

people like and so are usually rated as inferior to the imported product in flavor. This would militate against the development of any large commercial industry in citrus fruits.

It is possible, however, that it would be well worth while to increase the plantings of orange trees in back yards and home gardens. They grow so easily that any householder with sufficient space could have a few trees for supplying home needs. Even if the fruits so produced were not of the best appearance, they would taste better because they grew at home. Likewise, a lime tree would supply home needs for lemons for a large part of each year, and a mandarin or Kona orange tree or two would save the expense of buying at the market.

See also "Chinese Orange," "Mandarin Orange" and "Citrus Fruits."

Ref.—Haw. Exp. Sta. Bul. 9 (1905); Bul. 71, "Citrus Culture in Hawaii," (1934); Bul. 77:56-58 (uses); Annual Rep. 1905:61; 1906:33; 1909:47; 1910:35; 1911:38; 1912:43; 1915:66; 1921:16; 1922:3; 1923:5; 1924:6; 1926:4; 1927:8; 1930:29; 1933:9; Thrum's Annual 1892:75; 1921:90-96 (W. T. Pope, on restoration of industry).

**ORCHARD GRASS** Orchard grass (*Dactylis glomerata*) is suitable only for the higher elevations, above 4,000 feet, where it is valuable for pasturage.

Ref.—Haw. Exp. Sta. Bul. 65:16, 1933.

**OSTRICH** Ostrich farming offered attractive possibilities in the latter part of the nineteenth century, when the demand for plumes was at its height. A small farm was established near Honolulu by Charles M. Cooke in the 1890's, with some 15 or 20 birds. Later, the activities were transferred to Kauai, but the project was not continued long.<sup>5</sup>

More recently, within the last few years, Paul Fagan undertook to establish ostrich farming on Molokai, but no results of commercial importance followed.

**OYSTER PLANT** See "Salsify."

**PANICUM GRASS** Panicum grass (*Panicum purpurascens*<sup>1</sup>), called also para grass, was introduced in

<sup>5</sup>Information furnished by Mr. Richard A. Cooke.

<sup>1</sup>Sometimes referred to as *Panicum barbinode*.

1902 and is now widely disseminated. It is valuable for pasturage and for fattening paddocks, and is often cut for use as green fodder for dairies. It is used as a soiling crop in pineapple fields.

Ref.—Haw. Exp. Sta. Bul. 65:31, 1933. Also, U.H. Agr. Dept. Annual Report 1922:18.

**PAPAIN** Papain is a digestive enzyme present in the milky exudation from the green fruits and the leaves and stem of the papaya. Although in Hawaii there has been no commercial exploitation of this, in some countries it is an important by-product. Considerable quantities of the dried exudation (known to the trade as “paw-paw juice”) containing the enzyme are imported into the United States annually<sup>2</sup> to be used in the manufacture of certain patented preparations used as aids to digestion. A chemical study of papain is in progress in the University laboratories by Prof. F. T. Dillingham.

See also “Bromelin.”

**PAPAYA** This delicious fruit (*Carica papaya*) has been known and used for several centuries in the American tropics and is believed to have originated in Mexico by a natural hybridization, or perhaps as a sport. In the seventeenth century it was carried to India and thence spread throughout the tropical regions of the Old World. Sometime before the discovery trip of Captain Cook it seems to have been introduced into Hawaii,<sup>3</sup> if we may credit certain circumstantial evidence. The papaya is not mentioned in the list of agricultural products noted by Captain Cook’s crew, but on the other hand, subsequent observers reported that the Hawaiians appeared to be familiar with the fruit, thus suggesting that it had been known to them a long time.

The papaya is not closely related to any other familiar fruit; the papaw of North America is not even a distant relative.

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<sup>2</sup> 1931 .....	65,257 pounds valued at \$121,481
1932 .....	54,491 pounds valued at 50,565
1933 .....	83,334 pounds valued at 79,007
1934 .....	111,209 pounds valued at 189,057

<sup>3</sup>See Pope, Bul. 61, Hawaii Exp. Sta., p. 2, 1930.

In its flowering and fruiting habits it is erratic and unstable. Most of the cultivated varieties usually produce stamens and pistils in separate flowers on separate plants, but occasionally it happens that a staminate flower has a fully developed pistil and sets a fruit on a tree which is supposed to be "male." These are not "male" fruits, however, for their seeds seem to produce about the usual percentage of staminate and pistillate trees.

These two sex forms are not distinguishable until the flowers begin to form, then the "males" produce long, pendent clusters of flowers and the "females" (pistillate) develop larger flowers singly, each with a very short stem and many crowded closely together at the base of the leaf stalks. "Male" fruits, therefore, can be distinguished readily from normal fruit by the habit of hanging from a long stem.

Many claims have been made for various methods for distinguishing between males and females in the seed or seedling stage, but none have stood the test of scientific experimentation.<sup>4</sup>

Propagation of the papaya is usually effected by the planting of fresh seeds; it is possible, with difficulty, to root cuttings in a sand box but the resulting plants are not as vigorous as seedlings. Grafting has been successfully done but not commonly and thus far it offers no attractive promise as a means of propagation.

Successful propagating by seeds requires that the seeds be of as near a pure strain as possible, and this may be guaranteed by first isolating a good strain through plant breeding methods and then growing no other strain within cross-pollination distance of it.

The growth of the papaya plant is rapid, usually maturing its first fruits in about a year from the planting of the seedlings. It bears actively and continuously for three to five years, then goes into a decline. For detailed information about culture and selection of varieties, consult Dr. Pope's bulletin already cited.

The nutritional value of the papaya as human food was not fully appreciated in Hawaii until comparatively recently, the prevalent notion having been that it was a

<sup>4</sup>Pope, Bul. 61, Haw. Exp. Sta., p. 18, 1930.

fruit fit only for hogs. At about the beginning of this century, however, there began to develop an interest in this fruit in the mainland states, which caused the Hawaii Experiment Station in 1907 to begin some studies of the possibilities of shipping to the Pacific Coast. These tests were only partially completed when the fruitfly quarantine put an end to all dreams of an export industry, for the papaya was put on the list of prohibited fruits, even though it is but rarely infested.

This interest abroad, however, had the natural reaction of causing the people here to add the papaya to the diet and local consumption of this fruit has increased greatly, making its cultivation an industry of no mean size. The total plantings in 1936 were about 400 acres, with the market not fully supplied.

Prospects for the future are very encouraging. Efforts now being put forth to control the fruitfly or at least to devise some means of treating fruit so that the existing quarantine order may safely be modified to allow papaya shipments to the mainland seem to offer some promise of being successful. This would open the way to a very large market, for the papaya has been well advertised of late as a nutritious and health-giving fruit, for its papain content and its delicious flavor.

Meanwhile the Hawaii Experiment Station is investigating the possibilities of manufacturing various by-products from the papaya: preserves, juice, gelatine, and others. In addition, there is the possibility of extracting papain from the leaves and bark, and fiber from the trunk, thus increasing the profitableness of this crop.

Ref.—Haw. Exp. Sta. Bul. 61, "Papaya Culture In Hawaii," 1930; Bul. 77:59-65 (nutritive value and uses as food, etc.); Annual Reports 1902:320; 1910:33; 1911:26; 1912:40; 1913:22; 1914:29; 1915:24; 1919:28; 1920:20, 36; 1921:14; 1922:3; 1923:5; 1924:6; 1926:6; 1927:7, 1928:11; 1936:9, 26, 58 (nutrition studies). Thrum's Annual 1906:146-154 (article by H. M. Wells). Haw. For. Agr. 1904:136-138 (papain); 1905:278 (fiber extracted from trunk in Mexico, for paper making); 1913:100 (medicinal values).

**PARA GRASS** See "Panicum."

**PARSLEY** Parsley (*Petroselinum hortense*) is the most widely used garnishing plant on meat and fish dishes,

probably because of the delicate beauty and equally delicate flavor of its leaves. Although widely used, the total amount required is never large because of the fact that only a few sprigs are required at a family meal. It grows readily and well in Hawaii and is found in many commercial and home gardens, the total acreage being less than 5 acres for the Territory.

See also "Truck Crops."

**PARSNIP** The parsnip (*Pastinaca sativa*) is a relative of the familiar carrot. Although it can be produced here with comparative ease, most of the local demand for this vegetable is supplied by imports from the mainland. Small amounts are produced in our truck gardens, the aggregate probably not amounting to more than an acre or two. Shipments from the mainland total about 80,000 pounds per year, thus indicating that the consumption of this commodity is not very great.

See also "Truck Crops."

**PASSIFLORA** See "Passion Fruit."

**PASSION FRUIT** There are several kinds of passion fruit in Hawaii, all placed by botanists in the genus *Passiflora* and each known commonly by one or several colloquial names, as lilikoi, waterlemon, etc.

The most widely distributed species in this Territory is lilikoi (*Passiflora edulis*), the purple fruits of which are found at certain seasons of the year in the foothill regions of all our Islands. It was brought here from Australia about 1880 and from some of the early cultivated plantings it has been widely disseminated into the lower forest areas by birds.

Another species, commonly offered in local markets under the name "waterlemon" (*Passiflora lingularis*) is grown in semi-cultivation in Kona. This, also, is believed to have been brought here from Australia, probably about the same time as the other species, but there seems to be no certain knowledge about either of them as to the time and mode of arrival here.

Several other edible species are occasionally encountered here, including a yellow-fruited lilikoi which is thought to be a hybrid between the two species mentioned

above; also, a giant species, known as granadilla (*Passiflora quadrangularis*), which produces fruits as large as a small watermelon.

The edible portion of the passion fruit is the sweet, gelatinous matrix surrounding the seeds which are encased in a leathery shell. To eat a fruit out of hand, one cuts it open and swallows the gelatinous contents, seeds and all. The flavor is very agreeable, remotely suggestive of apricots.

