come into bearing. This is a brief summary of the situation that exists regarding lychee cultivars and their utilization in Hawaii. Lychees are and probably will remain a favorite ornamental fruit tree since there is hardly a more attractive ornamental fruit tree than a well shaped dark green lychee tree heavily laden with clusters of bright red fruit.

**PINEAPPLE CULTIVARS 1970**

George Samuels

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* University of Puerto Rico
* Rio Piedras, Puerto Rico

Aside from the banana, the pineapple (*Ananas comosus*) is the most popular tropical fruit consumed in temperate climates. Its production has almost tripled in the past 20 years (3) (figure 1). The major portion of the crop, almost 90 percent, is consumed as processed fruit primarily canned; the other 10 percent is consumed as fresh fruit.

Canned pineapple is produced mainly in Hawaii followed by Taiwan, Malaysia, Philippines, South Africa, and Puerto Rico with the principal importers United States, United Kingdom, France, and West Germany (table 1). The leading producers of fresh pineapple for export are located in the Americas primarily in Mexico, Puerto Rico, and Brazil (table 2). It is interesting to note that the leading fresh fruit export countries produce only about 10 percent of the world's canned pineapple. In fact, Brazil a leading fresh pineapple exporter has no appreciable canned fruit production.

Although pineapple varieties have been cultivated in greenhouse, gardens, and commercial production for over 100 years, many of these cultivars have disappeared remaining as memories in the literature or as specimens growing in a pineapple variety collection. There are relatively few varieties available from the standpoint of commercial production. The large increase in pineapple production of the past 20 years has taken place with approximately the same varieties. The varieties available for 1970 and their potential are given in the following section.

**VARIETIES**

Pineapple varieties are often known by different names in different countries, often only by the locality where they are grown, or from where they were introduced. There appears to be no adequate taxonomic or horticultural classification of pineapple varieties or cultivars. However, the varietal groups of Hume and Miller...
Table 1.- The canned pineapple producing countries of the world and their export markets, 1962-63

<table>
<thead>
<tr>
<th>Producing country</th>
<th>Percent of total production</th>
<th>Consuming countries and % imported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Americas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hawaii</td>
<td>46.4</td>
<td>U.S. 96</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>6.8</td>
<td>U.S. 100</td>
</tr>
<tr>
<td>Mexico</td>
<td>3.0</td>
<td>U.S. 56</td>
</tr>
<tr>
<td>Martinique</td>
<td>1.2</td>
<td>France 99</td>
</tr>
<tr>
<td>Cuba</td>
<td>0.7</td>
<td>Communist Block 100</td>
</tr>
<tr>
<td>Africa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>7.1</td>
<td>U.K* 54</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>0.9</td>
<td>France 100</td>
</tr>
<tr>
<td>Kenya</td>
<td>1.2</td>
<td>U.K. 53</td>
</tr>
<tr>
<td>Asia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>10.5</td>
<td>U.S. 39</td>
</tr>
<tr>
<td>Malaysia</td>
<td>9.2</td>
<td>U.K. 51</td>
</tr>
<tr>
<td>Philippines</td>
<td>6.8</td>
<td>U.S. 81</td>
</tr>
<tr>
<td>Ryukyu Is.</td>
<td>2.6</td>
<td>Japan 100</td>
</tr>
<tr>
<td>Australia</td>
<td>3.7</td>
<td>U.K. 39</td>
</tr>
</tbody>
</table>

* U.K. - United Kingdom

Compiled from (2, 12, 13)

(10) of Cayenne, Queen, and Spanish, as modified by Py (19) with the addition of the Abacaxi group can serve as a good basis to evaluate the present status of pineapple cultivars. The standard characteristics of the varietal group, its cultivars and where most popularly grown, and a discussion of their merits or disadvantages are presented.

Cayenne Group

Canning: very good
Local Fresh Fruit: good
Export Fresh Fruit: fair
Leaf: smooth with a just a few spines near the tip
Fruit Shape: cylindrical with slight taper-
Table 2.- The fresh pineapple growing countries of the world and their export markets, 1962-63

