constraints to grape production in the Region. These were understanding and managing vine nutrition in the tropics, efficient irrigation management, manipulation of bud burst, optimizing crop load, maximizing bud fruitfulness, managing flowering, fruit set and berry growth and effective practices for grape production under protected (temporary and permanent) systems.

7.1 The need to determine the nutrient requirements of vines under tropical conditions and petiole interpretation standards for the accurate monitoring of vine nutrients status was identified as important for effective and efficient vine nutrition management. This has implications for fruit quality, cost of production and environmental preservation.

7.2 Water resources in many countries are limited and water quality is often declining (salinity), hence the need to increase water use efficiency. Firstly, it is necessary to quantify the amount of water required under each local growing condition for optimum yield and fruit quality. Subsequently, an efficient irrigation programme will have to be developed and the grape grower trained in the use of irrigation scheduling. Some countries are experienced in irrigation scheduling and sharing of their knowledge could expedite achieving greater water use efficiency and sustained grape production.

7.3 The factors affecting bud break under tropical conditions are not well understood yet poor bud break has a huge impact on vine productivity and hence profitability of the grape grower. This is a major problem affecting all countries in the Region with grape production in hot environments. A collaborative effort to understand the physiology
involved and subsequently the development of management practices to optimize bud break would have a considerable impact upon industry viability.

7.4 Under tropical conditions efforts to increase vine yield often lead to other problems of fruit quality (water berry, low sugar concentration). To increase yield but still achieve desired fruit quality and harvest time it is necessary to determine maximum crop load in relation to leaf area index (LAI). Many of the table grape industries throughout the Region have a narrow market window, outside of which competition from other fruits or adverse weather conditions affects price and fruit quality.

7.5 Knowledge of the factors contributing to floral initiation in the tropics is poor and in many countries there is a lack of vineyard management practices that enhance floral initiation. To increase vine yield it is important for grape growers to be able to successfully manipulate floral initiation.

7.6 Several problems were identified with flowering, berry set and berry growth, all of which impinged upon fruit quality and yield. It was considered important to develop labour saving practices (chemical treatments and other techniques) for cluster elongation, flower thinning and berry sizing. Some countries have progressed in developing chemical treatments (GA, BA, and CPPU) and a large amount of work has also been undertaken in the temperate zones. However, it was noted much higher rates of GA are usually required under hot and humid conditions common in the Region, compared to levels used in temperate climates.

7.7 Several countries have developed protected culture of table grape, both permanent and temporary coverings, to improve fruit quality, reduce pesticide applications and prevent rain damage to fruit. Yet the production techniques need further refinement to overcome several problems associated with protected culture. This in turn will improve the viability of grape production and enable the grower to meet the additional cost of the protective cover.

For each of the previously mentioned vineyard management problems limiting grape production, research is being conducted in one or more of the countries in the Region. The forum concluded that there were opportunities for collaboration between countries to maximize the outcomes from individual efforts and that this would enhance development of the grape industries in the Region.

8. The high use of chemical pesticides, current spray practices and the spray equipment used has led to chemical residues on the fruit and a reluctance of consumers to purchase grapes, as well as poor control of pests and diseases and increased pressure on the environment. Many advancements in grape production will result from improved grower knowledge of the weather conditions conducive for disease and pest outbreaks, the critical times to apply sprays for effective control, and
selection of the appropriate chemical for each disease/pest. Training of grape growers in the safe handling of chemical pesticides is required to reduce the risk of contamination, both to the environment and vineyard workers. Improving the knowledge of grape growers in the critical factors in preparing spray solutions (water quality, solution pH) will increase the efficacy of pesticides applied in controlling the target disease or pest. The reluctance of grape growers in several countries to adhere to the chemical registration and safe use of chemicals was considered to be a major contributing factor to high residues on fruit in the market. The forum recognized a change in grower attitude was necessary and that this could be facilitated both through grower training and greater implementation by governments of residue testing of fruit. Several countries in the Region have strengths in training of growers in pesticide application. The forum concluded that improvements in pesticide use were vital for the success of the grape industries in the Region.

9. Several examples in the Region of successful biological control of pests were noted. The forum agreed it was important to identify locally occurring parasites and predators for the biological control of pests. Further, the greater adoption of integrated pest management (IPM) by growers was seen as important for minimizing chemical use and residues on fruit, which in turn will reduce the cost of production and increase consumption. To achieve this will require a change in attitude of growers. Disease forecasting models currently being used in several countries should be furthered refined for accuracy under local conditions and made available to countries in the Region. However, for maximum grower adoption such models must be simple to use and affordable. The forum recognized that developing and encouraging organic grape production would be important for future viability of regional grape industries.