It is not, however, in the fresh state but as the source of a bottled or canned juice that this fruit offers commercial possibilities which ought not to be overlooked in Hawaii, for the climatic conditions seem to be almost ideal for its cultivation here and heavy yields are being obtained in current tests at the Kona substation of the Hawaii Experiment Station. Grown on a trellis as an inter-crop between rows of more slowly growing trees the passiflora vines can be made to produce a quick revenue, provided (1) adequate facilities are available for processing the fruit and (2) adequate market outlets are opened by a campaign of advertising.

Our present knowledge concerning the cultivation of edible passion fruit is summarized well in Bulletin 74 of the Hawaii Experiment Station, published in 1935.

Ref.—Haw. Exp. Sta. Bul. 74, "The Edible Passion Fruit In Hawaii," 1935; Bul. 77:65-68 (uses, recipes, etc.); Annual Report 1936: 28, 94. "Passiflora edulis" by Jared G. Smith, in Hon. Advertiser, Nov. 29, 1935. See also, an article in The Fruit Products Journal, May, 1935, on improved methods of extracting juice of this fruit.

## PASTURE GRASSES See "Grasses."

**PEA** The common garden pea (*Pisum sativum*) is adapted to temperate zone conditions and is at some disadvantage in Hawaii. The production here is small, probably not over 10 acres in the entire Territory being devoted to this crop. Most of the local demand is filled by the imported canned product from the mainland. The quick freezing process now enables importers to bring in fresh peas (shelled) which by some people are preferred to the canned.

See also "Beans" and "Truck Crops."

Ref.—U. H. Agr. Ext. Bul. 16:60, 1932.

**PEACH** White foreigners settling in Hawaii longed for the temperate zone fruits to which they were accustomed: peaches, apples, plums, and others. They learned by repeated trials that most of them would not do well in the tropics except at high elevations where the climate was cooler. One variety of peach (*Prunus persica*), however, was found which grew well and produced fruit abundantly, even in the lowland areas of these Islands. It is believed to have been brought in from Asia, probably by early Chinese immigrants.

The fruit is small, the meat white, with a very delicious flavor. This variety of peach is frequently mentioned in horticultural notes and articles<sup>5</sup> and was much prized by all, especially the foreigners. The fruit sold for as much as fifty cents per pound at times.

Unfortunately, the accidental introduction of the Mediterranean fruitfly about 1910 put an end to any chance which may have existed of developing even a small peach growing industry here, for this fly found the peach a very delectable home for its maggoty offspring and it became very difficult to find any ripe fruits which were free from worms. So long, therefore, as this fruitfly pest continues to exist in Hawaii it will be practically impossible to consider the peach as a commercial possibility.

**PEANUT** Peanuts (*Arachis hypogea*) have been produced in Hawaii for a century, but never on a large scale.<sup>6</sup> The Chinese use peanut oil in the preparation of certain foods and naturally, therefore, they tried the growing of peanuts here as a means of obtaining the needed oil at a lower cost as compared with the imported product. There was not much saving, however, and importations continued to fill most of the local demand.

The Hawaii Experiment Station in 1902 called attention to the possibilities of extending this small industry to larger proportions, and in 1908 began some experiments to improve cultural methods. Several new varieties were introduced and some of them proved to be superior to the small type which the Chinese gardeners had been growing. A good bulletin on the peanut was

<sup>5</sup>As in Transactions of the Royal Hawaiian Agricultural Society, 1850-1856.

<sup>6</sup>A maximum of production last century was attained in 1872 when about 105,000 pounds of peanuts were exported.

issued at about that time,<sup>7</sup> giving directions as to the cultivation of this crop and the selection of proper locations for successful results.

It was pointed out that Hawaiian conditions are favorable for peanut production, since average yields of the better varieties were about one ton of cured nuts per acre. In the matter of quality of the nuts, it was said that both in flavor and firmness the Hawaiian product compared well with any other.

During the War years there was a further effort to develop an interest in peanut production on a larger scale, and some increase in the total acreage resulted; unfortunately, however, there was inadequate attention given to the selection of good seed and the harvested nuts were so variable in size and quality that they had little value for roasting and consequently found their way into oil manufacturing channels, but at prices too low to yield a profit to the producers.

There are certain areas in Hawaii where the soil and climate are very favorable for the peanut and where, with proper planting and cultivation methods, the crop could be made to pay at least a moderately good profit. At present very little of such land is used in this way, for current surveys indicate that the total plantings of peanuts in the Territory amount to less than 100 acres. The best varieties seem to be the White Spanish and the Improved Valencia.

Ref.—Haw. Exp. Sta. Annual Reports 1902:322; 1908:84; 1921:33; 1924:12; U.H. Agr. Dept. Annual Reports 1918:9; 1919:10; 1920:13; 1921:16; 1929:54. *Planters Monthly* XIII, 470 (1894).

**PEAR** The pear (*Pyrus communis*) is a temperate zone fruit grown in Hawaii only in the higher altitudes where climatic conditions are favorable. The total of several small plantings is less than five acres.

**PEPEIAO AKUA** Pepeiao akua<sup>8</sup> is the Hawaiian name for a fungus (*Hirneola polytricha*) which grows on the dead trunks and branches of the kukui tree (*Aleurites*) in the mountain forests. While this fungus is edible, it did not enter into use as a human food until the Chinese

<sup>7</sup>Haw. Agr. Exp. Sta. Press Bul. 28.

<sup>8</sup>The name translated literally means "ghost ears."

discovered that it was somewhat similar in taste to certain species of mushrooms to which they were accustomed in China.

During the gold rush years there were thousands of Chinese in California, and they found it exceedingly difficult for a time to secure their customary foods. When this Hawaiian fungus was offered to them as a substitute for mushrooms, they seized upon it eagerly and thus there developed a brisk trade almost over night. In 1851 some 5,000 pounds of the dried fungus was sold in San Francisco, most of it coming from the Waialua (Oahu) district.<sup>9</sup> It promised well as a business, for in the following year the shipments were trebled, to 15,000 pounds, with the price ranging from six cents to as high as forty cents per pound.

About 1855 the demand for this commodity in San Francisco diminished, but the local Chinese shippers found a ready market in China and forthwith shifted their activities. Steadier prices prevailed there, ranging from 9 to 12 cents per pound, and total annual shipments increased greatly after 1859; the maximum shipped to San Francisco had been 23,542 pounds (in 1853), but in 1860 the year's total to China jumped to 178,794 pounds and to 368,835 pounds in 1864. Thereafter the shipments declined irregularly to less than 100,000 pounds per year in the 1870's and less than 10,000 pounds annually in the 1880's, finally ceasing entirely in 1888.

The industry, at its height, had yielded a return to the Islands of about \$35,000 per year, but there was some fear that this was being more than offset by the destruction of kukui forests, for the fungus would grow only on dead trees and the exploiters of this commodity in their eagerness for larger supplies cut down many fine trees. The extinction of the industry was, therefore, not greatly regretted.

Ref.—Thrum's Annual 1914:201-203.

**PEPPERS** Two species of pepper (*Capsicum annuum* and *C. frutescens*) grow wild throughout the Territory, having been introduced a great many years ago, perhaps by Don Marin, who mentions in his diary that he "planted

<sup>9</sup>Trans. Royal Haw'n Agr. Soc. Vol. I, No. 4, p. 91.

peppers and chili" sometime about 1815, but gives no intimation as to the source of his material. It is quite likely that he obtained the seed from Mexico or South America. In more recent times several other species, mostly of the bell pepper type, have been introduced for commercial production. Although all do well here, none have entered extensively into cultivation. At present (1936) the total planting of bell peppers is less than twenty acres, and the acreage of chili peppers is practically negligible in amount. In the fresh state, bell peppers are barred from shipment to the mainland by the melon fly quarantine regulations.

The fact that large quantities of dried peppers are imported into the United States from foreign countries has been noted here on several occasions and used as an argument in favor of developing a large pepper industry in this Territory. Attention has been directed especially toward the two species which grow wild, for they fruit abundantly and prosper even with no cultivation. The Hawaii Experiment Station sought in 1903<sup>10</sup> to arouse popular interest in this potential industry, and at various intervals since then others have called attention to the commercial possibilities of this wild crop.

Recently, in response to inquiries from the mainland, the chemical laboratories of the University of Hawaii made some analyses of the local peppers.<sup>11</sup> Samples submitted at various times in the past to mainland dealers indicate that our product is of excellent quality and could find a good market, in competition with other producing areas. Interest in this prospect was beginning to gain some headway in 1931 and 1932 but was abruptly ended when the Territorial Board of Agriculture and Forestry ordered the destruction of all pepper plants as a means of eradicating a noxious insect. This order has subsequently been lifted and the way is again open to exploit this potential crop.

Ref.—U.H. Agr. Ext. Bul. 16:113-114, 1932; Haw. Exp. Sta. Annual Report 1903:404; U.H. Agr. Ext. Bul. 16:113, 1932.

**PERILLA** *Perilla frutescens* is a native of southern Asia and occasionally grown in Hawaii for its scented

<sup>10</sup>Annual Report 1903, p. 404.

<sup>11</sup>The investigational work was done by Dr. L. N. Bilger.

foliage which is used by Orientals in flavoring certain dishes. Its scent is suggestive of balsam, while in appearance the leaves resemble mint.

Ref.—Haw. Exp. Sta. Bul. 60, p. 20, 1929.