<table>
<thead>
<tr>
<th>Producing country</th>
<th>Percent of total production</th>
<th>Consuming countries and % imported</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Americas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>20.5</td>
<td>U.S. 99</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>14.8</td>
<td>U.S. 99</td>
</tr>
<tr>
<td>Brazil</td>
<td>14.0</td>
<td>Argentina 83</td>
</tr>
<tr>
<td>Cuba (1958)</td>
<td>43.0</td>
<td>U.S. 99</td>
</tr>
<tr>
<td>Hawaii</td>
<td>8.0</td>
<td>U.S. 96</td>
</tr>
<tr>
<td>Martinique</td>
<td>1.2</td>
<td>France 93</td>
</tr>
<tr>
<td>Jamaica</td>
<td>0.1</td>
<td>U.K.* 100</td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azores</td>
<td>1.8</td>
<td>W. Germany 36</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guinea</td>
<td>2.4</td>
<td>France 75</td>
</tr>
<tr>
<td>South Africa</td>
<td>2.2</td>
<td>U.K. 88</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>1.9</td>
<td>France 99</td>
</tr>
<tr>
<td>Kenya</td>
<td>0.1</td>
<td>U.K. 100</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td></td>
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<tr>
<td><strong>Asia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.4</td>
<td>U.K. 100</td>
</tr>
</tbody>
</table>

* U.K. - United Kingdom

Compiled from (2, 12, 13)

* U.K. - United Kingdom

**Cultivars**

Hawaiian smooth cayenne (world wide)
Hilo (world wide)
Cayenne Guadeloupe (Guadeloupe)
Cayenne Lisse (Guinea)

**Description**

- Weight: 5 pounds
- Core: medium size
- Outside Color: dark orange
- Flesh Color: pale yellow to yellow
- Taste: sweet, mildly acid, low fiber, tender and juicy

**Disease:** mealy-bug wilt
Cayenne Martinique (Martinique)
Smooth Guatemalian (Guatemala)
Typhone (Taiwan)
St. Michael (Azores)
Esmeralda (Mexico)
Baron Rothschild (Guinea)

The Smooth Cayenne variety, which probably originated in French Guyana before 1840, has spread throughout the tropics to become the leading commercial pineapple variety. It serves as the base of the canning industry due to its cylindrical shape and shallow eyes (fruitlets), which gives a minimum of wastage in processing, and its high yields per acre. Its yellow flesh color and sweet, mildly acid taste has become the standard for market acceptance of canned pineapple.

The major cultivar of the Cayenne group, the Hawaiian or Smooth Cayenne, has a very similar cultivar, the Hilo. It differs from the Hawaiian in some of the following characteristics: plants are smaller, absence of slips, more numerous shots, and fruit shape more cylindrical and slightly smaller (6). Much of the cayenne cultivars now being used are mixtures of the Hawaiian and Hilo plus mutations, the exception being the commercial plantations in Hawaii where the pure clonal material has been maintained by selection and rouging. Py (18) also believes that the Cayenne Lisse of Guinea is the Hilo cultivar, homogeneous because of limited introduction from the same source and then careful multiplication of this uniform material. The Cayenne grown in the Dominican Republic contains more of the Hawaiian cultivar (18). The Cayenne grown in Puerto Rico, with introductions from Cuba and Dominican Republic, is a mixture containing a goodly portion of the Hawaiian cultivar as well as the Hilo and some mutations. Slip production is very poor. The Typhone cultivars were developed in Taiwan from the Cayenne variety having small differences in plant and fruit size.

One of the major problems of the Cayenne cultivars is disease susceptibility, especially the mealy-bug (Pseudococcus brevipes Cockerell) wilt. Py (19) states that the Guadeloupe Cayenne is more resistant to disease than the regular Cayenne, but the fruit shape is very poor. It could serve as a good source for breeding. Collins (6) reports several Cayenne cultivars in Hawaii that show resistance to mealy-bug wilt.

There are a few Cayenne cultivars grown in limited quantities that are not best suited for canning, but are used for fresh fruit. The St. Michael is grown in the Azores in greenhouses for the European market. The Baron Rothschild is still used in Guinea and the Esmeralda in Mexico for local fresh fruit.

**Queen Group**

Canning: fair
Local Fresh Fruit: good
Export Fresh Fruit: good
Leaf: spiny
Fruit Shape: conical with deep eyes
Weight: 1-2½ pounds. Core: small
Outside Color: yellow
Flesh color: deep yellow
Taste: sweeter than Cayenne, but less acid, crisp with low fiber
Disease: more resistant than Cayenne

**Cultivars**

Queen (South Africa)
MacGregor (South Africa)
Natal (Australia)
Ripley (Australia)
'Z' (South Africa)
Alexandria (Australia)

The Queen has good qualities as a fresh fruit, but it has a small fruit size and low tonnage production. This variety is not preferred for canning because of its small fruit size and deep eyes which require that a thicker cut be made when removing the shell in canning.

