HAWAII'S CROP PARADE

ABACA  See "Manila Hemp."
ACACIA  See "Koa," also "Tan-bark."

AKALA  The akala is a native species of raspberry (Rubus macraei) which flourishes in certain upland regions of Hawaii, notably in the Kona, Kau and Hamakua districts of the Big Island at elevations of 5000 to 7000 feet. It grows wild in the forest areas, the bushes being perennial and attaining a height of four to ten feet.

The fruit is typically about an inch in diameter and handsome in appearance, resembling a large dewberry or blackcap raspberry. Unfortunately, however, the flavor is tart and somewhat bitter—possibly too much so for successful marketing.

Since 1929 the Hawaii Experiment Station has been trying to modify this native akala berry by crossing it with other species of Rubus so that the flavor would be better. Thus far these efforts have been only partially successful, as some improvement can be noted but not enough to warrant commercial exploitation. Some are enthusiastic about this fruit, however, and believe that it might become an important item in Hawaiian horticulture.

Although naturally a denizen of the forest, the akala responds readily to cultivation practices and could be produced commercially at higher elevations. Perhaps a strain might be developed by selective breeding which would do well nearer sea level, as in the coffee belt of Kona.


ALCOHOL  With the advent of the white man into Hawaii there came the art of making alcohol. This art,

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1Another, less common, species which also is called akala, is Rubus hawaiensis.
however, was not used commercially on a very extensive scale; small industries developed in the making of wine from grapes and other intoxicants from various starchy or sugary substances (see "wine," "ti," "molasses," etc.). With thousands of tons of molasses coming out of the sugar mills as a by-product, it is remarkable that the manufacture of alcohol was not more extensively developed in the nineteenth century.

Interest in the making of industrial alcohol became active early in the current century. H.S.P.A. scientists turned their attention to the possibilities of making denatured alcohol as a substitute for gasoline to be used as a fuel in automobiles, engines, and ships. S. S. Peck and Noel Deerr reported in 1909 that Hawaiian molasses was worth about 8.3 cents per gallon when figured in terms of the alcohol and other products capable of being made from it. In addition to the alcohol distilled out, it was pointed out that the residue contains brewer's yeast, useful as a feed for livestock, and some potash, useful as a fertilizer; also, carbonic acid gas (carbon dioxide) is recoverable during the process of alcohol manufacture.

Tests were made to ascertain the value of alcohol in comparison with gasoline, with results that were somewhat encouraging but not sufficiently so to cause the sugar industry to develop the manufacture of this fuel on a large scale. One plantation on Maui undertook to make it in moderately large quantities and used it experimentally in tractors, trucks and other internal combustion engines with good results. The general attitude, however, was not favorable to it, chiefly because of the higher cost compared with gasoline. One expert expressed the attitude of many when he declared that alcohol is "hopelessly handicapped where petroleum oil is abundant and labor costly."3

Interest continues, nevertheless, in the manufacture of this fuel from molasses because of its potential importance in time of emergency when normal imports of gasoline and petroleum fuels might be interrupted.

Meanwhile, attention turned some twenty years ago to

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2Agricultural Bulletin 28, H.S.P.A. Experiment Station.
pineapple juice as a possible source of industrial alcohol. One large pineapple cannery in Honolulu uses its excess juice and waste in this way, marketing considerable quantities of denatured and absolute alcohol. The carbon dioxide evolved in the process of fermentation is sold to a neighboring firm which compresses it in steel tanks and sells it for use in the making of carbonated beverages and other purposes.

Ref.—Out of many references in the Planters Record, the following are of special interest: Vol. I, 197; IX, 580; X, 78; XI, 107; XIV, 144; XVI, 165, 439; XVIII, 379; XX, 23; XXI, 345; XXII, 172; XXIII, 38-52; also, Agr. Bul. (H.S.P.A.) No. 28 (1909).

ALFALFA Alfalfa (*Medicago sativa*) is an excellent forage and hay crop for livestock, especially for dairy cattle, but is not extensively used in Hawaii because of the relatively high cost of producing it. Weed control, especially during the first year when a field is being established, is very expensive and troublesome, causing most dairymen to plant other kinds of feed crops which are better suited to Hawaiian conditions. Once established, an alfalfa field produces about ten crops per year for six to ten years before replanting becomes necessary, the annual production being 40 to 60 or more tons of green fodder, or 10 to 15 tons of hay. Except in some dry localities, it is almost impossible to cure alfalfa hay properly, and consequently it is nearly always used green, in combination with other green feeds; too much green alfalfa may have a laxative effect on dairy cattle.

Production of alfalfa in Hawaii is not extensive; only a few dairymen cultivate it, and the total of their plantings is probably not over 100 acres.

A spreading pasture type of alfalfa (*Medicago falcata*) has been introduced from Wisconsin during the past few years and is doing well in the cooler upland areas. This type is not suited to hay making, but may be an important feature in pasture improvement.4


ALGAROBA The algaroba (*Prosopis chilensis*), introduced a little more than a century ago (1828)\(^5\) has become one of the most valuable of our forest trees in the lowland areas. It is commonly said to be the same as the mesquite of southwestern United States but that is not true, for there are important botanical differences between them. It is more probably true that our algaroba came from Peru, for there is in that section of South America a *Prosopis* species which seems to be identical with ours. The first seeds were brought here by Father Bachelot, a Catholic missionary, and the original (Hawaiian) tree was growing until a few years ago in the downtown portion of Honolulu.

From this parent tree there are millions of offspring, some growing even in the remotest sections of the Territory, so thorough and widespread has been the dissemination—largely natural. Practically all the drier areas on the leeward side of the islands have been occupied by this immigrant tree which forms dense, sometimes almost impenetrable, forests extending from the ocean shore to several miles inland and to a hundred or two hundred feet elevation above sea level. Fully 90,000 acres of semi-arid shore-plain lands not exposed to the salt spray of the ocean are now covered by it.

The algaroba is a leguminous tree and produces pods which have a very considerable value as a feed for livestock. Many tons of the pods are gathered annually as they fall to the ground and are used for feeding horses, cattle and swine. But to every ton gathered and used in this way many tons are picked up by grazing livestock as a supplement to grasses and other forage plants.

Estimates of the yield of algaroba pods indicate that in some localities it may be as high as 4000 pounds per acre per year while in others it may not be more than 1000 pounds. Taking 2000 pounds as a conservative average,\(^6\) and allowing a value of about $20.00 per ton,\(^7\) we find that

\(^6\)Director E. V. Wilcox of the Hawaii Experiment Station estimated in 1913 (Press Bul. 59, p. 3) that the yield of algaroba pods varies from two to fourteen tons per acre. This is probably excessive.
\(^7\)The feeding value is considered about equal to that of barley, which averages about $40.00 per ton.
this species of tree is worth nearly $2,000,000 per year to the Territory for its yield of livestock feed. In 1912 the actual sales of this commodity for feed purposes amounted to over $750,000. The volume of sales has not continued in this amount to the present, but the value of the feed is no less real even if it is not recorded in commercial transactions.

The pods are not the only valuable feature of the algaroba. The flowers yield excellent honey and the wood is good both for fuel and for fence posts.

The total honey crop of the Territory is worth about $75,000 per year, this being a rough average of the past ten years. It is a conservative estimate when we say that 75 percent of the total crop is gathered from the flowers of the algaroba trees. So far as market value is concerned, probably 90 percent comes from algaroba, for honey derived from most other sources here is dark and less desirable.

The wood of the algaroba is very hard, when dry, and makes excellent fuel, better by test than oak and hickory. How much is burned as fuel wood is impossible even to guess, but the amount must be very large. Also, as charcoal it enters extensively into consumption; an estimate by F. G. Krauss places the amount of charcoal consumed at about 100,000 bags, worth about $100,000 per year.

Algaroba makes good fence posts after being soaked in salt water. There is a boring beetle which quickly reduces the sapwood of dead branches and logs of this tree to dust if they are not impregnated with sea water, but after post material has been allowed to lie a few months in salt water it becomes immune to the attacks of the beetle and makes excellent fence posts which withstand decay for several years. Probably over $10,000 worth of such posts are used in a typical year.


ALLIGATOR PEAR  See “Avocado.”

ALLSPICE  In the H.S.P.A. forestry station grounds in Manoa Valley (Honolulu) are several good specimens

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of the allspice tree (*Pimenta officinalis*), the species from which the allspice of commerce is derived. While it may offer some possibilities for exploitation in Hawaii, the experimental plantings have not yet proven themselves.