**PERSIMMON** The persimmon (*Diospyros kaki*) is a temperate zone fruit cultivated extensively in northern China and Japan. It was introduced into Hawaii a good many years ago but can be grown successfully only in the higher elevations where temperate zone conditions are simulated. On the uplands of Maui there are some small plantings aggregating perhaps 8 to 10 acres, and a few trees on other islands. Some fine specimens of fruits have been exhibited at county fairs, but the persimmon cannot be said to offer as attractive possibilities for Hawaii as many other fruits which are better adapted to this climate.

Ref.—Wilder, "Fruits of the Hawaiian Islands" (1911), pp. 170-171.

**PIA** See "Arrowroot," also "Cassava," and "Starch."

**PIGEON PEA** The Pigeon Pea (*Cajanus indicus*) has been cultivated as a food plant for many centuries in most of the tropical world and in some countries its dried beans are an important article in the diet of the people. By some it is believed to be one of the world's oldest cultivated plants.

Its first introduction into Hawaii seems to have been in 1824, by seed brought here by the captain of a whaling vessel.<sup>12</sup> Probably at other times, later, seed was brought from various parts of the world, for in the latter half of the nineteenth century it was recognized by botanists as being a well established plant in these Islands. However well it may have been established, it did not figure much as a cultivated crop, for its values to mankind were not appreciated here.

F. G. Krauss, whose name is inseparably linked with the pigeon pea because of his success in developing it into a very important crop, began his investigations of this plant in 1906. Although attached then to the Hawaii Experiment Station as a specialist in rice culture, he

<sup>12</sup>James Macrae visited Hawaii in 1825 with Lord Byron and was shown a garden in Lahaina, Maui, containing flourishing pigeon pea plants from seeds brought in the year before. See Bul. 64, Haw. Exp. Sta., p. 12, 1932.

extended his studies to other crops which he thought might have some possibilities for commercial development. Among a number of leguminous plants tried in these investigations was the pigeon pea, from seed which had come to the Station from Porto Rico. A little later he added some other varieties of pigeon pea from India and other countries. Among many plantings he observed one small cluster of plants which grew much more luxuriantly and bore seed pods much more abundantly than the rest. This strain was preserved, propagated and built up by breeding and selection until it became the New Era variety which now covers thousands of acres of land in all parts of the Territory and has been sent to dozens of tropical and subtropical countries where it is displacing even varieties which are very ancient; so great may be the value of a single plant when recognized by an expert plantsman like Krauss.

At first the pigeon pea attracted interest here because of its obvious value as a windbreak. Its rapid and dense growth to a height of five to ten feet seemed to make it particularly useful in this way when protection was needed quickly for a vegetable garden.

Next came the realization that this plant had great value as a feed for livestock, providing about the same elements as alfalfa hay but at much lower cost, for alfalfa has always been difficult and expensive to grow here and equally expensive to import from California. Here was a new crop which would grow readily, seemed perfectly adapted to Hawaiian conditions and could be used either as pasturage or as hay. That realization established the pigeon pea firmly as an economic plant of great importance, and beef cattle producers began planting large experimental areas. The results were so good that by 1920 the plantings covered a thousand acres, and by 1930 eight thousand acres. The present acreage is approximately 6,000. For finishing off cattle for market a few months in pigeon pea pasturage is excellent, putting on good weight (one to two pounds per day) and marbling the beef almost as well as by finishing off on corn.

For other livestock, too, this plant is of very great value and is relished greatly. Hogs thrive on it, as do horses and mules, also sheep and goats. For poultry the

meal made by grinding pods and leaves is an excellent and nutritious feed.

Its value is not limited, however, to its use as feed for livestock. Being a leguminous plant, the pigeon pea develops nitrogen-containing root nodules and therefore is a good plant for green manuring. This caused pineapple growers to use it as a cover crop between cycles of planting, and thousands of acres were sown to the pigeon pea to be plowed under in a few months as a soil builder. For a time this practice was abandoned because of fear that the pigeon pea roots harbored large quantities of a tiny worm (nematode eel worm) injurious to pineapple plants, but later this seemed to be a groundless fear and the former popularity began to be regained, so that now there are large areas under this cover crop.

As bee pasturage the pigeon pea has some value, even though it is impossible to measure it in dollars and cents.

For bird reserves and hunting preserves the pigeon pea offers great possibilities, for the larger game birds such as pheasants and partridges thrive excellently on the dry seeds.

In most tropical countries it is as human food that the pigeon pea is especially valued, but in Hawaii this use has thus far been of very minor importance. This should not be, however, for the seed is very nutritious and has a flavor to which one could become accustomed quite as readily as to that of any other bean or pea. For large scale commercial production for its dried peas (really they are beans) this plant undoubtedly offers very great possibilities, whether the product be sold or canned.

Ref.—Haw. Exp. Sta. Bul. 64, 1932 (the most comprehensive and authoritative work on the subject); Annual Reports 1910:40; 1920:62; 1930:5; Thrum's Annual 1923:85-97 (F. G. Krauss).

**PIGEONS** The raising of pigeons and squabs for market is practiced in Hawaii only to a very limited extent. There is, however, a considerable demand from hotels and restaurants and the small industry could well be expanded sufficiently to meet local needs.

See "Poultry."

**PIKAKI** See "Floriculture."

**PILI GRASS** Pili grass (*Heteropogon contortus*) is

a lowland species well liked by cattle, and widely distributed. This should not be confused with the other pili grass growing at high elevations and not relished by livestock. This latter had formerly a definite economic value, for it provided most of the material for thatching the houses in earlier periods.

Ref.—Haw. Exp. Sta. Bul. 65:23, 1933.

**PILI NUT** The pili nut resembles the Brazil nut in flavor and general appearance, but is more rounded in shape and has a smooth shell. Two closely related species of this nut tree have been brought into Hawaii, *Canarium commune* from Java and *Canarium luzonicum* from the Philippines.

A large tree of the former may be seen at Nuuanu and Judd Streets, Honolulu, while smaller trees of both species occur in gardens as ornamentals.

No commercial exploitation of this nut has been attempted in this Territory, but it seems to offer some interesting possibilities.<sup>13</sup>

**PINEAPPLE** The pineapple (*Ananas comosus*), long recognized as the King of Fruits, is the basis of an industry in Hawaii second only to sugar production. The development of this industry, very remarkably, has occurred mostly during the present century and is the first major movement toward the diversification of Hawaii's agriculture. Many minor crops have contributed toward diversification but none has seemed able to claim and hold a position of near equality with sugar, as the canning of pineapple has done.

Although this industry is a twentieth century affair, the pineapple arrived in Hawaii probably a hundred years earlier. Its early history here is shrouded in some uncertainty. An entry in Don Marin's diary of November 14, 1809, declares that he had planted some pineapples.<sup>14</sup> Since many of his plants and seeds were brought from Mexico, it is probable that he obtained pineapple planting material there, for this fruit has been grown in tropical America for many centuries, its original home probably having been Brazil, whence it had been disseminated up

<sup>13</sup>Information furnished by Dr. H. L. Lyon, Director, H.S.P.A. Experiment Station.

<sup>14</sup>See Johnson's "The Pineapple," p. 5, 1935. (Paradise of the Pacific Press.)

and down through the American continents and into the West Indies. Columbus took some fruits back to Europe where they achieved great popularity in hot-house culture. Spanish and Portuguese mariners, probably in the sixteenth century or the seventeenth, carried the pineapple to the Philippines, East Indies and southern Asia, and it is possible that it reached Hawaii then, but not probable, for Captain Cook made no mention of the pineapple in his list of Hawaiian crops.

In the nineteenth century there developed something of an industry in the production of pineapples in the Kona district of the Big Island, the fruits being small and sweet, of the "Queen" type, probably the variety introduced by Marin. Shipments were made to Honolulu and other centers, where they were in demand not only for consumption by local residents but by the whaling crews, as well. A summary of exports in 1850-1851 includes an item of 21,000 pineapples.<sup>15</sup>

As this export business required double handling in the trip from Kona to Honolulu and then transfer to outbound ships, efforts were begun in 1885 to produce pineapples on Oahu. At first only the Hawaiian (Kona) variety was planted, but a little later several others were brought in from various parts of the world. Among these was the Smooth Cayenne, which subsequently became the basis of the great Hawaiian pineapple industry and displaced all other varieties from commercial planting.

"Mystery surrounds the origin of this, the finest of pineapples," writes J. L. Collins in his recent account of the evolution of the Hawaiian pineapple industry.<sup>16</sup> "There is even uncertainty regarding its first importation to Hawaii, for the Director of the Department of Agriculture of Jamaica, states that they sent Cayenne plants in the early '70's. However, no records of these plants in Hawaii have been found. In 1882, Captain John Kidwell arrived in Hawaii and soon became interested in growing pineapples. To him is given the credit of importing and demonstrating the value of the Cayenne

<sup>15</sup>Trans. Royal Haw'n Agr. Soc., Vol. I, No. 2, p. 87, 1851.

<sup>16</sup>Paradise of the Pacific Magazine (Honolulu) Dec. 1935, pp. 71-77.

variety.<sup>17</sup> He secured 12 plants from Florida in 1885 and 1,000 from Jamaica in 1886. Soon after this he collected 31 varieties from various parts of the world and tried them out on his farm in Manoa Valley which is now the site of the University of Hawaii.

"During the period of 1885 to 1893 there was an intensive interest in the growing of pineapples. During this period approximately 102,500 plants were imported (mostly Cayenne) from many parts of the world.

"Although Kidwell started his plantation for the purpose of supplying fresh fruit, he soon realized that the rapid expansion of the acreage would result in a supply much larger than could be absorbed by the limited fresh fruit market. In 1892 he, with the aid of John Emmeluth, began canning pineapples at a small cannery near Wai-pahu, Oahu. This company continued to preserve pineapples until 1898 when the business was sold out to the Pearl City Fruit Company.