The 'Z' appears to be a mutation of Natal Queen with a larger fruit and squarer shoulders. MacGregor and Alexandria are selections of the Natal, except more vigorous with larger suckers similar to Cayenne.

**Spanish Group**

Canning: fair
Local Fresh Fruit: good
Export Fresh Fruit: very good
Leaf: spiny
Fruit Shape: globular, deep eyes
Weight: 2-4 pounds. Core: large
Outside Color: deep orange
Flesh Color: pale yellow to white
Taste: spicy-acid flavor, fibrous
Disease: gummiosis, but resistant to wilt
Cultivars

Red Spanish (Puerto Rico, Cuba, Mexico, Central America)
Singapore Spanish (Malaysia)
Green Selangor (Malaysia)
Castilla (San Salvador)
Puerto Rico 1-67 (Puerto Rico)
Cabezona (Puerto Rico)

The Spanish group is characterized by the Red Spanish which is noted for its very good shipping qualities as an export fresh fruit. It is not favored for canning because of its shape, deep eyes, fibrous flesh, and flesh color. It is a strong ratooner, many times giving better tonnage than the plant crop. However, the spiny leaves are bothersome when cultivating or picking the fruit. The Red Spanish is more resistant to wilt (1), but the fruit is highly susceptible to gummosis (8, 16). It is caused by larvae of Batrachedra sp. The Puerto Rico 1-67, a new cultivar developed by the Agricultural Experiment Station, University of Puerto Rico (20), from open pollinated seed of Red Spanish grown in a field adjacent to Smooth Cayenne, has resistance to gummosis and the mealy-bug wilt. The fruit is large, 5 pounds, with tonnages of 30 tons per acre. The taste is sweeter and more acid, but less fibrous than the Red Spanish. It is recommended for fresh fruit export and canning.

The Singapore Spanish is used for canning only in Malaysia. This variety has been classified as related to the Queen by Collins (6), but Py (19) places it in the Spanish group because of leaf coloring and inflorescence. The Singapore Spanish or Canning has yellow flesh and narrow core good for canning, but its deep eyes and spaces in the flesh are poor canning characteristics.

The Cabezona is the only naturally occurring triploid pineapple of commercial value. This cultivar can produce very large fruits, sometimes weighing as much as 12 to 15 pounds. It is exported for special display and banquet uses. However, its poor yields per acre and large size make it unsuitable for canning.

Abacaxi Group

Canning: poor
Local Fresh Fruit: good
Export Fresh Fruit: fair to poor
Leaf: Spiny

Fruit Shape: conical
Weight: 3 pounds  Core: small to very small
Outside Color: yellow
Flesh Color: pale yellow to white
Taste: sweet, tender and juicy
Disease: resistant

Cultivars

Abacaxi (Brazil)
Abakka (Florida)
Pernambuco (Brazil, Ivory Coast)
Sugar Loaf (Puerto Rico, Cuba, Central and South America)
Eleuthera (Florida)
Venezolano (Venezuela)

The cultivars of this group are best suited for local fresh fruit because of their tender, juicy, and sweet flavor. However, their tender skin and rapid ripening before assuming a yellow color make them poor risks for fresh fruit export. Their low yields per acre, shape of fruit, and ripening pattern make these cultivars poor risks for canning.

The majority of the cultivars of this group are found in South America and Central America many having originated in Brazil. The Pernambuco, also called Abacaxi, and Eleuthera, is the most well known variety of this group forming the basis of the fresh fruit export industry of Brazil. Ananas Vermelho and Amarella are minor varieties.

Included in this grouping is the Sugar Loaf (Pan de Azucar). This name has been given to many local varieties usually of small size and quite sweet and juicy fruit low in fiber (7). Johnson (11) lists 18 cultivars which have sugar loaf as synonym.

The Abakka cultivar used in Florida as a local fresh fruit for table use is very similar to the Pernambuco, but it has yellow flesh and larger fruit size (15, 17).

Unclassified

Not placed in the four variety groupings are several varieties with limited commercial plantings at present. The Perolera and Monte Lirio are varieties found in Central and South America that have completely smooth leaves without any spines near the tip as is found in Smooth Cayenne. The Monte Lirio has a white fleshed fruit, globose in shape, with a good unusual
flavor and aroma. It is now being exported from Costa Rica as a fresh fruit to Europe (5).