**ANGLETON GRASS** Angleton Grass (*Andropogon annulatus*) is a very promising range grass which is still on trial in the experimental grounds.  

**APICULTURE** See "Bees."

**APPLE** A few trees of this temperate zone fruit (*Pyrus Malus*) are to be found at elevations above 4000 feet. Fruits of good appearance are occasionally exhibited at county fairs, but it cannot be said that there are attractive commercial possibilities in apple production in Hawaii. A recent crop survey (1936) indicates scattered plantings totalling about 4 acres in the uplands of Maui.

**APRICOT** The apricot (*Prunus Armeniaca*) like other temperate zone fruit trees, may be grown successfully in the higher areas of the Islands, at elevations above 3500 feet, and one may find a few trees here and there bearing fruit of good quality. It cannot be claimed, however, that the apricot offers any commercial possibilities of interest in these Islands.

**ARROWHEAD** Arrowhead (*Sagittaria sagittaefolia*) is an aquatic plant, the corms of which are used as food both by Chinese and Japanese. Originally introduced into Hawaii by Oriental gardeners, this plant has escaped from cultivation and now grows wild in swamps. The leaves are shaped like an arrowhead, hence the name.  
The corms are small, weighing an ounce or less, somewhat yellowish inside and of a consistency resembling that of the sweet potato.  
See also "Truck Crops."

**ARROW ROOT** An old advertising poster, yellowed with age, reposing for many years among the Judd papers recently opened for study, announces that "The Drug Store of the Undersigned (G. P. Judd), corner of Fort and Merchant Streets" is prepared to furnish "Sandwich Island Arrow Root" in large or small quantities.
This arrow root was a native starch, known as pia, and was made from the roots of a tropical plant (*Tacca pinnatifida*) which at one time grew wild in certain localities. It was used to a limited extent by the early people of Hawaii, but efforts to make it a cultivated crop about 1840 were unprofitable, for there seemed to be relatively little, if any, gain in profit from the cultivated crop as compared with the wild plant.

A market in California was developed for this product during the gold rush days; in 1850 there were some 16,000 pounds of arrow root shipped out. The Royal Hawaiian Agricultural Society, through various members and committees, sought to foster this industry into something larger, one report, for example, declaring that “some hundreds of tons per annum might be manufactured at a cost not to exceed 4 cents.”

In spite of much urging, however, there never developed much of an industry in arrowroot and it remains today an article which could be exploited with profit, but is not.

There is some interest in this crop at the present time. Small quantities of the starch are made by Hawaiians in Kona by the ancient methods and the demand for it is such that as much as $1.00 per pound is sometimes paid for the product. It is believed to have some special values both for medicinal uses (in cases of dysentery) and for cosmetic uses, as well. The Hawaii Experiment Station is growing the plant on its Kona grounds with a view to enlarging the commercial plantings and perhaps reviving at last this ancient industry.

Arrowroot starch made from another plant (*Maranta arundinacea*) has been in more or less common use in Europe and to some extent in America, also, for a long time. Sold in small packages, at about $1.00 per pound, it is in limited demand for use by invalids because of its ready digestibility. American imports of this starch are small, usually only a few hundred tons per year. This

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9 For a good description of the process by which arrow root was made in the early days, see Trans. Royal Haw'n. Agr. Soc. Vol. II, No. 2, pp. 133-4 (1854).
11 Good culture directions for the growing of this plant are given in Planters Monthly XII, p. 163 (1903).
plant is cultivated here to a limited extent by Oriental gardeners for its fleshy root, which when young may be cooked to make a delicious food, somewhat resembling a sweet potato. The older roots are good only as a source of starch, and there is a very small industry in the making of this at the present time. This starch is much like the other arrowroot made from *Tacca pinnatifida* and is sometimes confused with it.

Both of these kinds of arrowroot starch offer limited possibilities for exploitation in Hawaii. The demand now existing here and on the mainland might become greater if the unit price were lowered, which could easily be done if production methods were modernized and large plantings developed. At best, however, the industry would probably never be very large, for neither of these plants offers as good prospects for starch manufacture as does canna or the sweet potato.

**ARTICHOKE** The artichoke (*Cynara scolymus*) is a perennial thistle plant which thrives best in cool, foggy areas. Although it is occasionally grown in Hawaii it does not seem to be well adapted to climatic conditions here and therefore does not offer much promise as a vegetable crop of importance. The edible portion is the immature flower, the bracts enclosing it being somewhat succulent and useful for salad purposes when cooked.

See, also, "Jerusalem Artichoke."

**ASPARAGUS** Asparagus (*Asparagus officinalis altillis*) is a perennial plant which thrives well under Hawaiian conditions. The new, tender, fleshy stems as they first emerge from the ground are so much prized as a food that during the winter months when this product is very scarce it may command prices as high as 75 cents and even $1.00 per pound, in the large cities of the mainland.

Efforts to establish asparagus growing as an industry in these Islands have been sporadic and thus far have not brought any large results. In 1889 Allan Herbert made an experimental planting of this crop in Kalihi valley, obtaining roots from California. The results were excellent and he reported a realization of about $1500 from one acre (the extent of his planting). A considerable interest

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12 Planters Monthly VIII, 483-484, 1889.
was aroused by this experiment and he offered to sell roots to others who wished to go into the production of this crop. Again, in 1901, there was a brief interest in asparagus growing, but it did not develop into anything of importance.\textsuperscript{13}

During the past thirty years there have been several small commercial plantings, none of which were successful except one in the Pupukea district of Oahu where for the past five years one grower has been operating on an experimental scale; he is now cultivating something over 10 acres of this crop and has been successful in marketing his product on the mainland\textsuperscript{14} at very attractive prices. This doubtless will lead to an expansion of the planting, for in the winter and early spring months fresh asparagus tips are scarce and expensive in the mainland markets and there is an excellent opportunity for Hawaiian producers to fill the demand.

Hawaii consumes a considerable quantity of asparagus, but mostly in the canned form. It is not probable that the local fresh product will be able to displace this, for the canned product meets certain needs which the fresh material does not fully satisfy.

Asparagus plants grow continuously for a number of years, producing few if any marketable tips the first year and increasing amounts in the second and third years when there should be about 4000 pounds per acre.

For detailed information on culture, harvesting and other features, consult the University’s bulletin on truck crops.\textsuperscript{15}

**AUSTRALIAN BLUEGRASS** Australian bluegrass (\textit{Andropogon sericeus}) is a hardy and very desirable grass for dry lands at low elevations, and is well established on Maui.


**AVOCADO** The avocado (\textit{Persea gratissima}) is considered by many to be the potential basis of a very large

\textsuperscript{13}Planters Monthly XX, 125, 1901.

\textsuperscript{14}Until recently asparagus tips were included in the list of commodities quarantined by the U. S. Department of Agriculture because of the fruitfly and melon fly, but by the efforts of Mr. Farrar, the Pupukea grower mentioned above, it was proven to be immune to attack and the quarantine was lifted.

industry in Hawaii. The popular demand for this salad fruit has increased greatly throughout the United States and in other countries as well during the past quarter century and the outlook for the future seems to be for a further expansion of the market for it. How much of this market might be captured by Hawaii depends chiefly on two factors: the fruitfly quarantine and the competition from mainland producing areas, notably California and Florida.

Hawaii might have become a leading production center for the American market if the Mediterranean Fruitfly had not come into the situation just as popular interest was beginning to show itself in the possibility of developing an avocado industry here. Conditions of soil and climate were known to be almost ideal in these Islands, for the avocado thrives best in a subtropical climate which is wholly free from frost. It was no mere theory that this fruit would do well in Hawaii, but a known fact, for it had been widely grown as a backyard tree ever since early in the nineteenth century after its first introduction by Don Marin, the Spaniard to whom we owe our thanks for having brought hither many valuable fruit trees and other economic plants.

The first large introduction of many avocado varieties was in 1853 when the United States warship Portsmouth left a considerable number of seedling trees at Lahaina. These and numerous other importations resulted in there being a great many bearing trees of dozens and scores of different varieties by the end of the century, when Annexation stimulated a renewed interest in diversified agriculture in these Islands. Although at that time the avocado was a rarity in the United States and scarcely known to the rank and file of American people, yet there were some persons here in Hawaii who thought even then that they could see a great industry capable of being built on this valuable and nutritious salad fruit of the tropics.

The interest was enough, at least, to prompt the new Hawaii Experiment Station, just then being established (1901), to turn its attention to the study of this fruit, among others. The many existing varieties were examined and

more imported, with a view to finding some which would be superior for shipping to the states, and experiments were begun to devise the best way of sending this perishable fruit to Pacific Coast ports.