"These efforts of Kidwell undoubtedly furnished the foundation for the present pineapple canning industry. His pineapple canning was not the first to be done in Hawaii, however, for the year that Kidwell came to Honolulu, Akerman and Muller of North Kona, Hawaii, were preserving pineapples in tins which were reported to be 'of excellent flavor and would take first place in any market.' The variety which was canned by Akerman and Muller is not known but it was probably the Wild Kailua, the so-called Native Pine.

"The Cayenne, when introduced to Hawaii, was already an old and tried variety. Mention of it was made by English gardeners in one of their journals as early as 1842. The variety is probably 100 or more years old.

"This variety, when grown elsewhere, does not appear to produce fruits of such good quality as it does in Hawaii. It is indeed a remarkable variety because of its ability to produce so well in such a wide variety of climatic and soil conditions. It produces fruit from close to sea level to an elevation of 3,000 feet and in areas having an

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<sup>17</sup>W. H. Purvis secured several suckers of Smooth Cayenne from the Kew Gardens in England and planted them in Hawaii in 1885, which is claimed by some to have been the first introduction of this variety here. The first fruits were harvested in 1887 by D. McH. Forbes, Purvis' horticulturist. (Footnote by D. L. C., based on statement made to him by Forbes.)

annual rainfall from 20 to 100 inches. Temperature and soil conditions are also widely different. We have spoken primarily of Cayenne because it is the most widely grown variety in the Islands but it should be stated the industry makes use of two varieties, which are indeed very much alike. The Hilo variety is grown to a considerable extent on the island of Kauai, but very little is to be found on the other islands. Hilo differs from Cayenne in some fruit characters but most obviously in the almost complete absence of slips together with a large number of shoots. The canned fruit of these two varieties is so much alike that even cannery experts cannot with certainty distinguish them."

Annexation of Hawaii as a territory of the United States and the opening of a new homesteading tract in central Oahu in 1900 attracted a good many white farmers into the new pineapple industry, among them being James D. Dole, Alfred W. Eames and Byron O. Clark. Although some extensive efforts were put forth in the exportation of fresh pineapples, it was in the canned state that this fruit forged ahead in the American market. Production mounted rapidly from a few hundred cases in 1903 to over 12,000,000 cases (of 24 cans of about 2 pounds each) in 1930, making this industry one of the largest of canning activities anywhere in the world.

Growth<sup>18</sup> of the Pineapple Industry as Shown by the Increase in the Total Cases of Fruit Packed in Successive Years, 1903 to 1933<sup>19</sup>

<i>Year</i>	<i>Cases of Fruit Packed</i>	<i>Year</i>	<i>Cases of Fruit Packed</i>
1903.....	1,893	1919.....	5,071,976
1904.....	10,304	1920.....	5,986,982
1905.....	45,041	1921.....	5,262,503
1906.....	74,245	1922.....	4,770,239
1907.....	168,205	1923.....	5,895,747
1908.....	343,726	1924.....	6,825,904
1909.....	401,940	1925.....	8,728,580
1910.....	464,968	1926.....	8,939,590
1911.....	725,742	1927.....	8,879,252
1912.....	1,313,363	1928.....	8,663,056
1913.....	1,667,122	1929.....	9,211,376
1914.....	2,268,781	1930.....	12,672,296
1915.....	2,669,616	1931.....	12,726,291
1916.....	2,609,483	1932.....	5,063,793
1917.....	2,607,031	1933.....	7,813,540
1918.....	3,847,315		

<sup>18</sup>This table of figures is taken from the article by J. L. Collins referred to above.

<sup>19</sup>Since 1933 the industry has not published its annual packs, but it is known to be increasing very greatly over the relatively small totals of 1932 and 1933.

*Juice*—The canning of pineapple juice has in the past few years become a very important feature of the pineapple industry here, with the yearly pack running into millions of cases.<sup>20</sup>

Many years ago a strong effort was made to develop a market for pineapple juice, but without much success. At that time it was believed that only a clear juice, free from sediment, would be wanted by the public, and accordingly a clarified product was offered, in bottles. Unfortunately, the clarification process deprived the juice of its natural flavor and the results marketwise were very disappointing. Large quantities of the bottled juice remained unsold and after a few years the effort was abandoned to utilize in this way the juice that flowed so abundantly from the canning of the fruit.

Next came a scheme to concentrate the juice by partial evaporation into a thick, heavily sweetened liquor which was to be diluted for use in the making of fountain drinks. One such preparation was called "pinectar" and figured in the market in a minor degree for a few years. The concentrated juice did not prove popular, however, and its manufacture soon ceased.

For several years thereafter practically the only use made of the juice liberated in the canning of pineapples was to transform it into syrup, and in that way it became an item of considerable value to the industry. Some ten years ago, however, there began a revival of interest in the marketing of juice, but this time in as near its natural state as possible, with neither clarification nor concentration. Fresh, natural juice, with its suspended solids, was placed in cans and given a minimum of heat treatment for sterilization. It gained steadily in popularity until the point was reached where the juice flowing from the canning process as a by-product was insufficient to fill the demand and it became necessary to send many thousands of tons of pineapples through juice presses. Statistics are not available as to the total output of canned pineapple juice at present, but indications are that it is in excess of 4,000,000 cases per year and apparently destined to increase still more.

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<sup>20</sup>This output of canned juice is not included in the table of figures above.

*Research*—The early experimentation which led to the founding of this industry was by private individuals, as no research station was in existence here prior to the present century. With the establishment of the federal station in 1901 some attention began to be directed toward pineapple problems, at first mainly in the matter of insect pests but later (1909) some soil difficulties arose and were ably investigated by station experts.<sup>21</sup>

In 1914 the industry found it necessary to have more assistance than the Hawaii Experiment Station was able to give, especially in the problem of controlling pests and diseases, and turned to the Experiment Station of the Hawaiian Sugar Planters Association (H.S.P.A.). An arrangement was made for a certain amount of research work on pineapple problems to be done by various members of the sugar station. This plan continued in operation about ten years, the program of research work meanwhile having grown and expanded considerably.

In 1924 an experiment station was established by the pineapple industry, affiliated with the University of Hawaii but supported independently by an assessment on the pack of pineapples.<sup>22</sup> This has subsequently become a large and important research institution, with excellent laboratories at the University campus.

The industry has organized a cooperative association which "is composed of seven companies"<sup>23</sup> producing pineapples on Oahu, Molokai, Maui, Lanai and Kauai. The fruit is preserved in nine canneries of which three are in Honolulu, four on Maui, and two on Kauai. A few pineapples are grown by independent farmers and there is on Kauai an association of Japanese growers which operates a small cannery independent of the Cooperative Association.

"There are approximately 90,000 acres of land avail-

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<sup>21</sup>See Bulletins 26, 28 and 52 of the Hawaii Experiment Station.

<sup>22</sup>See R. N. Chapman "Cooperation in the Hawaiian Pineapple Business." Amer. Council, Institute Pacific Relations, p. 8 (1933).

<sup>23</sup>Quotation is from Collins' article cited above. The cooperative association referred to is the Pineapple Producers Cooperative Association formed in 1932 as a result of the depression; preceding this, there had been the Association of Hawaiian Pineapple Canners, which established the experiment station referred to above. For an account of the major achievements of this Station, see Collins' article cited above, pp. 76-77, also numerous publications of the Station itself.

able for pineapple growing in the island group. At no one time is the total acreage producing fruit. Each plantation is so organized that every year a portion of its land is in each of the following stages of pineapple culture:

1. Young plants not yet reached fruiting age.
2. Plants producing fruit.
3. Fields of old plants which have completed their period of productiveness.
4. Fallow fields. These may be without growing pineapple plants for one to three years. Part of this time fallow fields will produce cover crops intended to prevent soil erosion and to increase organic soil matter. This period, when no pineapples are grown, is called the intercycle."

In addition to the sales of millions of cases of the canned product, there is some business in the shipping of the fresh fruit to the mainland, the total of such shipments in a typical year amounting to a little less than 50,000 boxes<sup>24</sup> of about 75 pounds each. There is considerable loss suffered from decay in transit, for the Smooth Cayenne pineapple is not a good shipper. Returns from these exports add perhaps \$100,000 to the value of the entire industry, and in addition there is a large volume of local sales of the fresh fruit which is probably equal to the amount shipped away in the fresh state.

*By-products* of the pineapple canning industry are important commercially and add materially to the returns from this fruit. First, is a large amount of juice which is caught and conserved, most of it being boiled down and made into syrup to be used in the canning process. Much of it, however, is canned for sale as juice.

The second by-product is pineapple bran (which see) made from the shell and core. Third is alcohol distilled from the fermenting waste and juice. Fourth is calcium citrate and its derivative, citric acid, both in much demand commercially. Vinegar is another by-product, made in

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<sup>24</sup> 1931 .....	38,308 boxes
1932 .....	59,027 boxes
1933 .....	46,324 boxes
1934 .....	33,303 boxes
1935 .....	53,990 boxes

one cannery. For a detailed statement of by-products see Thrum's Annual 1932:77-82 (article by D. W. Malott), and 1926:87-91 (T. F. Sedgwick).

Among possible new by-products which might be developed is the extraction of fiber from the leaves. It is known that the fiber of the pineapple leaf is good for the making of a fine cloth, but it is not known whether the Smooth Cayenne variety would be suitable for this purpose.

There is an abundance of published information pertaining to the pineapple industry in Hawaii, including cultural practices, disease and pest problems, canning, marketing, etc. The following list is by no means exhaustive.