**Discussion**

There are pineapple varieties or cultivars available today for canning, fresh fruit export, or local home use. None of the cultivars mentioned, however, are perfect for all three uses. The ideal variety or cultivar suitable for canning or fresh fruit should have the smooth leaves, high yields per acre, large fruit size with cylindrical shape and flat eyes of the Smooth Cayenne; the deep yellow color, crisp texture, and low fiber of the Queen; the ratooning power, resistance to wilt, and fresh fruit shipping qualities of the Red Spanish; the pleasant aroma, sweet taste, and small core size of the Pernambuco Abacaxi; and the resistance to root nematodes of, perhaps, one of the wild species such as *Ananas ananassoides*. Since this ideal variety of pineapple does not exist as yet, pineapple growers must decide for what market they will grow their crop, canned or fresh, and then use the variety which best approaches these characteristics for his local conditions.

The Smooth Cayenne is the best variety we have for canning at present as evidenced by its wide use throughout the tropics. Breeding and selection are needed to increase its resistance to wilt, ratooning ability, and fresh fruit shipping qualities. The Red Spanish offers the grower the best choice as far as fresh fruit shipping qualities. The Puerto Rico 1-67 cultivar gives high tonnage, resistance to wilt and gummosis, and ratooning ability. Selection and breeding are needed in the Red Spanish to provide smooth leaves.

The Queen cultivars do not offer at present much promise to the growers in the Americas. Although it is superior in flesh color and flavor for canning, the Queen has the disadvantages of low yields per acre and wastage in canning due to fruit shape. In fact in South Africa, it is now being replaced by the Smooth Cayenne for canning (13). It is known that decreasing the space between plants can raise yields per acre (see table 3); however, this decreases fruit weight and size. Thus this practice is of no help in the Queen variety which has a small fruit size.

The Abacaxi has good taste, but yields per acre are not high, ripening is fast and difficult to judge, and export shipping qualities only fair. There remains much room for selection in this cultivar grouping in South America, especially Brazil. However, to date no variety or cultivar from this source has shown enough promise to challenge the Smooth Cayenne and Red Spanish for canning or export fresh fruit.

A discussion of pineapple cultivars for 1970 would not be complete without mentioning the crucial problem concerning the lack of homogeneity of the existing cultivars. Perhaps, the best example of the lack of uniformity in our pineapple cultivars would be the Smooth Cayenne variety. As was mentioned before, most of the Cayenne grown in various countries with various local names are mixtures of the Hawaiian and Hilo cultivars plus some somatic mutations. It is doubtful that there exists reasonably pure stands of either one of these cultivars except for the large commercial pineapple plantations in Hawaii, Philippines, and Taiwan. The mixtures of cultivars masquerading under a variety name is also evident for the Red Spanish. The author has not visited pineapple plantations in South Africa and Australia to determine if this lack of homogeneity exists for the Queen cultivars in commercial usage.

A fallacy seems to exist that because the pineapple is grown by propagation of vegetative planting material, it will maintain itself true-to-type. This is not true in practice. Somatic mutations of pineapple occurs and vegetative propagation maintains and multiplies the mutation in a population. The Cayenne variety probably originated in its history as a clone, but as time has passed with occurrence of gene and chromosomal somatic mutations, we have today a collection of clones. Truthfully, the same must be said of many of the other commercial pineapple varieties.

The task of reworking our pineapple varieties to develop more homogeneous cultivars will not be easy, but it is a necessity if any true progress is to be gained in pineapple production. This will mean a combined effort of geneticists, horticulturists, and farmers. Experiment Stations and large commercial growers can begin with individual clonal material and propagate them rapidly using the quarter section of disc techniques (14). Farmers can do their part by selection and roguing of their fields. If such efforts are not practiced by our growers, new varieties just released as Puerto Rico 1-67, can soon lose its homogeneity and many of its valuable characteristics.
Table 3.- The influence of planting distance on weight per fruit, production per acre, slip and sucker production, and multiple crown *

<table>
<thead>
<tr>
<th>Spacing between plant in the row, inches</th>
<th>Mean weight per fruit, pounds</th>
<th>Production per acre, tons</th>
<th>Number per plant of Slips</th>
<th>Number per plant of Suckers</th>
<th>Multiple crowns, percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>3.28 a **</td>
<td>28.8 a</td>
<td>5.0 a</td>
<td>1.6 a</td>
<td>0.16 a</td>
</tr>
<tr>
<td>13</td>
<td>3.66 b</td>
<td>21.4 b</td>
<td>6.0 b</td>
<td>2.1 b</td>
<td>0.63 a</td>
</tr>
<tr>
<td>18</td>
<td>3.99 bc</td>
<td>17.4 c</td>
<td>6.6 bc</td>
<td>2.1 b</td>
<td>0.87 ab</td>
</tr>
<tr>
<td>23</td>
<td>3.84 b</td>
<td>13.4 d</td>
<td>6.8 bc</td>
<td>2.3 bc</td>
<td>1.95 c</td>
</tr>
<tr>
<td>28</td>
<td>3.99 bc</td>
<td>11.4 e</td>
<td>7.4 c</td>
<td>2.5 c</td>
<td>1.78 bc</td>
</tr>
</tbody>
</table>

* Red Spanish plant crop. After González (9).  
** Treatments not having the same letter are significantly different at the 5-percent level.