At that time the only known way of propagating the avocado was by planting seeds and trusting to nature for the results. Sometimes the seedling tree proved to be like the parent from which it came, but just as often it was a disappointment. The Experiment Station experts realized that an essential factor in the building up of an avocado industry would be the discovery of some method of propagating the tree vegetatively, to escape the uncertainty of using seedlings. After much experimenting the Station succeeded in developing a technique for budding young seedlings. This seemed to open the way to a large and important horticultural industry.

Then the Mediterranean Fruitfly came. In 1910 it was discovered and the discovery caused a furor in California, for it was feared that the great fruit industries of that state would be ruined if the pest should gain entrance there. A California state quarantine was quickly applied and in 1913 the federal government added a nation-wide prohibition against any importations of fruits from Hawaii which were known to harbor the fruitfly. The avocado was on the list of fruits thus banned, and that seemed to be almost a death blow to the potential avocado industry.

Meanwhile, there had been some pioneering souls in California, and others in Florida, who believed that this tropical fruit could be produced successfully on a commercial scale in those states, in spite of occasional frosts. Although the commercial plantings then were few and very small, many people had a tree or two as a novelty, and some of these became phenomenally valuable when the market began buying up the fruits at 50 cents apiece. This started a new gold rush—green gold, they called it. Commercial orchards began to make their appearance; those that were in comparatively frostless areas succeeded fairly well, but a large percentage did not. Avocado land took on a market value of $2000 and $3000 per acre, and a veritable boom was under way. The notion was prevalent that the American people would continue indefinitely to buy
unlimited quantities of the new fruit at the dizzy prices they were paying then.

By vigorous advertising, the consumption of avocados was greatly increased, but not as rapidly as the production increased. In California the 1924 crop was 129 tons, but in 1934 it had grown to over 9000 tons. The Florida record was similar: 420 tons in 1929 and 2000 tons in 1934. When the 1934 crop in California was nearly five times as large as the 1933 and earlier crops, a natural result was that avocados were being sold (retail) at fruit stands for five cents apiece, where a few years before they would have commanded 75 cents and a dollar each.

This, obviously, has an important bearing on any plans or aspirations for an avocado industry in Hawaii, for even granting that the fruitfly quarantine were modified in such a way as to permit Hawaiian avocados to be shipped to the mainland states it would not be easy to compete with the California and Florida producers. In the past quarter century they have made great progress in perfecting their technique and placing the industry on a sound footing. Our exports would have to meet all the marketing expenses borne by the mainland product and much more in addition, for there would be the ocean freight in cold storage and the cost of special treatment of the fruit to make it exportable by the terms of the quarantine. The quarantine regulations, as they now stand, do not prevent avocado exports if some treatment is applied which United States Department of Agriculture experts declare to be effective in making all the fruits non-carriers of the fruitfly. Thus far, no effective treatment has been devised which is not detrimental to the avocado fruit itself. Mild heat, prolonged for some hours, is an effective way of killing the fruitfly in the fruits, but it causes a marked deterioration of the fruit and therefore cannot be used, although this method is useful for citrus fruits. Low temperatures, around freezing, kill the fruitfly if prolonged for a sufficient number of days, but this treatment injures the avocado and makes it unsalable. It is possible that some elec-

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18Earlier statistics are not readily available.
trical treatment might be devised, but there is nothing very encouraging in sight.

To export avocados in some processed form is not only possible, so far as the quarantine is concerned, but is actually being done. No one has as yet devised a successful technique for canning this fruit; there is an exceedingly disagreeable odor and flavor which develops upon heating the fruit for sterilization in cans or jars. It may, however, be preserved in other ways, as in vinegar, without developing the offensive qualities noted above.

As a basis for salad dressing the pulp of the avocado is being exported, with some possibilities of a good market developing.

As a substitute for butter fat in the manufacture of ice cream it seems to offer some promise, provided its natural flavor is covered by the use of familiar flavors, such as lemon, pineapple, orange, etc. Avocado paste used thus with skim milk and flavoring extracts makes a smooth and delicious ice cream. In addition to local consumption, such a product could be exported and might find a large market, as avocado pulp is cheaper than butter fat.

In an earlier paragraph we noted that the fruitfly quarantine was almost a death blow to the potential avocado industry in Hawaii which seemed destined to develop into something of large importance. As a matter of fact it was not actually a death blow, for some interest continued and much hope was felt that somehow, sometime, the quarantine would be lifted or modified. The Hawaii Experiment Station kept its investigations going forward, and not a few individuals developed small commercial plantings. An association of interested people was formed about ten years ago, which worked for the advancement of the cause. The best encouragement came when the United States Bureau of Entomology transferred its Florida laboratory a few years ago to Hawaii and began a program of investigation aimed at discovering some effective means of treating the avocado and other fruits and vegetables for export.

At the present time there are two moderately large avocado orchards in these Islands, one developed by Dr. W. D. Baldwin on Maui and the other by the Hawaiian Avocado Company on Oahu. If these and all the scattered
plantings throughout the Territory were brought together it would probably cover an area of about 750 acres, with an estimated yield of about 600 tons. This is small when compared with California's 10,000 tons and Florida's 2,000.

There are large areas of land here suitable for the avocado, but the present indication is that Hawaii would do well to think more of other crops which offer less difficult obstacles for large commercial development. For local consumption and perhaps for the manufacture and export of some avocado specialties there should be maintained something of an industry in the producing of this valuable salad fruit, but its prospects of developing into major proportions seem very distant and doubtful.


AWA Awa or kawa (Piper methysticum), is either indigenous or was introduced many hundreds of years ago by the Hawaiians. It is a shrub, related to the plant from which the black pepper of commerce is made, and is widely distributed in Polynesia.

The root contains a soporific drug which the ancient Hawaiians had learned to use to produce an artificial relief from fatigue.

In the latter part of the nineteenth century something of an export industry developed around this drug plant, the chief demand coming from Germany where it was used in medicinal manufactures. The first shipment (1886) was small, about 4,000 pounds, and brought $346. In the remaining years of the century this business increased a little, but never reached large dimensions, as shown by the following table of exports:

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A large part of the plantings are still young and not yet producing at the maximum rate.

Pronounced as though the "w" were a "v".
The awa plant was usually not cultivated, but allowed to grow of itself in certain favorable localities in the forests. Individuals desiring to gather it in the forests for sale to exporters purchased a license from the government. At the present time there is practically no commercial exploitation of this plant, as synthetic substitutes have been developed which are cheaper.

Ref.—Thrum’s Annual 1903:130-140 (O. P. Emerson, on the “awa habit” of the Hawaiians); export figures from earlier and subsequent issues. Haw. For. Agr. 1911:356-358. See also “Paradox in Hawaii” (D. L. Crawford), p. 130 (1933).

**BABASSU** Babassu oil is obtained from the kernels of the seed or nut of a palm (*Orbignya speciosa*) which is abundant in some parts of Brazil. Exports of this oil from Brazil have been increasing since 1915 to such an extent that some American farmers have become alarmed. At first the oil figured only in the soap trade, but now it is being used chiefly for edible purposes, in competition with domestic vegetable and animal oils and fats. It is a competitor of tung oil, also, in the manufacture of varnishes and paints.

While the babassu palm does not occur in Hawaii, it is believed that climatic conditions here would be well suited to it and efforts are being made by J. M. Westgate to establish it here for commercial purposes.

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**Table:**

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21 Figures not available for 1889-1891, 1894, 1897.
22 J. G. Smith states that Magoon Brothers at one time cultivated more than 50 acres of awa in South Kona.
1 Prof. Westgate was formerly director of the Hawaii Experiment Station. He has furnished most of the information contained in this statement about babassu oil.
BAEL See “Bhel Fruit.”

BAGASSE Bagasse is a by-product of the sugar industry, being the fibrous residue remaining after the juice has been extracted from sugar cane. As about 22 per cent of the sugar cane consists of fibrous materials, nearly two tons of bagasse come out of the mill for every ton of sugar. At present, therefore, the total for the Territory is about 2,000,000 tons of bagasse. It is used in several different ways and has considerable economic value.

As fuel, one ton of bagasse is equivalent in value to about 1½ barrels of crude oil and it is in this way that most of it is used, for it can be conveyed directly into the furnaces, thus obviating the expense of baling and transporting it to more or less distant points for other uses. Bagasse being a very bulky commodity, this is an important feature.