Ref.—“The Pineapple” by Maxwell O. Johnson, p. 306, Paradise of the Pacific Press 1935 (contains an excellent and extensive bibliog.) “Paradox in Hawaii” by D. L. Crawford, Chapter IV, pp. 85-105, Stratford Press, 1933. “Cooperation in the Hawaiian Pineapple Business” by R. N. Chapman (American Council, Institute of Pacific Relations, 1933); “Evolution of the Hawaiian Pineapple Industry” by J. L. Collins (Paradise of Pacific Magazine, pp. 71-77, Dec., 1935). Haw. Exp. Sta. Bul. 26—“Manganese in Plants and Soils,” 1912; Haw. Exp. Sta. Bul. 28—“Manganese in Pineapple Plants,” 1912; Haw. Exp. Sta. Bul. 52—“Manganese Chlorosis of Pineapples,” 1924; Haw. Exp. Sta. Bul. 77, pp. 69-72 (uses, recipes, etc.). Haw. Exp. Sta. Annual Reports: 1902:318, 1903:406; 1907:57; 1908:27; 1909:58; 1910:14, 41; 1912:35; 1913:23; 1914:33; 1915:58; 1916:14, 23, 36; 1917:11, 25; 1918:20, 44; 1919:37; 1920:20, 35, 43. Thrum's Annual 1909:58-82; 1917:36-46; 1935:87-89. Haw. For. Agr. 1904:334-335 (Kidwell).

**PINEAPPLE BRAN** Pineapple bran is the trade name applied to a by-product of Hawaiian pineapple canneries made by drying and grinding the rind and core. Preliminary experiments by H. E. Savage of the Hawaiian Pineapple Co., with the cooperation of Professor L. A. Henke of the University of Hawaii, led to the first commercial manufacturing of this product in 1923, when the total out-turn was 1,726 tons. In subsequent years it has increased to over 10,000 tons per year.

Pineapple bran has a considerable value as a feed for livestock, a fact established both experimentally and by practical use on a large scale. Chemical analysis shows that it is rich in sugar and starch and has some protein,

also; its fiber content adds some roughage value. It is essentially an energy-producing food and is, therefore, valuable for work animals. It is used extensively on plantations as a feed for horses and mules, in combination with barley and hay.

For dairy cattle it has been demonstrated to be a good feed when used in proper combination with other concentrates. The cattle relish the pineapple bran and the milk flow increases, resulting in an appreciable decrease in the cost of milk production without affecting the quality.

Hogs fed on a ration containing 50 per cent pineapple bran gain less rapidly but at less cost per pound of gain than with imported concentrates.

As a feed for poultry pineapple bran is of much less value than for other livestock. Egg production seems to decline when any considerable percentage is added to the feed mixtures.

Ref.—Haw. Exp. Sta. Circ. 2, "Pineapple Bran as a Feed for Livestock," 1931. Also, U.H. Agr. Dept. Annual Reports 1922:37-40; 1924:18, 28; 1925:24-32; 1926:14-21; 1927:7; 1928:11; 1929:7-11.

**PINEAPPLE GUAVA** See "Feijoa."

**PLUMERIA** See "Floriculture."

**POHA** The poha (*Physalis peruviana*), sometimes called ground cherry or Cape gooseberry, resembles a small tomato in some respects. It is an introduced plant and probably originally was cultivated but it has long since escaped into the wild state and now occurs in the lower foothills and waste areas, though not abundantly. The fruit grows inside a papery husk and hence escapes injury from the fruitflies.

The poha is very commonly used in the making of jams, jellies and preserves and is the basis of a small industry which might be considerably expanded. While there is some cultivation of this fruit, the total area is very small, most of the home canning depending on the wild product for its supplies.

It is quite possible that an industry of important size could be developed by cultivating large areas of this fruit in regions well suited to it, as the Kona and Glen-

wood regions of Hawaii, and establishing canning plants nearby, to keep transportation costs at a minimum.

Ref.—Haw. Exp. Sta. Annual Report 1921:23. Bul. 47, pp. 20-22, 1923; Bul. 77:73-76 (uses, recipes, etc.).

**POI** Poi is the staff of life of the Hawaiian people. It is a very nutritious food made by steaming taro corms until thoroughly cooked, then removing the outer peeling and mashing the rest into a pulp which is allowed to ferment for several days. Its characteristic flavor is such that one must acquire a taste for it before relishing it and for this reason there is little probability that this product would find a ready market outside of Hawaii of any considerable size, notwithstanding the fact that it is believed to have special value as a food for convalescents, invalids and infants.

For possibilities of transforming it into other foods with larger market possibilities, see "Taro."

For details of poi manufacture see Haw. Exp. Sta. Bul. 70, "The Manufacture of Poi From Taro in Hawaii," published in 1933.

**POMEGRANATE** The pomegranate (*Punica granatum*) is a familiar fruit, grown in many parts of the world and common in the gardens of Hawaii. Its fruits are about the size of an apple, its leathery skin enclosing a multitude of small compartments packed together like cells of honey-comb and each containing a sweet, juicy morsel.

There is no considerable market demand for this fruit, however delicious it may be, and most of it falls to the ground unused.

The bark of the tree and the skin of the fruit contain a liberal amount of tannin which in some countries is used for tanning fine Morocco leather.

Ref.—Wilder, "Fruits of the Hawaiian Islands" (1911), p. 12.

**POMELO** See "Grapefruit."

**PORTUGUESE PLUM** See "Java Plum."

**POTATO** The Irish potato (*Solanum tuberosum*) is a western innovation in Hawaii, probably the first planting having been by Marin prior to 1813, for his journal of that year says that "he had planted at sundry times"

a long list of things new to Hawaii, Irish potatoes among other items. Probably from this beginning or perhaps from some other introduction, it was occasionally planted by Hawaiians, but by no means commonly, for it was rarely seen in the markets before 1835 and the native people did not use it as a food.

Gradually they learned that it had value and increased their plantings, especially in the Kula uplands of Maui. By 1840 potato growing had become a recognized, though still small, industry and the farmers used to carry them in barrels on their backs to the ports where whaling ships would buy them, paying in cloth the equivalent of from \$1.00 to \$3.00 per barrel.

During the early years of the California gold rush there was a very great demand for Hawaiian potatoes and at almost unbelievable prices. One account<sup>25</sup> tells of a whaler who loaded his ship with as many barrels of potatoes as he could obtain at a dollar or two per barrel and sold them in California at forty to fifty dollars per barrel! This situation, of course, did not last long, for California began producing its own potatoes and other foodstuffs as soon as the worst of the gold fever had subsided. For a few years, however, the Irish potato topped the list of all exports from Hawaii, in the best year (1850) there having been 71,985 barrels sent out.<sup>26</sup> At the height of this movement, the eagerness to obtain potatoes for shipment became so intense that even half grown plants were dug up and the miniature tubers sold, for the prices offered here had gone up to \$8.00 or \$9.00 per barrel and too little attention was given to quality. This naturally brought disastrous results, for Hawaiian potatoes earned the reputation in California of being exceedingly poor and the market demand dropped off in consequence.

The situation changed swiftly: in 1848 to 1851 Hawaii was supplying California's needs, as just stated; by 1854 California was shipping potatoes to Hawaii. When boom prices receded to respectable levels, most producers here lost interest and ceased growing potatoes,

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<sup>25</sup>G. D. Gilman, in *Trans. Royal Haw'n Agr. Soc.*, Vol. II, No. 1, p. 139 (1854).

<sup>26</sup>*Trans. Royal Haw'n Agr. Soc.*, Vol. I, No. 2, p. 87.

so that even home consumption needs could not be met. Growers were urged to return at least to the extent of meeting local needs and filling the demand from the whaling fleets; this total need was estimated in 1854 to be about 20,000 barrels. But the response was not forthcoming. In a very few years the whaling industry itself began to wane, and the once-flourishing potato industry passed out almost completely, until 1932 when a new combination of world events pushed it out again into a new role.

Prior to this latter date interest in the potato had not lain dormant, for the Hawaii Experiment Station began in 1901 to call attention to it as a crop that had once been of great importance and should be again. Test plots were planted with many imported varieties in an effort to discover some that would be resistant to the diseases which seemed more virulent here in the tropics than in the temperate zone. Because of its importance as a food crop and because of the fact that large quantities were being imported continually, special efforts were put forth by the Station to solve the problem of adapting this crop to Hawaii. Extensive study was made of the prevalent diseases, which led to the publication of an excellent bulletin (No. 45) in 1920. Also, the trial of many varieties continued, followed by careful selection for developing a type suitable to this tropical environment.

Success began to come as F. G. Krauss on Maui was able to obtain yields of 100 bags per acre and better, of excellent tubers. Disease control seemed to be quite possible and no longer offered the serious threat it once did. But still the growing of potatoes continued on a very small scale and importations increased with the increasing population. There seemed to be no room for potato production; sugar and pineapples had the right of way and were forging ahead in good markets.

In the 1930's, however, both industries suffered reverses from dwindling markets and falling prices. Production, both of sugar and pineapples, was curtailed and large areas of erstwhile busy land became idle. In casting about for some new crop to fill the void, the potato was given a good trial, with encouraging results. The many

years of research which had seemed so futile now enabled the Experiment Station and Extension Service<sup>27</sup> to direct these trials with precision, the planting being confined to early fall and winter so that the crop would come off in time to reach the California market for "new" potatoes and thus command a high price. Even though importation of large amounts of potatoes continues,<sup>28</sup> a partial

<sup>27</sup>Much credit is due, also, to Podmore and Sons, Commission Merchants, for their active work in reviving this industry.

<sup>28</sup>Imports of potatoes into Hawaii in the past several years have been as follows, compiled from the Monthly Summary reports issued by the U. S. Department of Commerce, Washington, D. C.

