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Medicinal Plants of Tropical and Subtropical Regions

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MEDICINAL PLANTS OF TROPICAL AND SUBTROPICAL REGIONS

INTRODUCTION

The botanical drugs used in the United States are obtained from many regions throughout the world. During periods of normal world trade the problem of securing the necessary supplies of such drugs causes little public concern and there is little general interest in developing new sources. Adaptation of the species from which the botanical drugs are derived and availability of cheap labor are the principal considerations that tend to perpetuate production of such materials in the regions that have long furnished them for the world's markets. Only during a widespread war, when the usual sources are not accessible, do the possibilities of securing these products from new sources nearer home receive serious consideration. The United States obtains many drugs from remote tropical and subtropical Old World regions, the climatic conditions of which can be found in Central and South America. There is, therefore, a natural interest in the possibilities of introducing Old World species into those regions in the Western Hemisphere where conditions for them appear favorable and where their utilization as sources of useful products may be economically feasible.

The species included in this discussion are largely limited to those native in or adapted to tropical and subtropical regions, but several with a wider range of adaptation are also included on account of their economic significance. As the title suggests the primary consideration is their use in medicine, although many of those included also find important application in industry.

Published information on many of these plants with respect to the conditions under which they grow, how they are cultivated, and how the products obtained from them are gathered is incomplete, contradictory, or lacking. To those who wish to investigate the possibilities of growing them in other parts of the world a summary of the essential information concerning them is helpful and greatly needed. This pamphlet was prepared as a summary and ready reference to serve that purpose. It does not purport to give all of the information that it is necessary or desirable to have in estimating the commercial possibilities of a species in a region in which it does not already occur or has not previously been grown. However, it will enable those interested to determine with reasonable certainty if such a species is likely to be sufficiently well adapted to warrant its introduction and trial and whether the prevailing economic conditions would make a commercial development possible.

The species indicated as botanical sources of the drugs discussed are those mentioned in the United States Dispensatory, twenty-second edition (1937), but the Latin names and authorities as given are in accordance with the latest botanical information and the International Rules of Nomenclature.

The statistical information on all imports of the drugs by the United States was obtained from Foreign Commerce and Navigation of the United States.¹ Production figures are given when available. Though imports by the United States do not indicate world consumption, they are of value to prospective producers in the Western Hemisphere because they show the principal market outlet nearest to the point of production.

¹ Compiled annually by the U. S. Department of Commerce, published by the Government Printing Office, Washington, D. C.

Some of the source material used is very old, but in such cases more recent information in similar detail was not available or the older literature was found to be particularly interesting and informative. Where special references are cited, these constitute the principal source material; but in all cases information was also obtained from one or more of the general sources herewith listed with the names of the publishers:

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1933. A TEXT BOOK OF PHARMACOGNOSY; BEING AN ACCOUNT OF THE MORE IMPORTANT CRUDE DRUGS OF VEGETABLE AND ANIMAL ORIGIN, DESIGNED FOR STUDENTS OF PHARMACY AND MEDICINE. Ed. 6, 564 pp., illus. J and A. Churchill, London.
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1933. A NOTE-BOOK OF TROPICAL AGRICULTURE. 149 pp., illus. Imp. Col. Trop. Agr., Trinidad.

ALOE

Botanical Sources.- *Aloe barbadensis* Mill., *A. chinensis* Stend., *A. perryi* Baker, *A. ferox* Mill., *A. africana* Mill., *A. spicata* L.f., and other species. Fam. Liliaceae. (Note: In the literature on the subject *A. barbadensis* is incorrectly referred to as *A. vera*.)

Habitat.- *A. barbadensis*, Mediterranean countries and West Indies; *A. perryi*, Socotra; *A. chinensis*, Asia; *A. ferox* and *A. africana*, South Africa; *A. spicata*, tropical Africa.

Nature of Plants.- Perennial succulents.

Part Used. - The fresh leaves and their dried juice.

Commercial Uses, Sources, and Importance.- Aloe is the source of aloin, which is used medicinally. Most plants of the genus *Aloe* contain a juice with laxative properties, so that often a commercial brand of aloes is a composite of the juices of several species. The fresh leaves are used in the treatment of burns, particularly those resulting from overexposure to X-ray. There are many commercial types of aloes, but the most important ones and their principal sources are as follows:

- (1) Socotrine Aloe.- This is principally obtained from *A. perryi* and is imported from Socotra, the east coast of Africa, and the Arabian coast. Zanzibar aloe is considered a variety of the Socotrine.
- (2) Curaçao Aloe.- This is said to come from both *A. chinensis* and *A. barbadensis*. It is obtained from the West Indies. Barbados aloe is a variety of the Curaçao.

- (3) **Cape Aloe.**- This is chiefly a product of *A. ferox*, *A. africana* and *A. spicata*. It is produced in South Africa.

Aloes imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Netherlands West Indies	518,418	154,022	767,874	219,349	603,935	208,289
Arabia	16,399	2,545	11,200	1,551	3,248	649
Africa	43,380	5,245	70,505	6,078	118,942	8,465
British West Indies	-	-	2,170	104	612	47
Venezuela	-	-	13,555	4,621	74,463	21,436
Other countries.....	-	-	-	-	100	18
Total	578,197	161,812	865,304	231,703	801,300	238,904

In 1941, the Dominican Republic exported aloes for the first time.