As a feed for livestock, bagasse has some value and is used thus extensively on some plantations in combination with molasses. Honokaa Sugar Company, for example, has with good results fed to its mules a mixture consisting of 100 pounds dried, sifted bagasse, 100 pounds cane molasses and 40 pounds soybean oil cake meal. The same plantation manufactures a livestock feed composed of 45 per cent bagasse and 55 per cent molasses, to which the trade name “Karbotex” has been given. Some other plantations merely pour molasses over the bagasse and feed it thus to horses and cattle. Tests of Karbotex in the University dairy herd showed no saving in the cost of milk production when 50 per cent or more of the total ration consisted of this feed. In smaller amounts it may have a slight advantage over imported feeds.²

Paper—Bagasse is an important source of fiber for the manufacturing of paper and wall-board. Experiments and investigations by H.S.P.A. scientists, begun in 1910,³ had a practical outcome when in 1919 the Olaa Sugar Co. undertook to make paper on a large scale for use in the cane fields as a means of curtailing weed growth between the cane rows. A large paper mill was erected, costing

³See Planters Record II, 206-208; VI, 12-21; IX, 619-620; X, 82-87.
about $300,000, and by a combination of bagasse fiber, cloth rags, waste paper and wood sulphite, a heavy mulching paper was manufactured in large quantities and saturated with a mixture of asphalt and fuel oil.

The mill continued in operation until 1928, manufacturing large amounts of paper each year and supplying not only its own plantation but several others as well.

The use of mulching paper as a means of weed control in sugar cane fields did not increase, as it was at one time believed it would, but rather decreased. "Improved technique in field operations, combined with the spread in suitable locations of faster growing cane varieties, resulted in a general earlier closing in of the cane rows, so that fewer weedings were required and it was found that in general it is cheaper to eliminate the weeds by the use of weed poison and mechanical and hand weeding than to apply the mulch paper." While pineapple plantations took up the use of mulching paper, the bagasse paper was not able to withstand weathering effects as long as some standard roofing papers.

As the demand for this locally made paper diminished, the operations of the mill were curtailed and finally, in 1928, brought to a close.

Wall-board—The manufacture of wall-board in Hawaii began in 1932. The Hawaiian Cane Products Company, organized in 1930, developed a large factory in Hilo to use the bagasse of two nearby sugar mills in the making of saturates.

4According to information supplied by H. A. Walker, of American Factors, Ltd., the yearly output of the Olaa paper mill was as follows:

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<tr>
<td>1921</td>
<td>1939</td>
</tr>
<tr>
<td>1922</td>
<td>1826</td>
</tr>
<tr>
<td>1923</td>
<td>2316</td>
</tr>
<tr>
<td>1924</td>
<td>1881</td>
</tr>
<tr>
<td>1925</td>
<td>2365</td>
</tr>
<tr>
<td>1926</td>
<td>1214</td>
</tr>
<tr>
<td>1927</td>
<td>1000</td>
</tr>
<tr>
<td>1928</td>
<td>783</td>
</tr>
</tbody>
</table>

This saturated paper consisted of two-thirds (by weight) raw paper and one-third asphalt and oil. The raw paper consisted of about seven-eighths bagasse fiber and one-eighth other fibers.

5Statement by H. A. Walker, President of American Factors, Ltd.

6Hilo Sugar Company, and Waiakea Mill Co.
of structural and insulation board to which the trade name "Canec" was given. Unlike the mulching paper mentioned above, this board required no additional fiber in its manufacture, the bagasse being sufficient for the purpose.

The factory began operating in 1932, at first with a relatively small output; in each succeeding year the business has grown, as shown by the following record of production:

1933—20,631,000 board feet  
1934—23,562,000 board feet  
1935—31,105,000 board feet  
1936—40,000,000 board feet (Approximately)

Shipments of this product go not only to the mainland United States but to many foreign countries, as Australia, Africa and countries of Europe and Asia. This is believed by some to be the beginning of a very large industry which will ultimately add much to the returns from the sugar cane crop of these Islands.

Cellulose—The making of alpha cellulose from bagasse offers some interesting possibilities. This substance is used in immense quantities in the making of cellophane and many other things, and bagasse appears to be an excellent source from which to obtain it on a large commercial scale. Experiments in the using of bagasse in this way are now being carried on in the laboratories of one of the sugar companies and may lead to an important development for the utilization of bagasse with more profit from it than now accrues from its use as a fuel.

**BALSAM PEAR** The balsam pear (*Momordica Charantia*) is somewhat like a small cucumber in general shape, but has a warty and irregularly ribbed surface. It is the fruit of a vine which thrives very well in Hawaii and is cultivated by Chinese gardeners to a moderate extent. Unfortunately, the fruits are very susceptible to attack by the melon fly and have to be protected by being enclosed in a paper bag.

The balsam pear is harvested in the immature stage and is used especially by the Chinese in combination with certain meat dishes.
A recent crop survey (1936) showed about 20 acres devoted to this crop.

BAMBOO Several species of bamboo (*Bambusa* spp.) have been introduced into Hawaii from the Orient and are well established. In addition to many small plantings in gardens and estates, there are several of large extent, 100 acres or more. These latter are used as a source of fishing poles and similar articles and the owners more or less regularly supply the local market. In a very small way the building trade uses this product for novelty structures, while furniture manufacturers also draw upon the local supply to a small extent, their preference being for imported stocks.

In the Orient certain species of bamboo are used as a source of fiber for the manufacture of paper, and it has been suggested that such an industry could be established here in Hawaii. There is no doubt but that the bamboo can be produced here with ease, and by utilizing some of the cheap, marginal lands the cost of production could be kept at a low figure. This is a possibility which ought to be considered carefully in any broad plan for diversification.

The young shoots of several species of bamboo are commonly used as food in Hawaii, especially by the Chinese and Japanese people. The bamboo is a giant type of grass, and propagates itself by underground, root-like stems which at frequent intervals send up vertical stems. These latter emerge from the ground as thick, sharp-pointed shoots enclosed in several layers of leafy bracts. These shoots, when stripped of their bracts, are sufficiently tender and succulent to be eaten when cooked.

There are several species of such edible bamboo in Hawaii, all having come originally from the Orient. Bamboo shoots are offered in the city markets throughout the year, with a small but appreciable business in them resulting.

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BANANA The banana (*Musa sapientum*), perhaps the first of all the fruits brought under cultivation by man, was introduced into Hawaii by the Polynesians long before Captain Cook's time. It was an important element in the diet of the early Hawaiians, being one of the relatively few fruits available to them.

It can scarcely be said that they cultivated the banana, but they did go to some pains to establish their plantings in mountain gulches and valleys where they could be more certain of a perpetual water supply than in the lowlands. To a limited extent there was natural dispersal by the force of freshets, so that the supply of the fruit increased.

There seem to have been a considerable number of varieties of banana brought in at various times by the early Hawaiians, but none of them proved to be of great commercial value in the modern era. Most of them are now extinct.

In the nineteenth century a dwarf variety, now known as the Chinese or Cavendish banana (*Musa Cavendishii*), came in a roundabout way from South China through England and the South Sea Islands and finally to Hawaii about 1855. In a relatively few years it had established itself as the most important and valuable of all the banana varieties here, for it had great vigor and productiveness and the fruit was of excellent flavor and quality.

The Brazil variety, good but not quite as valuable as the Chinese, was introduced into Hawaii about the same time, and proved to be an important addition to our list for local consumption, but not for export.

The new interest in agriculture which sprang up immediately following annexation resulted in some special attention being turned to the banana as a basis for a new industry. A general survey of the situation in 1903 by the newly established Hawaii Experiment Station suggested the desirability of bringing in some of the tested Central American varieties which were well known in the markets of the United States. Accordingly, in 1904 several lots of the Bluefield or Jamaica variety were imported for trial, and several others besides.
The Bluefield did well in certain localities, but it has never really established itself here on a wide commercial scale. The trade winds are too stiff, except in protected areas such as Kona. The Panama disease was first recognized in Hawaii in 1911, though it probably had been present even before 1900. It has been an important factor in retarding the spread of this variety.

Although banana production has received a good deal of attention in Hawaii in the past thirty years it has not become a large industry. As a matter of fact, Hawaii is not considered a particularly good banana country, for most of the land that is not used by the more lucrative sugar industry is of rough topography and not suitable for the application of large scale production methods. The prevalence of rather stiff trade winds in most localities where the soil is good and the rainfall adequate makes it difficult to produce the Bluefield, which is the only variety that would be marketable on a very large scale. Even if these factors were omitted from consideration, there would remain the relatively high wage scale here as compared with Central America; also, the cost of land is much higher.