Year Ending <i>December 31</i>	Volume in <i>Pounds</i>	Value in <i>Dollars</i>	Average Value <i>Per Cwt.</i>
1911 .....	7,674,060	140,037	\$1.82
1912 .....	11,546,340	143,188	1.24
1913 .....	12,885,360	122,450	.95
1914 .....	12,981,600	142,248	1.09
1915 .....	13,907,520	165,878	1.19
Average .....	11,798,976	142,760	1.26
1916 .....	11,352,720	206,020	1.81
1917 .....	11,097,180	306,141	2.75
1918 .....	12,072,900	224,385	1.85
1919 .....	10,784,520	248,403	2.30
1920 .....	9,549,120	347,410	3.63
Average .....	10,971,288	266,472	2.47
1921 .....	18,387,240	317,828	1.72
1922 .....	16,746,300	235,199	1.44
1923 .....	17,013,840	254,041	1.49
1924 .....	16,988,840	324,838	1.90
1925 .....	17,872,560	415,266	2.32
Average .....	17,401,756	309,434	1.77
1926 .....	15,891,720	386,794	2.43
1927 .....	16,670,000	328,956	1.97
1928 .....	16,966,440	215,473	1.27
1929 .....	18,455,520	321,687	1.74
1930 .....	17,490,180	365,969	2.09
Average .....	17,094,772	323,776	1.90
1931 .....	19,504,140	203,420	1.04
1932 .....	19,932,360	179,317	.90
1933 .....	17,829,154	219,095	1.23
1934 .....	16,081,766	189,801	1.18
1935 .....	18,983,547	225,882	1.19
Average .....	18,466,194	203,503	1.11

reversal of the current of trade has begun with exportation of our winter crop at high prices while we import storage potatoes at lower prices. Hundreds of acres have been planted and shipments to the Pacific Coast have been large enough and profitable enough of late years to indicate that there are great possibilities in this crop as a means of diversifying Hawaiian agriculture in an economically sound manner.

For a full treatise on the production of potatoes in Hawaii consult the first publication in the list below, a comprehensive booklet by F. G. Krauss, who chiefly was responsible for the success in re-establishing this industry in Hawaii.

See also "Truck Crops."

Ref.—U. H. Ext. Bul. 15, "Commercial Potato Production in Hawaii," 1931; Haw. Exp. Sta. Bul. 45, 1920; Annual Reports 1901:374; 1902:312; 1903:395; 1906:10; 1913:39; 1914:39; 1915:40; 1916:27; 1917:34, 48; 1918:40, 45; 1925:10; 1926:11; 1927:13; 1936:24, 40. *Planters Monthly* I, 282 (1883); VII, 361 (1888); XII, 314 (1893).

**POULTRY** Chickens were brought to these Islands by the ancient Hawaiians and have for centuries been an important article in their diet. Although raised in confinement, some must have escaped and established themselves in the forests, for even to this day wild fowl are occasionally found.

Poultry raising as an industry, however, did not begin until after the coming of Captain Cook, when he and many other sea captains who came after him bartered for or purchased chickens and eggs from the Hawaiian people. Improvements in the poultry stock of the Islands began not long afterwards by the importation of American and European breeds, and by the end of the nineteenth century there had developed a considerable industry. This was based largely, however, on imported layers, for the "native" stock was inferior in egg production. The 1900 census showed about 95,000 chickens in the Territory, but, if the egg production figures gathered by the census takers can be credited, those chickens were not very prolific, for they seem to have laid an average of only a dozen and a half eggs each per year.

In the 1900's there began to be developed some large poultry plants, and with that the modern industry had its beginning. In 1905 the Hawaiian Poultry Association was formed. With each passing year the number of layers increased, so that in 1930 the census showed more than three times as many as in 1900, with the total egg production about nine times as great, thus indicating that much improvement had been effected in the average quality of the stock.

The income from the poultry industry is nearly a million dollars annually.<sup>29</sup> In 1931 the value of this industry was estimated by the Agricultural Extension Service of the University of Hawaii to be \$998,895.00. During that year this industry was the sixth agricultural income producer for the Territory; not long ago it was regarded by most farmers of the Territory merely as a home source of pin-money for the women and children. The new appreciation for poultry has grown out of the better knowledge of the efficiency of the farm hen in turning feed and labor into substantial profit and income. Poultry has been the means of carrying many a hard-pressed family through financial stress, and has finally emerged as an established industry.

Although the poultry industry has made great advances during the past 30 years, it still has a long way to go in its development program. Hawaii is still importing each year more than two million dozen eggs valued at approximately \$500,000.00, as well as more than a million pounds of poultry valued at more than \$200,000.00. These imports might well be replaced by eggs and poultry of local production.

The per capita rate of egg consumption is increasing in Hawaii, but is still considerably below that of the mainland, being about 12 dozen per year per person here compared with 25 dozen in the states.

Through the efforts of poultry producers and especially of our Experiment Station and Extension Service, the industry here has been put upon a more sound basis than was true in 1910 or even 1920. Diseases formerly

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<sup>29</sup>This and the following paragraph are taken from Bulletin 20 of the Agricultural Extension Service of the University of Hawaii, 1934, by H. L. Chung, A. S. T. Lund, and C. M. Bice.

took a very heavy toll but now do not; in the earlier time practically all layers were imported, but now only a few breeders are brought in and all layers are locally produced; it used to be thought that in the tropics 100 eggs per year was as good a record as could be expected, but now we have our 300-eggers and our hens can compete in this regard with the best anywhere in the world, as proved in several egg-laying contests conducted here under standard rules and techniques.<sup>30</sup>

The cost of feeds remains a serious problem, for Hawaii produces no cheap cereals and must rely on imported concentrates until suitable substitutes can be found. Some progress is being made in this line, but not enough to bring our egg prices down to an equality with the mainland product where cheaper feeds are available.

Anyone desiring full information about the poultry industry, the selection of breeds, the problems of feeding, marketing, etc., should consult first the University bulletin referred to above in a footnote; also, the following bulletins are of importance:

Ref.—Haw. Exp. Sta. Circ. No. 1, "The Management of Baby Chicks in Confinement"; No. 3, "Natural and Artificial Incubation of Hens' Eggs"; No. 4, "Poultry Feed Supplements"; No. 5, "Poultry Diseases Common in Hawaii"; No. 7, "Capon and Caponizing"; No. 8, "Fowl Pox (Sorehead) Control By Vaccination"; No. 10, "Turkey Management In Hawaii." Annual Report 1936:73-82 (diseases, feeds, etc.).

**PRIDE OF INDIA** The Pride of India, also known as Oriental Lilac (*Melia azedarach*) is a common ornamental tree throughout the Hawaiian Islands, with little or no commercial value associated with it.

At one time it was recommended for wide planting as a source of fuel wood, with the further possibility of being valuable for timber purposes.<sup>31</sup>

**PULU** See "Tree Fern."

**PUMPKIN** See "Squash."

<sup>30</sup>For detailed reports upon these egg-laying contests see Annual Reports of U. H. Agr. Dept. 1924:43-46; 1925:29; 1926:49; 1927:24-27; 1928:25-27; 1929:23-24.

<sup>31</sup>Trans. Royal Haw'n Agr. Soc., Vol. I, No. 2, p. 83 (1851).

**PYRETHRUM** Pyrethrum, or buhach, is an insecticide powder made from the flowers of certain chrysanthemums (*Ch. coccineum* and *Ch. cinerariaefolium*). In 1909 an attempt was made to establish a small industry based on the cultivation of these plants.<sup>32</sup> Dr. A. Marques obtained seed from Algiers and requested the cooperation of the Hawaii Experiment Station and several individual gardeners in trial plantings. Although these experiments were successful in demonstrating that the plants would grow here, nothing of importance developed out of them.

A renewed effort is now being made to establish the cultivation of this plant as an industry here. The Agricultural Extension Service of the University recently obtained seed from Colorado and several experimental plantings in various parts of the Territory are under observation. Because, however, of the large amount of hand labor involved in the harvesting and handling of this crop, it is not likely that in a high-wage country like this the industry could develop into anything of large importance.

Pyrethrum plants are perennials, flowering at the end of the first year and bearing increasingly large crops of flowers in each successive year for 6 to 12 years.

See also "Derris."

Ref.—Thrum's Annual 1910:101-105.

**QUINCE** The quince (*Cydonia vulgaris*) is a temperate zone fruit which is occasionally grown in Hawaii at relatively high elevations (4000 feet and above) where the cool climate is favorable. Fruits of good quality are sometimes exhibited at county fairs, but the quince is not considered as offering any promise for commercial exploitation here.

**QUININE** See "Cinchona."

**RABBITS** Rabbit raising as an industry is very old in some parts of the world, but did not have a beginning in Hawaii until some seventy-five years ago. There was a small importation of rabbits into these Islands, perhaps

<sup>32</sup>Twenty years prior to this there had been a show of interest but no serious effort was made to establish the cultivation of the plant. *Planters Monthly* VIII, p. 256 (1889).

the first, in 1853, and in 1873 permission was granted to use a small islet near Hilo for rabbit propagation. Rabbit raising has never, however, rivalled the poultry industry in size anywhere, always being relatively insignificant. In Australia, where rabbits have escaped and become very plentiful, an industry has been developed in the last two decades in the canning of the meat.

In Hawaii one must obtain permission from the government to raise rabbits, whether as pets or for commercial purposes, a rule imposed by the Territorial Board of Agriculture and Forestry as a protection against the escape of these animals and their propagation in the wild, to the detriment of agriculture and forests.

As a means of increasing and diversifying the home food supply and perhaps also increasing the family income, rabbit raising on a small scale offers attractive possibilities, especially in rural and suburban districts. Anyone desiring detailed information on the subject, as to suitable breeds and correct methods of procedure, should consult Bulletin 12 of the Agricultural Extension Service of the University of Hawaii, 1931, by H. L. Chung.