10. The quality of table grapes in several countries is adversely affected by the lack of cool storage infrastructure, lack of a continuous cool chain from vineyard to consumer and inadequate sulphur dioxide technology. If these issues are not addressed, the long-term viability of regional grape industries will be at risk. Imported table grapes of superior quality have already eroded the market share of the local industry in some countries in the Region. The forum recognized the need to establish cool storage infrastructure close to vineyards as well as cooling facilities throughout the supply chain to provide optimum post-harvest temperature for grapes. It was noted that in some countries most problems with sulphur dioxide (SO₂) damage was caused by breaks in the cool chain. Training of growers and packers in the correct use of SO₂ releasing pads and cool handling of grapes could minimize the loss in fruit quality. It was noted that developments in SO₂ technology and packaging have been made in other countries, and concluded that to evaluate and modify these technologies for local conditions would be the most cost effective strategy for countries in the Region.

11. The health benefits of moderate wine consumption were noted. However, this benefit is not widely known within the populations of many countries and could be promoted to enhance wine consumption. Well developed wine industries are present in some countries but are absent or relatively small in others. For successful wine industries to develop in these countries the winemaking skills of winemakers must be improved. The opportunity exists for countries aiming to develop a wine industry to utilize the experience and training programmes in winemaking available in other
countries with well developed wine industries. In some countries, a change in
government policy is needed in order to promote the health benefits of wine over
other alcoholic beverages for the development of the wine grape industry.

12. Juice production was not common in the Region and is the smallest of the
viticulture industries. The quality of grape juice is often variable and inferior which
results in reduced consumption and consumer acceptance of the product. Modern
equipment and training to improve juice-making skills of operators was considered
vital for the production of nutritious, good quality grape juice. There is also the
opportunity for other value-added grape products to be developed.

13. Export trade in grape products (wine, table grapes, raisins) by countries in the
Region was relatively small, with many countries requiring imports to satisfy local
demand. However, exports are an important means of increasing the wealth of a
country and consequently should be encouraged and assisted wherever possible. A
major impediment to growth in exports of table grapes was the lack of market
intelligence and local contacts, as well as understanding of local business and cultural
practices. The forum considered that those countries whose objective is to increase
grape exports should develop the necessary market intelligence.

14. It was noted that locally produced wine, table grapes and raisins sold in the
domestic market now face strong competition from high quality imported products.
Hence, for the long-term viability and survival of grape industries in the Region it is
necessary for grape growers and winemakers, to produce a product that is both cost
and quality competitive. This will require the development of cost effective
production practices and technologies adapted to regional conditions. Over-supply of
table grapes, particularly in short supply seasons, seriously reduces price and grower
income. Development of production practices to spread the supply season was
considered important for sustaining the income of grape growers and industry
viability.

15. The forum recognized that there was considerable potential for the
development and long-term viability of the viticulture industries in most countries
throughout the Region. To achieve this goal it is important to identify in each country
the districts with the climate and soils suitable for successful grape growing. It was
noted that these optimum growing conditions will vary for grape type (wine, table,
raisin). Once identified it is necessary to encourage grape growers to establish
vineyards in the preferred districts, where production costs are least and high fruit
quality can be achieved. The identification of locally suited multipurpose varieties
which can be used for table, wine and raisin production is desirable, as this would
improve the economic stability of grape growers and hence industry viability.

16. The development and expansion of wine grape industries in most countries of
the Region is highly promising because of the anticipated large increase in local wine
consumption. Currently wine imports are required to satisfy this increasing demand.
In several countries consumers prefer imported wines as locally produced wine is
more expensive and of inferior quality. The forum strongly advised that in countries
with developing wine industries, cost effective production practices should be
developed and training undertaken to improve the skills of winemakers. This will
enable industries to achieve the potential for growth and increase the value of the
local economy. Collaboration between countries in the Region was encouraged instead of individual efforts.

17. The limited experience and viticulture knowledge of scientists and advisors working in the grape industries was recognized as a constraint to growth of the industry in several countries. Training of scientists and production viticulturists is vital if growth and development of the grape industries is to be achieved. Several countries in the Region have well developed grape industries and viticulture education programmes. Staff and grower exchanges for training in viticulture was considered an effective way of improving the knowledge of grape specialists and ultimately promote development of the industry.

18. It was proposed that the information presented at the Consultation be collated and published in the form of proceedings, which can subsequently be distributed to the grape growing countries of the Region.

19. It was noted that despite the efforts of most countries to upgrade aspects of grape production, there are still many constraints hindering further development. Most of the problems appear to be common to all countries. The Consultation therefore recommended that assistance should be sought for the formulation, funding and implementation of a Regional Project to address the existing problems.

20. The possibility of setting up a Network for Research and Development of the Grape Industry in Asia was discussed during the meeting. It was felt that such a Network may facilitate pooling and sharing of resources for the development of viticulture. The Consultation endorsed this approach for Regional Cooperation and recommended the establishment of such a Network. It is expected that if a Regional Project on Viticulture is implemented it will eventually lead to the establishment of a Regional Network.
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