Bananas have been shipped from Hawaii to the Mainland in moderate amounts ever since 1856. Beginning with 93 bunches in that year, the annual shipments gradually increased to over a thousand in 1864 and passed the 10,000 mark in 1875; by 1885 they were over 60,000, and in 1889 were in excess of 100,000 bunches; with some fluctuations the shipments remained at about that figure until 1911 when they began increasing again rapidly, going to a maximum of 280,000 in 1915, then dropping off a little to an average of about 225,000 to 250,000 bunches per year until 1928, then declining considerably below that level in subsequent years. In 1935 the total exports were 98,296 bunches.

Compared with imports from Central America into the United States a hundred thousand bunches per year is a mere "drop in the bucket," for banana imports into the United States in 1910 were reported as being over 40,000,000 bunches and in 1930 over 65,000,000.

Small as these shipments are in comparison with total
mainland imports, they constitute an important item in Hawaii’s list of agricultural exports. The following tabulation shows the gross returns from banana shipments during several years:

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1910</td>
<td>$51,229</td>
</tr>
<tr>
<td>1911</td>
<td>108,414</td>
</tr>
<tr>
<td>1912</td>
<td>140,720</td>
</tr>
<tr>
<td>1913</td>
<td>143,472</td>
</tr>
<tr>
<td>1914</td>
<td>126,455</td>
</tr>
<tr>
<td>1915</td>
<td>189,578</td>
</tr>
<tr>
<td>1916</td>
<td>166,977</td>
</tr>
<tr>
<td>1917</td>
<td>170,368</td>
</tr>
<tr>
<td>1918</td>
<td>90,988</td>
</tr>
<tr>
<td>1919</td>
<td>102,796</td>
</tr>
<tr>
<td>1920</td>
<td>176,020</td>
</tr>
<tr>
<td>1921</td>
<td>151,968</td>
</tr>
<tr>
<td>1922</td>
<td>214,255</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1923</td>
<td>$212,624</td>
</tr>
<tr>
<td>1924</td>
<td>211,343</td>
</tr>
<tr>
<td>1925</td>
<td>255,614</td>
</tr>
<tr>
<td>1926</td>
<td>245,465</td>
</tr>
<tr>
<td>1927</td>
<td>247,703</td>
</tr>
<tr>
<td>1928</td>
<td>216,802</td>
</tr>
<tr>
<td>1929</td>
<td>184,531</td>
</tr>
<tr>
<td>1930</td>
<td>201,227</td>
</tr>
<tr>
<td>1931</td>
<td>118,410</td>
</tr>
<tr>
<td>1932</td>
<td>103,805</td>
</tr>
<tr>
<td>1933</td>
<td>79,708</td>
</tr>
<tr>
<td>1934</td>
<td>85,811</td>
</tr>
<tr>
<td>1935</td>
<td>92,536</td>
</tr>
</tbody>
</table>

Local consumption absorbs probably as much as the total of exports, thus doubling the economic value of this industry over the figures tabulated above. Thus, banana production was worth in 1925 something like $500,000, and now perhaps $200,000 per year.

A very important feature enhancing the value of this crop to Hawaii is its potential usefulness in time of war or other emergency which might cut off normal imports of foodstuffs into these islands.

The banana is a very nutritious and palatable food, capable of being used in a great variety of ways to supplement other foods which are produced locally. The normal yield of bananas in these islands, including the usual exports, is about 8 to 10 millions of pounds per year, equivalent to about 20 to 25 pounds per capita. Production is distributed widely throughout the Territory, thus reducing the cost of transportation to the consumer; and the fruit ripens throughout the year, which makes it the more valuable as an emergency food crop. It would be a wise expediency, therefore, if all available means were used to keep the banana industry at least at its present level; perhaps it might well be extended.

There are two interesting possibilities in the way of manufactured products: canned bananas and dried bananas.
Certain varieties of cooking bananas, as the Popoulu, if attractively canned, might find a large market. These fruits, being short and thick, would fit a can neatly.

Some of the very sweet varieties which do not ship well can be dried into a delicious and nutritious food product, marketable on a basis more or less equal to dates, figs and other fruits when prepared as sweets. In Europe the dried banana is in as much demand as dried figs, dates and prunes.

There are other commercial possibilities, as banana flour, and banana beer, but none as promising as the two foregoing. It is conceivable that either or both of these manufacturing processes might open the way to a very great enlargement of the banana industry. On this basis the industry could expand greatly, but otherwise it is probable that banana production will not in the future become a factor of any materially greater importance in the economic life of these Islands than it is now.

Banana fiber has been extracted from the stalk in southern Asia and used in the manufacture of cloth. This has not been attempted in Hawaii, although the idea was suggested many years ago. Manila hemp is made from a closely related species of plant and it seems likely that the banana might be a good source of commercial fiber.


According to F. G. Krauss, who has recently returned from Europe, the average quality of the dried banana product sold there is not equal to that of the product made locally on an experimental scale.

Banana beer is a product developed in Africa and said to be an effective remedy for malarial fever. Those who had sampled it declared that they preferred the malaria. (Planters Monthly, Vol. V, p. 24 [1886].)

BATS  The introduction of insectivorous bats was urged by Frederick Muir and H. L. Lyon in 1914, as a means of reducing the mosquito nuisance. Thus far, however, the suggestion has not been put into effect.

BAYBERRY  The bayberry tree (*Myrica cerifera*), source of a commercial wax used in the manufacture of certain types of candles, was introduced into Hawaii a few years ago by the H. S. P. A. Experiment Station. It is flourishing here and spreading by natural means of dissemination into the wild state.

BAY RUM  Bay rum of commerce is an extract from the leaves of *Pimenta acris*. This species of tree has been introduced into Hawaii in recent years, and thriving specimens in Kona and other districts give evidence of its having found conditions here suitable. There seems to be no tendency toward wide planting of the tree, however, and no effort to establish an industry for the manufacture of bay rum.

BEANS  Next to the cereals, beans and peas are probably the most valuable of all the plants domesticated by man, for they not only furnish exceptionally nutritious food but enrich the soil at the same time by the help of nitrogen-fixing bacteria which live in the roots.

The first introduction of beans into Hawaii was by the white people. Although Don Marin speaks of planting beans in 1813, that is probably not the first instance of such planting, for dried beans were an inevitable part of the food stores of all European and American ships and it is quite likely that some were planted in this new land considerably before Marin's diary entry was made. It is not strange that the Hawaiians were not cultivating beans before the coming of white men, for the Polynesian people had never used any legumes as food, and on their coming to these islands found none here suitable for eating.

During the nineteenth century many species and va-
rieties of beans and peas were introduced here from var-
ious parts of the world, some by Occidentals and some by
Orientals. A few of these have become widespread and
are of considerable economic importance: notably the
pigeon pea, the algaroba (kiawe), etc. Most of the
introductions, however, are of only minor importance
among the present products of this Territory, for Hawaii
has never been much of a bean producing region in
spite of the fact that there are many kinds and varieties
which can be grown here very successfully.

Consumption of beans and peas in Hawaii amounts
to a large annual total, probably fully 5,000,000 pounds
when both the canned and dried forms are included with
the local fresh products; and most of this is imported
from outside, the value of the imports being something
like $250,000 per year.

Some of the principal kinds of beans and peas which
have been or are of some considerable economic interest
here are the following:

I. Used as livestock feeds:
   1. Algaroba
   2. Cowpeas
   3. Pigeon pea
   4. Soybean

II. Used as human food:
   A. Seeds only, dry, fresh or canned:
      1. Lima bean
      2. Mungo beans
      3. Pea (garden pea)
      4. Peanut
      5. Shell beans
      6. Soybean

   B. Pods and seeds:
      1. Chinese pea

13During the World War period there was a larger planting of beans here
than at any other time, the maximum having been about 1000 acres of both red
kidney and white navy varieties. Difficulties were encountered in the drying
of the beans, because of humidity of the atmosphere.
2. Cowpea  
3. Goa bean  
4. String bean (snap bean, wax bean)  
5. Yard long bean

C. Sprouted seeds:  
1. Mungo bean  
2. Soybean

While bean production on a regular commercial scale would not be as profitable here as cane sugar, nevertheless as a means of utilizing certain idle lands and especially as an interim crop between the harvesting of a final ratoon crop of sugar or pineapples and the next planting, it might be possible to develop an industry of considerable magnitude in the production of certain kinds of beans and peas. There are several attractive possibilities: green string beans, dry field beans, pigeon peas and soybeans.