**RADISH** The small table radish (*Raphanus sativus*) is a very widely cultivated crop in market and home gardens but the total production is small, nevertheless, for the consumption per capita is exceedingly limited. The fleshy root, usually eaten raw, is used as a relish because of its peppery flavor.

The Japanese and Chinese have a special variety of radish, known as *daikon*, the root of which is elongate in shape and much larger than the other varieties and instead of being eaten raw is either cooked or pickled.

Daikon production in Hawaii occupies a part of many vegetable gardens, amounting in the aggregate to over 50 acres, according to a 1936 survey of crops. Other varieties of radish occupy probably less than 5 acres.

The tops of young radish and daikon plants are commonly used by Orientals as cooked greens. The ordinary planting practice is to seed heavily and later thin out the rows of seedlings. The seedlings thus eliminated

are saved and marketed as greens.<sup>1</sup> Their mild peppery flavor makes them very delicious.

See also "Truck Crops."

**RAMIE** Ramie fiber, sometimes called "China grass," is well known in commerce and is much in demand for cordage and other uses. It is made from the bark of a plant (*Boehmeria nivea*) somewhat related to the Hawaiian olona.

Production of this fiber plant in Hawaii was begun in the early 1880's in a small experimental way, in the hope that it might be the means of diversifying industry here which was thought to be too much centered on one crop. The experimental plantings were sufficiently successful to arouse much interest and great hopes. There was, however, a serious obstacle to successful establishment of an industry in that no machine had been developed for the separation of the fiber of this plant, for it presented certain mechanical difficulties not encountered in the case of most other fiber plants. To overcome this obstacle the Hawaiian government in 1884 offered a reward of \$10,000 for the perfection of a machine suitable for making ramie fiber. The Hawaiian Ramie Company made such a machine and claimed the reward in 1886. Although it was conceded that the invention merited the reward, the government found itself unable to pay the money.<sup>2</sup> The company continued its operations, however, and popular interest was strong in this incipient industry, though not strong enough to prompt planting on a large scale. The first machine did not, after all, prove to be successful, and another was brought out by J. C. White, of Honolulu, in 1892. Interest, which had waned somewhat, now arose again, but only for a short time. The plantings were soon abandoned and attention turned to sisal as a more promising source of fiber.

Ref.—Planters Monthly Vol. II, 228 (1884); III, 394, 464, 669; IV, 5, 35, 141, 152, 156; V, 26, 248; VI, 111; IX, 516; X, 332 (1891). Thrum's Annual 1893:107. Haw. For. Agr. 1904:140-149 (good treatise on cultivation and extraction of fiber). Hon. Advertiser, Dec. 15, 1935 (statement on editorial page).

**RANGE GRASSES** See "Grasses."

<sup>1</sup>Haw. Exp. Sta. Bul. 60, p. 22, 1929.

<sup>2</sup>Planters Monthly V, p. 133 (1886).

**RASPBERRY** At elevations of 3000 to 5000 feet above sea level certain varieties of the common raspberry (*Rubus spp.*) do fairly well in Hawaii, but thus far the results do not give much promise for successful production on a commercial scale.

The Hawaii Experiment Station obtained plants of some 19 different varieties from mainland states in 1929 and 1930; while several made some growth, none prospered, regardless of whether they were planted at an elevation of a few hundred feet or over 2000 feet above sea level.

See also "Akala."

Ref.—Haw. Exp. Sta. Annual Report 1929:19; 1930:26; 1931:23; 1933:10.

**REDTOP GRASS** Redtop grass (*Agrostis alba*) is very widely distributed on Hawaii Island and less so on the other islands. It was introduced by David M. Forbes in the 1880's. Used in grass mixtures it is good on poor, thin soils.

Ref.—Haw. Exp. Sta. Bul. 65:3, 1933.

**RHODES GRASS** Rhodes grass (*Chloris gayana*) is considered very valuable on all ranches, as it furnishes abundant grazing and does well under a variety of conditions. It is sometimes used for hay.

Ref.—Haw. Exp. Sta. Bul. 65:13, 1933.

**RHUBARB** Rhubarb (*Rheum Rhaponticum*) is grown only to a limited extent (perhaps an acre or two) in Hawaii, as it requires a cool climate. In Waimea, Island of Hawaii, it does well and at corresponding elevations where there is ample rainfall and well drained soil farmers would be wise to produce this crop for market,<sup>3</sup> for Honolulu imports some 60,000 pounds per year from the mainland.<sup>4</sup>

The edible portion of the plant is the thick, succulent petiole which has a pleasant acid flavor and may be

<sup>3</sup>For directions in planting and cultivation see Agr. Ext. Bul. 16, 138, 1932.

<sup>4</sup>According to Mr. Jared Smith, the Honolulu market was well supplied some years ago by W. H. G. Arnemann, who cultivated rhubarb at Alike (Hawaii) until the 1919 lava flow destroyed his land.

cooked in a number of ways. The leaves are good when cooked as greens.

See also "Truck Crops."

**RICE** Rice (*Oryza sativa*), the food staple of the Orient, was a "luxury from abroad" in Hawaii in the first half of the nineteenth century. In 1853 a Kauai agriculturist noted the fact that \$10,000 to \$12,000 was being spent each year for rice imported from China "which might readily be raised here." (That has a familiar and modern sound to it!) The Royal Hawaiian Agricultural Society began some experiments, using seed from South Carolina introduced by Holstein, and found that rice could be grown here successfully, and from then there developed a considerable industry in the production of this crop. Before long there was enough to supply all local needs and Hawaii became a rice exporting country. The peak was reached in 1887 when over 13 million pounds were exported.

It was in that period, the second half of the century, that Chinese immigrants were coming into Hawaii by thousands and they not only created a large local market for rice but, also, went extensively into its production. Nearly all the rice growers were Chinese, and they used here the same production methods that had been used in China for centuries.

By the end of the century there began to be a decline in this industry, for cheaper and better rice was coming in from Japan and also from Texas and Louisiana, and later from California. In 1901 these imports amounted to about 250,000 pounds, which was just the beginning of the flood that was to come in a few years to swamp local producers.

During the past forty or fifty years this industry has been suffering a slow but steady decline, due to several factors:

(1) Sugar was proving to be more profitable and was therefore taking away some of the acreage once used for rice.

(2) The coming in of thousands of Japanese turned a very large part of the demand to Japanese rice, as it was considered by them to be superior to Hawaiian grown rice.

(3) The higher wage level here made it impossible to compete with rice produced in Asia where wages were much lower, and the antiquated methods used here made it impossible to compete with the American-grown product of Texas, Louisiana and California. In other words Hawaii was trying to produce rice by Oriental techniques at American wages, and naturally was finding it practically impossible to meet outside competition.

In 1906 the Hawaii Experiment Station began to try to do something for the failing industry. F. G. Krauss was taken from Kamehameha Schools and put in charge of an extensive series of experiments to find some variety of rice that would be better than the one commonly grown here, and to develop better methods of cultivation. The Station had 130 kinds under test within a year or two and one especially promising variety seemed to be emerging. In 1907 a survey of the Hawaii rice industry was made and it was found that it occupied about 10,000 acres and returned about \$2,500,000 annually to the Territory. The sugar industry at that time was returning about \$30,000,000, while the infant pineapple industry had not yet reached the one million mark in its value to the Islands. Rice was the second industry in the Territory.

For several years the work of the Experiment Station stimulated a renewed interest in the industry of rice production, and for a time its downward movement was somewhat checked. Since the Japanese seemed to insist on their own kind of rice, seed was brought in from Japan to be used instead of the Hawaiian seed. But after a few years it was announced by the Experiment Station that the results were not up to expectations. The preference for Japanese rice was said to be due not to its flavor but to certain physical qualities, and it was claimed that even when Japanese seed was used the Hawaiian-grown product did not have the same characteristics in that respect as the rice grown in Japan. It developed later, however, that Japanese seed grown in California was acceptable to the Japanese in Hawaii, perhaps because it was a little cheaper; California thereby captured most of our rice market, which now absorbs about two-thirds of the total output of California.

By 1915 the revival of interest in this industry had be-

gun to wane, for the local producers would not change their old methods of cultivation, and the market seemed to be steadily slipping away to the importers. As the old Chinese planters died, the younger generation was not taking their places, and the acreage was diminishing. In 1920 a survey indicated only about 6200 acres in rice, while a decade earlier it had been 10,000.

In 1928 a new insect pest, the rice stem borer, appeared on the scene and caused a great deal of havoc in the dwindling industry. Many fields were abandoned because of this insect. This may prove to have been the last blow to kill the rice industry in Hawaii, for today there are less than 2000 acres throughout the entire Territory devoted to this crop. We import and consume annually over 92,000,000 pounds compared to our local production of about 4,000,000 pounds. Imports from California in 1919 and 1920 about equaled the amounts produced in the Territory, but by 1932 the latter had declined to such a low figure that local production amounted to only about 4 per cent of the total consumption, nearly 96 per cent coming from California.

The reasons for its failure to become permanently established in our economic structure are several:

- (1) High production costs.
- (2) Antiquated methods of cultivation.
- (3) Lack of suitable land areas where modern, large-scale production methods could be used.

At the present time there is a movement under way to build up the rice industry on new and modern lines, using more machinery in planting and harvesting and applying fertilizers judiciously. Kauai is leading in this movement, which may bring important results in the next few years. Much will have to be done, however, to place production here on a cost basis equal to California; a recent comparison by the Hawaii Agricultural Extension Service showed production costs on Kauai nearly three times as high as California production costs per 100-pound bag.

A dry land variety of rice was planted experimentally in 1918 at the University farm to ascertain the possibilities of this as a forage crop for livestock. The results were not

encouraging and the test was not repeated. (U. H. Agr. Dept. Ann. Rep. 1918:9.)