**Summary**

Pineapple production has tripled in the past 20 years with almost 90 percent of the crop devoted to canning and the remaining 10 percent to fresh fruit. Canned pineapple is produced mainly in Hawai’i then Taiwan, Malaysia, Philippines, and South Africa; fresh fruit for export is grown in Mexico, Puerto Rico, Brazil, and Martinique.

The commercial varieties available today can be grouped as to Cayenne, Spanish, Queen, and Abacaxi. The Smooth Cayenne is the leading variety for canning because of its high yields per acre, good fruit shape, taste, and color. It has become the standard variety for canning. It is grown throughout the tropics, but there are many mixtures of cultivars using this varietal name.

The Red Spanish, grown in Puerto Rico, Cuba, and Central America, is the leading variety of the Spanish group noted for its good fresh fruit shipping qualities, resistance to wilt, and strong ratooning ability. A recently developed variety, Puerto Rico 167 has resistance to wilt and gummosis, good fruit size, and high yields per acre.

Grown mainly in South Africa and Australia, the Queen variety is noted for its deep yellow flesh color and good taste. However, its lower yields and fruit shape limit its use as a canning pineapple. Its cultivars are recommended for fresh fruit use.

The Abacaxi group is best represented by the Pernambuco variety. Despite a good flavor, its low yields, fast ripening, and only fair shipping qualities limit its use as a fresh fruit for export to temperate climates.

A serious problem that now exists with pineapple varieties is the lack of homogeneity of the various varieties. Many varieties under a given local name are mixtures of more than one cultivar. A combined effort of geneticists, horticulturists, and growers is needed to develop more homogeneous cultivars of the desired varieties. Also needed is breeding and selection of the present varieties to develop an all purpose variety suited for canning and fresh fruit.

**Literature Cited**

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LOW CHILLING TEMPERATE ZONE FRUITS IN ISRAEL

R. J. Ticho

Director, Department of Fruit Culture
Ministry of Agriculture
Israel

There has always been an urge to extend the culture of crops beyond their optimum climatic range. Whenever people migrate they try nostalgically to introduce crops from their former place of residence.

Within the U. S. with its excellent deciduous fruit areas, there is no incentive to extend their culture further south, unless early out-of-season maturity is achieved. The best climatic combination for this is a cold winter and hot weather in spring, i.e. a continental climate. Early ripening cultivars (e.g. of peaches) are invariably of poor quality, size and have a low yield per acre, but they command a premium price.

There are, on the other hand, many countries with a subtropical climate, such as Israel, or tropical countries with highlands, which are interested in promoting deciduous fruit culture. Table 1 compares temperature records from three localities in Florida, California and Israel.

The leafing out and bloom of temperate zone deciduous fruit trees in warm climates is by now well known; it is largely regulated by hormones, but their specific role, antagonisms and synergisms, are less well known. Deciduous fruit trees require cold weather in winter (measured in hours below 45 degrees F) to break their rest period. Its effect is modified by the continuity of cold weather, interruptions by hot spells, the actual plant tissue temperature, intensity of radiation, possibly length of day, etc. Without cold weather, leafing out and bloom is delayed and may last many weeks; only a small percentage of buds will open. There is another problem to be reckoned with during warm winters (especially with stone fruits) : bud-drop. Nutritional disorders (deficiency symptoms) are more pronounced after warm winters. The redeeming feature under these circumstances is the more stable weather during bloom improving fruit setting.

Warm weather in fall and winter is the overriding cause for the retention of foliage (essentially an indirect effect on phyto-hormones). The minimum (or optimum) length of time deciduous fruit trees should be bare of leaves is another unknown factor. We intend to study the effect of leaf removal on the inception of growth. We obtained startling results when leaf removal predated leafing out of Cherimoyas by several weeks. We were taught that pome fruit trees require generally more hours of cold weather to break their rest than stone fruits. However, extensive bud-drop during warm winters of the latter, makes them actually more sensitive to lack of cold and less responsive to rest breaking treatments.