Several varieties of green string beans, as the Kentucky Wonder, do exceptionally well here, and could be produced in large quantities in the winter months when the mainland markets are but scantily supplied. If a way can be found to treat the green product so that it will not be the means of introducing the melon fly into the mainland states (at present string beans are prohibited from entry by quarantine laws), there might be developed a seasonal industry of great importance to these Islands. Especially would this be true if our canning plants would extend their range of activities to handle string beans in those seasons when shipment in the fresh state does not pay. In this way producers would be protected somewhat from loss, by having two outlets for the crop.

Production of dry beans, likewise, could be developed to large proportions on fallow lands or as an interim crop. The local market could absorb large quantities, and there would be the additional prospect of shipping to outside markets in large quantities, if production costs could be kept at a low figure. Past experience here indicates that this crop should yield a net return of $30.00 to $50.00 per
acre when the prevailing price for beans is 4 to 5 cents per pound.

The pigeon pea, discussed also under its own heading, is usually thought of only as a feed for livestock. As a food for humans the pigeon pea offers interesting possibilities. In India, some parts of Africa and in Porto Rico it is an important and much relished article of diet, eaten in the same ways that other beans and peas are used. Hawaii, with thousands of acres of this crop, is overlooking a good thing so long as no effort is made to commercialize it for human consumption, whether dry or canned. As a war emergency food it certainly must not be overlooked.

Soybeans offer some promise of being profitable in Hawaii, both for use directly as a food for humans and livestock and also for a number of industrial purposes. Large quantities of soybean products are shipped in every year; some well conceived plan ought to be put into effect to develop a soybean industry here.

**Bean Sprouts** By allowing beans to germinate and grow for a few days in darkness a succulent, nutritious food is produced. Two species of beans are commonly used for this in Hawaii, the soybean (*Glycine hispida*) and the mungo bean (*Phaseolus aureus*). The former produces a sprout about 3 inches long, the latter about half that length.

The seeds are soaked in water for 24 hours and then spread out between layers of wet burlap or woven mats which are moistened at six-hour intervals for four to six days. The sprouts are then ready for consumption and must be used within a day or two to be at their best.

See also various headings as listed in the tabulation above; also see "Truck Crops."

BEEF CATTLE\textsuperscript{14} The beef cattle industry of Hawaii was well established before the growing of sugar cane on a commercial scale was begun. Vancouver brought the first cattle to Hawaii in 1793. These cattle, which were Longhorns secured in California, were protected by a strict tabu for a number of years and by 1830 had greatly increased in number.

Mexican cowboys were brought to the Waimea plains about 1830 and they taught their worthy successors, the Hawaiian cowboys, how to conquer and manage the wild herds of cattle on the slopes of Mauna Kea.

By 1850 the practice of penning and domesticating the cattle rather than hunting them with the horse and lasso had become established and has continued until today the vast pastures of the early days have been fenced and cross fenced, making possible the segregation of different classes of cattle and also the resting and rotating of pastures. This, in turn, has made possible the introduction and planting of improved grasses\textsuperscript{15}—a matter in which the ranchmen of Hawaii are much interested.

Cattle in 1853 were worth five dollars per head. Even as late as 1875 it was reported that the hides and tallow were of more value than the meat, but this situation changed following Annexation and the development of refrigeration.

Modern English breeds, notably the Hereford, Shorthorn, Angus, Dexter, and Devon breeds were brought to Hawaii beginning about 1850, and by 1900 they had largely replaced the original Longhorns. About 1890 the Hereford began to gain an ascendency over the other breeds and today over 90 per cent of the beef cattle in Hawaii belong to this breed.

Hawaii is now producing about 15 million pounds of dressed beef annually, valued at about $2,100,000. The 1930 census credits the Territory of Hawaii with about 130,000 beef cattle, on some forty large ranches and some smaller ones located on all the islands. The Island of Hawaii has about 68 per cent of the total beef cattle in the Territory; Maui has about 16 per cent; Kauai, 5 per cent;

\textsuperscript{14}This statement was prepared by Prof. L. A. Henke.
\textsuperscript{15}For a list of these, see "Range Grasses."
Oahu and Molokai each have 4 per cent; Lanai, 2 per cent; and Niihau, 1 per cent. Approximately one-third of the total beef cattle in the Territory are found on one large ranch and its associated ranches on the Island of Hawaii.

The number of beef cattle has not changed greatly in the past forty years. As former ranch lands were taken over for sugar and more recently for pineapple production, improved pastures and better systems of management made it possible to carry approximately the same number of cattle on the reduced area.

The area devoted to beef production in the Territory is large, totalling about 1,300,000 acres and comprising about one-third of the area of the entire Islands. While there are fine pastures in this area, there are also thousands of acres of barren lava flow country of which 100 acres or more are required to support one animal. The average for the entire ranch area in the Territory is one head to 10 acres, but there are favored areas planted to pigeon peas or improved grasses in regions of ample rainfall where only one to two acres are required per head.

**Water Supply Important**—Formerly it was necessary for cattle to walk long weary miles to water, but this has been largely changed and hundreds of miles of pipe lines now bring water to the cattle. However, there still are areas where securing drinking water for the cattle during the dry season is a major problem. Large galvanized iron roofs are constructed to catch rain water from where it is led to large storage tanks to be used as needed. More of these are needed as a protection against occasional long periods of drought.

**The Breeding Season**—Many ranches have a definite breeding season lasting perhaps three or four months during which time the bulls are allowed to range with the cows. This is usually so timed that the calves will be born during the season of the year when the pastures are in best condition, often the winter months because of the greater rainfall at that time, although this varies in different parts of the Territory. This scheme facilitates the handling and segregation of the calf crop but requires more bulls than the plan followed by other ranchers who permit the bulls to run with the cow herd throughout the
year. The number of bulls required varies with the character of the range; in rough country having a low carrying capacity more bulls are required. One bull for each twenty-five cows is approximately the average ratio maintained. Ranchers who permit the bulls to range with the cows throughout the year maintain that this results in a larger calf crop.

*Marketing Methods*—Due to better, earlier maturing cattle, better pastures, and better systems of ranch management, cattle are marketed at a much earlier age now than formerly. From the better ranches, market steers now average between two and three years of age and produce a dressed carcass weighing between 550 and 600 pounds. Thirty years ago it required four to five years to produce a steer of this size.

The largest slaughter house with Federal inspection of the carcasses is located in Honolulu and slightly over half of the beef produced in the Territory is slaughtered at this plant. The number, average weight and prices paid in 1935 follow:

<table>
<thead>
<tr>
<th>Class</th>
<th>Number</th>
<th>Average Dressed Weight lbs.</th>
<th>Average Price Paid Per Pound cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steers</td>
<td>7983</td>
<td>593</td>
<td>14.54</td>
</tr>
<tr>
<td>Heifers</td>
<td>2804</td>
<td>413</td>
<td>14.19</td>
</tr>
<tr>
<td>Cows</td>
<td>2115</td>
<td>499</td>
<td>12.04</td>
</tr>
<tr>
<td>Calves</td>
<td>274</td>
<td>102</td>
<td>12.16</td>
</tr>
</tbody>
</table>

Most of these animals came from the Island of Hawaii. At present, few or no live cattle from Maui are shipped to Honolulu for slaughter, but dressed carcasses totalling over one quarter of a million pounds were sent from Maui to Honolulu in 1935.

Cattle from the Kona side of Hawaii are loaded on the steamers by being driven into the ocean, tied to small boats and forced to swim to the steamer where they are lifted on board by means of a crane.

Most ranches have small slaughter houses where enough cattle are killed to supply the local needs. Many plantations have a small beef herd which graze on lands not suitable for sugar cane and these are generally slaughtered at the plantation for local use.
Since the beginning of the industry in Hawaii, cattle have been marketed directly from the pastures without any supplementary feeding on concentrates. As the pasture grasses were improved, a better quality of beef resulted and in recent years the beef produced on improved pasture grasses, pigeon peas, and koahaole has been of very good quality although hardly equal to grain-fed steers. Increasing quantities of cane molasses are now being fed on some ranches, and experiments now in progress indicate that this is a very desirable practice, resulting in heavier carcasses at a given age and providing another use for the large quantity of cane molasses available in the Territory. Cane molasses is a cheap feed in Hawaii and it appears that using it in this way gives a better return for the molasses than other present available ways of disposing of it, and besides results in better beef. It is likely that this practice will increase. The common method is to supply the molasses in open troughs in the pastures. Experiments are also in progress at this time which may demonstrate that feeding some protein supplement, as soybean oil cake meal or perhaps fish meal, is desirable.