Ref.—Thrum's Annual 1877:45-49 (History of Rice Industry); 1912:128-132; Haw. Exp. Sta. Annual Reports 1901:377; 1906:15; 1907:21, 67; 1908:14, 65; 1909:14, 63, 66; 1910:12; 1911:54; 1912:64, 75; 1913:35; 1914:36; 1915:39; 1918:46; 1920:37; 1928:14. Bul. 21 (Composition of Rice Plant), 1910; 24 (Assimilation of Nitrogen), 1911:31 (Rice Soils), 1914; Press Bul. 19 (1907). U. S. D. A. Year Book (statistics). Koamalu, several references to rice culture.

**RICE BRAN** The milling of rice yields a by-product comparable to a combination of wheat bran and middlings and is called rice bran. It has excellent nutritive values both as human food and for livestock as well. The nutrition laboratory of the University has investigated the vitamin content and food value of this product for humans and recommends that it be used as an additional ingredient in bread. A local bakery has taken up the suggestion, but the limited supply of rice bran available in Honolulu has not permitted as great an exploitation of the idea as it deserves.

Some tests of rice bran in comparison with wheat middlings as a feed for hogs at the University farm showed the greater food value to be in the latter.

Ref.—U. H. Agr. Dept. Annual Report 1924:18.

**RICE GRASS** Rice grass, or laiki grass (*Paspalum orbiculare*) is good for poor thin soils but elsewhere is not equal to the better pasture grasses.

Ref.—Haw. Exp. Sta. Bul. 65:36, 1933.

**ROSE APPLE** The rose apple (*Eugenia jambos*) is an attractive tropical tree not infrequently grown as an ornamental. Its fruits are about the size and shape of a small guava. The flavor is suggestive of the aroma of a rose. Although it is relished by most people, this fruit is not produced on a commercial scale and rarely if ever comes into the markets.

Ref.—Wilder, "Fruits of Hawaii" (1906), p. 28.

**ROSELLE** Roselle (*Hibiscus sabdariffa*) is a small shrub closely related to the common garden hibiscus, producing flowers with succulent calyx of a pleasant flavor, which are useful in the making of jelly.

The plant is commonly cultivated in Mexico and the West Indies, where it is used primarily in the making of a refreshing drink. The Hawaii Experiment Station imported seed from Porto Rico in 1904 and maintained a small area for several years thereafter as a demonstration of the possibilities of this crop for Hawaii, especially for jelly-making. In 1913 a considerable interest developed in this plant as a quick cash crop to be planted between rows of young rubber trees on Maui. Also, in Kona there were a number of commercial plantings, the total area there and at Nahiku (Maui) at one time amounting to over 200 acres.

Disappointment came, however, when the expected market for jelly making did not materialize and the growers were obliged to resort to drying the crop for export to the mainland, where only a moderate demand existed. The returns were not encouraging and the young industry languished.

Now, except for occasional garden plantings here and there, the roselle no longer appears in the agricultural scene.

Ref.—Haw. Exp. Sta. Bul. 47, "Principles of Jelly Making," p. 17-20, 1923; Annual Reports 1906:10, 34; 1907:56; 1914:52; Haw. For. Agr. 1906:425-428 (J. E. Higgins).

**RUBBER** The meteoric rise of the automobile industry in this century developed a great demand for rubber. At the beginning of the century American imports of rubber from various tropical regions amounted to less than 40,000 tons per year, while by 1934 they had risen to over 600,000 tons. World production in that period increased from about 50,000 tons to over a million.

Rubber is extracted from the latex of a large number of plants, most of which grow only in the tropics. Several species have become commercially established as the chief producers of rubber, notably the *Hevea* in Brazil, the *Castilloa* in Central America, the *Ficus* in India, and the *Ceara* (*Manihot glazioviana*) in South America. Some of these were brought into Hawaii in the 1890's, a small grove of Ceara having been planted on Kauai in 1893.

In 1905 there came a wave of popular interest in rubber production as a possible industry in Hawaii, for the price of the commodity was mounting higher as the automobile

manufacturers began bidding up for the relatively small supply available in the world. At that time it was obtained by going into tropical forests and tapping the trees. The idea of cultivating rubber trees in a plantation was unheard of, as the natural supply in the forests had always been ample.

Two companies were organized here in 1905 to produce rubber, and the Hawaii Experiment Station began a program of research in that year which continued for over a decade. The little grove of Ceara rubber trees which had been planted on Kauai in 1893, even though they had been badly neglected, furnished a means of testing the yielding qualities of this species under Hawaiian conditions. As the results seemed promising, capital came out in fair abundance.

The Nahiku Rubber Co. was incorporated in 1905 with a capitalization of \$150,000, obtained a tract of 900 acres of land on Maui (Nahiku) and began planting operations at once. A six years test of Ceara rubber trees in that locality had preceded the establishment of this company, so that it was not a venture in the dark. By the end of 1906 the new plantation had 11,200 Ceara trees from 1 to 15 feet high, 14,860 *Hevea braziliensis* and 500 Castilloa, with many thousands of seedlings of these several species for future planting.<sup>5</sup> The other company, the Koolau Rubber Co., had about 10,000 trees on 25 acres, with larger plans ahead. A third company, the Puna Development Co., also had a hundred or more acres in rubber.

The price of rubber was then about \$1.00 per pound, and in the next few years went even a little higher than that. This was high enough so that the relatively high labor costs here did not worry the planters. At first it cost nearly half the market price to tap the trees and harvest the latex, but in a few years they were able to bring down the harvesting cost to about 25 cents per pound. Of course, in practically all other rubber-producing countries this item was much lower, for none was paying a dollar or more per day to their workers as Hawaiian producers had to do.

As several rubber-producing companies were being established in the first decade of this century, it was natural

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<sup>5</sup>Thrum's Annual 1906, pp. 155-6.

that an association of rubber producers was formed, with headquarters in Wailuku, Maui. Maui seemed to be becoming the rubber island. The outlook seemed very promising until 1912 and 1913 when the price of rubber dropped to a relatively low point because of great increases in world production. Hawaii was naturally the first to suffer, because of high wage costs, but persisted to 1915, when this industry, which had been flourishing so well, practically dropped out of sight. The extent to which the industry developed is shown in the following tabulation of exports, from Thrum's Annuals:

<i>Year</i>	<i>Value</i>	<i>Year</i>	<i>Value</i>
1908 .....	\$2,656	1912 .....	\$3,811
1909 .....	3,746	1913 .....	5,993
1910 .....	7,938	1914 .....	2,743
1911 .....	60 <sup>6</sup>	1915 .....	1,705

This experience illustrates well Hawaii's limitations in industrial development. We had climatic conditions suitable for several of the species of rubber-producing trees and undoubtedly we could have done as well as any other country, especially with Ceara, which was the most promising of all the rubbers for these Islands. But climate and soil do not, alone, determine the results. The wage rate is a factor of great importance, especially in handling a crop which requires so much hand labor. It is true that our rubber planters made excellent progress in reducing production costs, not by reducing wage rates, but by increasing the efficiency of laborers. At first the average rate of latex harvesting was two pounds per man-day, but by 1910 this had been doubled. And in certain instances it was increased to nine pounds per man-day. Even at that level it represented a pretty high labor cost if the price of rubber should drop materially, as it did soon after.

The planters were not satisfied even with nine pounds per man-day. The Experiment Station experts found a way to propagate the rubber trees from cuttings taken from the best producers; individual rubber trees, like all other living things, differ among themselves in the vigor of growth and the rate at which they yield, and it was found that by propagating vegetatively instead of by planting

<sup>6</sup>Evidently the 1911 sales were credited mostly to the preceding year by the statistician.

seeds a rubber plantation could be developed which would surpass anything theretofore conceived of. In fact, small scale operations on this plan proved in 1914 that the labor cost of harvesting rubber latex could be brought down to 6 cents per pound, with 17 pounds of rubber gathered per man-day. Of course, there are other cost items which have to be added to this, as the maintenance of the plantations, the manufacture of crude rubber from the latex, etc. These, it was estimated, would amount to 20 to 30 cents per pound, to which the 6 cents cost of gathering the latex would have to be added.

Any crop which cannot be handled largely by mechanical means has little chance of becoming the basis of a large industry in a high wage country, as Hawaii.<sup>7</sup> In considering possible ways of diversifying our present agricultural industry this basic fact must be kept in mind.

See also "*Euphorbia lorifolia*."

Ref.—Haw. Agr. Exp. Sta. Press Buls. 13 (1905), 44 (1913); Bul. 16 (1908), 19 (1910); Annual Rep. 1905:22; 1906:12; 1907:19; 1908:11; 1909:15; 1910:17; 1912:88; 1914:51; Haw. For. Agr. 1904:287-294 (Kidwell); 1905:255-260 (R. H. Anderson, on possibilities of industry in Hawaii).

**RUSHES** See "Matting Sedges and Rushes."

**RUTABAGA** The rutabaga (*Brassica campestris napo-Brassica*) is very similar to the turnip and in the market here usually passes as a turnip. It may be distinguished by the purplish color of the exterior.

See "Turnip," also "Truck Crops."

**RYEGRASS** Italian ryegrass (*Lolium multiflorum*) is considered very valuable on the Parker and Shipman Ranches.

Ref.—Haw. Exp. Sta. Bul. 65:26, 1933.

**SABUCAIA** See "Sapucaia Nut."

**SALSIFY** Salsify (*Tragopogon porrifolius*) is only sparingly grown in Hawaii, not because of any unfavorable climatic conditions but because the demand here is very small. The edible portion of the plant is its long,

<sup>7</sup>An exception to this is any crop which commands a very high unit price in the winter months when our freedom from frost makes it possible to produce. Even with high labor and overhead costs such production may pay well during a limited season.