The Army and Navy in Hawaii purchase large quantities of beef. This is purchased on the basis of Federal grades, with requirements that it grade as "good" or better; much of the locally produced beef does not at present meet this requirement, either because the carcasses are too small or do not grade high enough. Practically all of the Navy beef is secured from local sources, but most of the Army beef is produced on the mainland. It is anticipated that the more general use of local low cost feeds, as cane molasses and pineapple bran, may make it possible to produce more and better carcasses so that much of the Army beef can be supplied from local sources. Cereal grains that are ordinarily used to fatten cattle in the Middle West are too costly in Hawaii, for they must be imported.

Imports Compared With Local Production—A survey

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16See “Koahaole.”
17A study of the digestibility of various locally produced feeds is under way at the Hawaii Experiment Station. See Annual Report 1936, p. 72.
18See “Molasses” and “Bagasse.”
19See “Corn,” “Wheat,” etc.
of the beef situation in Hawaii made in 1928\textsuperscript{20} indicated that local production in that year totalled about 14,213,000 pounds of dressed beef, and during the same year 4,104,883 pounds of beef and veal were imported, or 22 per cent of the total beef consumed during that year was shipped to Hawaii. Ninety-six per cent of the beef shipped to Hawaii that year came from foreign sources.

During 1935, 4,568,934 pounds of fresh or frozen beef and veal were shipped to Hawaii; with an estimated local production of 15,000,000 pounds, about 23 per cent came from sources outside of the Territory. It is interesting to note that of the total fresh beef and veal shipped to Hawaii in 1935, ninety-five per cent came from the mainland United States, almost a complete shift in the situation as recorded for 1928.

In addition to fresh beef and veal, 2,021,057 pounds of pickled, cured or canned beef were shipped to Hawaii in 1935, making a total of about 21,600,000 pounds of beef consumed that year, or an average of slightly in excess of 50 pounds per capita, which figure compares rather closely with average mainland consumption.

**BEES AND BEEKEEPING**  Beekeeping, a very ancient art and probably the first means of supplying a sweet in human diet, was unknown in Hawaii until comparatively recent years because of the absence of the honey bee. Although insects of many species had gained entrance to these Islands by flight or otherwise, this useful species was not represented here when Captain Cook's discovery voyage opened the modern era in 1778.

During the next eighty years there were many times when the white settlers longed for fresh honey and wished that beekeeping might be established as an industry here. However, to transport a living swarm of bees from the Atlantic Coast around Cape Horn on a voyage which took several months seemed to be an almost insuperable difficulty. In 1853 an effort was made to bring two hives from Boston, one of them packed in ice to keep the bees dormant in a simulated winter. The experiment cost

$150 but was not successful, for neither swarm survived the trip.

In 1857 the first living swarm was established here, but for many years thereafter beekeeping was carried on simply as a household activity, with no important development commercially.

The first commercial venture in the production of honey and beeswax for export and general sale began in 1895, with the first exports in 1897, some 109,000 pounds.

At the beginning of the present century honey production was a considerable industry, with three corporations engaged in it and a capital investment of about $150,000. Nearly all the product was sold in Germany, some in the United States mainland, but very little of it was consumed locally. While large quantities of bulk honey were going out each year, a not inconsiderable amount of bottled honey was being imported for use by our local population.

In 1905 the Hawaii Experiment Station began directing some of its attention to this industry, for the annual crop was being greatly increased about that time by the presence in the sugar plantations of large quantities of honey dew secreted by the leafhopper, which then was exceedingly abundant. New strains were brought in by the introduction of improved queens, and efforts were made to increase the number and range of honey yielding plants.

An association of beekeepers was organized in 1907, to advance and protect the interests of the industry. One result of their efforts was to have a quarantine order issued by the Territorial Board of Agriculture to control the importation of bees as a protection against the foul brood disease which, fortunately, had not gained entrance to Hawaii.

By 1908 the industry had expanded to cover all the islands, with seven corporations and many individuals operating a total of about 20,000 colonies of bees. The industry continued to grow, the annual value of its product increasing from $40,000 in 1910 to the all-time maximum of over $300,000 in 1919, when phenomenally high unit prices greatly enhanced the year's returns. Subsequent years have brought forth large amounts of honey but
the values have been much less than in the bonanza years of 1919 and 1920, as shown by the following table, in which honey and beeswax exports are combined:

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
<th>Year</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1903</td>
<td>$15,280</td>
<td>1920</td>
<td>$211,508</td>
</tr>
<tr>
<td>1904</td>
<td>14,346</td>
<td>1921</td>
<td>79,963</td>
</tr>
<tr>
<td>1905</td>
<td>24,605</td>
<td>1922</td>
<td>65,853</td>
</tr>
<tr>
<td>1906</td>
<td>40,793</td>
<td>1923</td>
<td>85,765</td>
</tr>
<tr>
<td>1907</td>
<td>31,053</td>
<td>1924</td>
<td>99,464</td>
</tr>
<tr>
<td>1908</td>
<td>36,882</td>
<td>1925</td>
<td>107,495</td>
</tr>
<tr>
<td>1909</td>
<td>50,412</td>
<td>1926</td>
<td>114,832</td>
</tr>
<tr>
<td>1910</td>
<td>41,388</td>
<td>1927</td>
<td>88,687</td>
</tr>
<tr>
<td>1911</td>
<td>63,543</td>
<td>1928</td>
<td>73,033</td>
</tr>
<tr>
<td>1912</td>
<td>46,104</td>
<td>1929</td>
<td>105,115</td>
</tr>
<tr>
<td>1913</td>
<td>67,811</td>
<td>1930</td>
<td>114,897</td>
</tr>
<tr>
<td>1914</td>
<td>46,517</td>
<td>1931</td>
<td>97,159</td>
</tr>
<tr>
<td>1915</td>
<td>49,169</td>
<td>1932</td>
<td>67,528</td>
</tr>
<tr>
<td>1916</td>
<td>70,509</td>
<td>1933</td>
<td>33,664</td>
</tr>
<tr>
<td>1917</td>
<td>69,959</td>
<td>1934</td>
<td>42,091</td>
</tr>
<tr>
<td>1918</td>
<td>170,638</td>
<td>1935</td>
<td>69,178</td>
</tr>
<tr>
<td>1919</td>
<td>329,599</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In spite of quarantines, the foul brood disease finally did make its appearance here and has become a serious handicap to the industry. Although efforts are being made to control it, probably the disease can never be eradicated from the Islands. Other than this and the bee moth there are no very serious enemies of the industry.

The algaroba is the main source of honey here, and practically all the extensive areas occupied by this tree are covered by existing apiaries. It would seem, therefore, that this is one industry which ought to be and probably will be maintained at about its present level of development without material increases in the number of colonies.


**BEET** The production of the common edible beet (*Beta vulgaris crassa*) is a familiar feature of nearly all truck gardens in this Territory. Several varieties²¹ do well under Hawaiian conditions and there is a constant demand for a limited amount of the product, for the beet is a widely used food. In addition to the root, which is the part most commonly marketed, the tops are excellent as greens and frequently are used in this way.

²¹See Agr. Ext. Bul. 16, p. 69 for their names.
The area now used for commercial production of beets to meet the local demand is less than 50 acres, exclusive of home gardens. The chief demand is from the Caucasian peoples, the Orientals and Hawaiians having other root crops which take the place of the beet. It should be noted, however, that something less than the entire consumption demand is met by local production, for some 50,000 pounds of mainland beets are brought in annually by local vegetable dealers.

An attempt to grow sugar beets for the manufacture of sugar was made on Lanai some years ago before the island was acquired by the Hawaiian Pineapple Company. The effort was not successful.

See also “Truck Crops.”

BEGGAR WEED The giant beggar weed (*Desmodium tortuosum*) has proven to be good as a soil ing crop (green manure), as it makes rapid growth under Hawaiian conditions and produces an abundance of root nodules. Ref.—Planters Record (H. S. P. A.) III, 53.

BERMUDA GRASS Bermuda, or manienie* grass (*Cynodon Dactylon*), forms the foundation of most of the pastures of Molokai, Maui, Oahu, and Hawaii from sea level to elevations of 4,000 feet. A giant variety is under trial.


BETEL The leaves of a pepper (*Piper betle*) are used in flavorful certain foods by the Chinese, and a limited demand exists both here and in California. The betel pepper is a tropical plant, cultivated throughout the East Indies and southern Asia.

It was introduced into Hawaii many years ago, exports of the leaves to San Francisco having been made as early as 1875, when 100 “boxes” were shipped. The leaves are picked and packed fresh in small baskets or boxes.

A small business has been maintained in this way, with total annual shipments never reaching a high figure, how-

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22 Authorities for this statement are F. G. Krauss and J. G. Smith.

23 This name is said to have been derived from that of the Spaniard, Don Marin. It is the Hawaiian equivalent of his name.

24 Thrum’s Annual 1878:59.
ever. Within the past five years it seems to have been dis-
tinued and the cultivation of the plant has nearly
ceased.

In some tropical countries the betel pepper is used as
a drug; after stripping off the husks of the betel nut25 palm
seed, the seed itself is cut into thin slices or sections and
placed on the betel leaf with a little lime added, then the
leaf is rolled up and chewed. It is said to have the effect
of seeming to relieve fatigue, somewhat as awa root.

BETEL NUT The betel nut is the seed of a palm tree
(*Areca catechu*) which is grown extensively in Hawaii as
an ornamental. The fruits are globular, an inch or more
in diameter and orange colored, with a fibrous husk en-
closing a single seed. In some tropical countries the seed
is chewed by the natives (see “Betel”), but in Hawaii
very little use is made of it.

BHEL FRUIT The bhel, or bael (*Aegle Marmelos*), is a
tropical fruit tree sometimes grown in Hawaii as an
ornamental. It is spiny and has trifoliate leaves. Its fruit
resembles an orange in appearance and size, but its outer
rind is hard and gourd-like. The juicy pulp within is
pleasantly acid in flavor. There is no commercial pro-
duction of this fruit.

BLACKBERRY The common blackberry (*Rubus spp.*)
of the temperate zone has been introduced into Hawaii
and grows wild in certain upland areas, as in the vicinity
of the Kilauea Volcano, and the Olinda region on Maui.
To a limited extent it is cultivated in home gardens at
elevations of 3,000 to 5,000 feet above sea level, but the
total production is not sufficient to be of economic im-
portance. As a rule the berries are small and seedy in com-
parison with the mainland product.

BOWSTRING HEMP See “Sansevieria.”

BRAZILIAN PLUM The Brazilian plum (*Eugenia
brasiliensis*), also called Spanish cherry, is used in Hawaii
only as an ornamental shrub or tree. The fruit resembles

25See “Betel Nut.”
a small guava in shape, but is purplish-black in color; although edible, it is not used to any considerable extent.

**BREADFRUIT** Breadfruit (*Artocarpus incisa*) is the staff of life in certain islands of the South Pacific. While in Hawaii it has never filled a place quite that important, it was looked upon by the old-time Hawaiians as an exceedingly valuable item of their diet. In earlier times there were many more breadfruit trees growing in the Islands than there are now, for during the past hundred years the demand for this fruit has diminished almost to the vanishing point and once flourishing groves have been allowed to die from neglect, or they have been crowded out by other crops that seemed more profitable.26

In the 1920's there developed a renewed interest in this tropical fruit, due largely to the enthusiasm and exploratory work of the late G. P. Wilder, who made a number of trips to the South Seas and sent some fifty or more varieties of breadfruit cuttings to Honolulu. Because of the extreme difficulty in propagating this tree, not more than half of the importations became established here.

The Hawaii Experiment Station in 1921 began some propagation studies which resulted in the development of an effective technique, consisting of laying in sand a six-inch bit of surface root of the breadfruit tree removed in the dormant season just after the fruiting period. After several months these pieces of root send up shoots which grow into new trees. The breadfruit develops no seeds, hence the necessity of this procedure.

Eaten in the usual manner, this fruit will probably never be in great demand except among those local people who have cultivated a liking for the peculiar flavor and texture. If, however, a way were discovered to use the breadfruit in the manufacturing of some prepared or processed food product, it might be possible to develop something of an industry around this fruit. The tree is large and requires much space; grown commercially, an acre would support about 15 to 20 trees. The yield would average perhaps

26There are many scattered trees in the gulches along the Hamakua coast of Hawaii, bearing heavily, but most of the fruit is allowed to waste.
about 200 or 400 pounds per tree after a good degree of maturity is reached.


BROCCOLI Broccoli (Brassica oleracea botrytis) is a relative of the cabbage and cauliflower, and like the latter produces an abundance of small flower buds which with the associated leaflets and stems constitute the edible portion.

Broccoli is grown successfully in Hawaii, especially at higher elevations, but its production is insufficient to fill the existing demand. A recent crop survey (1936) indicates that this plant occurs in truck gardens on all the islands, but more extensively on Maui than on the others; the total acreage is probably less than 30 acres. Nearly as much is imported from California as is produced in the Territory; the total consumption here is between 125,000 and 150,000 pounds, of which local production provides about 80,000 pounds.

See also “Truck Crops.”


BROMEGRASS Bromegrass (Bromus unioloides) does well with Bermuda and certain other grasses and provides excellent pasturage. It is one of the favorites of Parker Ranch.


BROMELIN Bromelin is a digestive enzyme in the pineapple, resembling and possibly identical with the well known papain from papaya, which is well known in commerce and used in the manufacture of certain patented preparations used as aids to digestion.

Investigations in the P.P.C.A. Experiment Station27 at the University indicate that bromelin of very good quality could be extracted from the pineapple fruit and possibly, also, from the leaves, as a commercially valuable by-product.

27By O. C. Magistad and F. A. Abel; Dr. C. P. Sideris made preliminary studies of the enzymatic reactions of pineapple leaves.
BROOM CORN  There are three broom factories in Honolulu, including one operated for and by indigent blind men. These factories have to depend on imported broom corn (*Sorghum vulgare technicus*), for none is produced in Hawaii on a commercial scale. The amount consumed here in local manufacture is not large, about 125 tons per year, but it is an item of some importance when one is considering the diversification of agriculture in these Islands.

From 1910 to 1912 the Hawaii Experiment Station made some tests to determine the possibilities of producing this crop here. While the tests were not very extensive, they seemed to be sufficient to show that a good quality of broom corn can be grown in Hawaii, with a yield of 300 to 600 pounds of brush per acre. A later test in 1927 was not encouraging. Some of the locally produced brush was used in a Honolulu factory and found to be satisfactory.

Insect enemies, especially the aphis, are a serious menace to this crop in the lowland regions. It is possible that in the higher lands, at elevations about 3,000 feet, broom corn might be grown with moderate profit to the producer.


BRUSSELS SPROUTS  Although most of the local demand for brussels sprouts (*Brassica oleracea semmifera*) is met by importations from California, small amounts aggregating an acre or two are produced here. This plant is a close relative of the cabbage and requires about the same climatic conditions, such as are found in the cooler uplands at 3,000 to 4,000 feet elevation.

See also “Truck Crops.”

BUCKWHEAT  A small test planting of buckwheat (*Fagopyrum esculentum*) was made by the Hawaii Experiment Station in 1914 to see something of the possibilities of producing this plant in Hawaii, and another trial was made in 1927 at the University Farm. It is normally a temperate zone crop but in both instances seemed to grow well here, and yielded at a moderately good rate. As a rotation crop it may have some possibilities here, for

BUFFALO GRASS Buffalo grass (*Stenotaphrum secundatum*) grows extensively at the lower altitudes, but is not regarded by livestock men as having great value for pasturage. It is used for lawns in shady locations where manienie (Bermuda) grass does not do well. Ref.—Haw. Exp. Sta. Bul. 65:49, 1933.

BURDOCK Burdock (*Arctium Lappa*), called by the Japanese “gobo,” is a large-leaved plant which produces a long, fleshy tap-root, from one to four feet in length. Although the plant is normally biennial, it is usually grown as an annual so that the root may not become too long and too tough. In about ten months the root size desired by the market is attained. The root is boiled to make it edible. It somewhat takes the place of salsify, or oyster plant, in consumption demand.

The market demand for this root is limited and the production is small, some 30 acres being devoted to it, mostly in the upper portions of the valleys near Honolulu.

See also “Truck Crops.”

BUTTERBUR Small quantities of this Japanese plant (*Petasites japonica*) are grown for market on the Island of Hawaii near the Kilauea Volcano. It is a perennial herb28 with large leaves, the petioles of which are one to three feet long and very succulent, and used in soup by the Japanese.

CABBAGE Head cabbage (*Brassica oleracea capitata*) thrives very well in the cooler uplands of these Islands. The history of its cultivation here runs back to the early part of the nineteenth century, Marin recording it in his diary that among many other things he had planted “cabbages.” In the gardens at lower elevations there has been a limited amount of production of this crop, but always under some handicaps due to insects and diseases.

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