Cultivation and Propagation.- Commercial aloes is obtained from wild and cultivated plants. Cultivated Socotrine and Curaçao aloes are capable of growing on poor, well-drained limestone soils in dry situations where the mean annual temperature is 70° to 80° F. Under cultivation in Barbados, aloes are propagated with offsets separated from mature plants. They are set out in long beds about 18 feet wide. Trenches are dug between the beds for adequate drainage. Before planting, the soil is thoroughly forked and given an application of barnyard manure, if available. The young transplants are spaced at intervals of ½ to 1 foot in rows 1½ to 2 feet apart. Transplanting may be done at any time when the soil is moist enough to adhere to the roots of the offsets but not so wet as to encourage rot, to which the young transplants are susceptible. With proper weeding and care the plants will produce a commercial crop in 1 year.

Harvesting and Preparation for Market.- The leaves of the aloe are cut after the plant has completed flowering and the floral stalk has become withered and brittle. Cutting is done by gathering the mature leaves in one hand and severing them by slicing across the lower portion of the plant with a knife. The cut is made just high enough to leave the immature inner leaves at the base of the plant uninjured. In Barbados, as soon as they are cut the dripping succulent leaves are stood up in a sloping V-shaped trough, into which they drain. The juice is collected from the trough and taken to a boiling house. There the juice is boiled to a heavy consistency in copper evaporating pans, which are heated over a direct fire. When sufficiently boiled down it is poured into gourds or boxes, where it hardens and is then ready for shipping.

Yields.- The yield of aloe juice increases with the age of the plant. A mature 4-year old plantation will yield from 500 to 1,000 pounds of prepared aloes per acre. A 1-year old plantation will produce about 100 pounds. After the fourth year production usually declines, although production has frequently continued for 10 or 12 years.

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1902. THE ALOE INDUSTRY OF BARBADOS. West Indian Bul. 3:178-188, illus.
- ORME, THEODORE S.
1941. ALOE PRODUCTION DOMINICAN REPUBLIC. U. S. Cons. Rpt., 2pp. Oct. 21, 1941.
[Typewritten.]

ASAFOETIDA

Botanical Source.- *Ferula foetida* (Bunge) Regel, *F. rubricaulis* Boiss., and other species of *Ferula*. Fam. Umbelliferae.

Habitat.- Afghanistan and Iran.

Nature of Plants.- Perennial herbs.

Part Used.- Gum exuded by root.

Commercial Uses, Sources, and Importance.- Asafoetida, which has a taste stronger than onion or garlic, is used as a condiment especially in the Middle East. It has a number of medicinal uses based principally on its nerve-stimulating properties.

Asafoetida imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
British India	20,174	3,135	21,280	3,252	45,090	2,215
Iran (Persia)	33,653	3,456	59,948	6,791	52,404	6,150
Total	53,827	6,591	81,228	10,043	97,494	8,365

Propagation and Culture.- Asafoetida grows wild in Afghanistan in a high plains region 2,000 to 4,000 feet above sea level, arid and bare in winter but covered with a thick growth of *Ferula foetida* and other *Ferula* species in summer.

F. foetida is a hardy plant, able to thrive in semiarid country on pebbly or even stony ground on hillsides or among the detritus at the base of mountain slopes. It grows 5 to 7 feet high and develops a large fleshy root, which is sometimes as much as 6 inches in diameter. Production in Afghanistan is concentrated in the vicinity of Kandahar, where the mean annual temperature is about 60° F. and the average annual rainfall is about 15 inches. The plant can be easily propagated by seed.

Harvest and Preparation for Market.- The asafoetida is gathered in June in Afghanistan. The gum is caused to form by bleeding the root of the plant. Preparatory to the cutting operation, the soil is scraped away from around the root to a depth of about 6 inches. The top of the plant is severed at the crown and several lacerations made around the head of the root. Fresh cuts are made every 3 or 4 days until the sap ceases to run, which may be a week or a month depending on the vigor and size of the root. Immediately after cutting, the root stump is covered with a dome of twigs, herbs, stones, or other trash to protect it from the sun so that it will not wither. As the gum exudes it hardens into tears, or lumps. This material is collected and spread in the sun to harden.

Commercial asafoetida consists of tears, large masses, or paste. The tears are the purest form. The others are often adulterated. Asafoetida is usually shipped in cases, sometimes in skins, mats, or tins. A very high quality of asafoetida may be obtained by incising the terminal bud in the center of the leafy head of newly sprouting plants. Ordinarily the plant is not cut until it is 4 years old and has a root several inches in diameter.

Yields.- The amount of asafoetida obtained varies according to the size of the roots. Some are as small as carrots and others are 6 inches or more in diameter. Quantities ranging from a few ounces to several pounds per root have been reported.

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DUCKWORTH, DYCE.

1859. THE WARTHEX ASAFOETIDA: A DESCRIPTION OF THE PLANT, ITS PROPERTIES AND USES. *Pharm. Jour.* [London] 18:464-468, 111us.

BENZOIN

Botanical Source.- *Styrax benzoin* Dryand., *S. tonkinensis* (Pierre) Craib, and other species of *Styrax*. Fam. Styracaceae.

Habitat.- Southeastern Asia and the East Indies.

Nature of Plants.- Trees.

Part Used.- Gum.

Commercial Uses, Sources, and Importance.- Gum benzoin has a number of medicinal uses. It is most commonly employed as an inhalent and in dressing wounds. Small quantities of gums sometimes classed as benzoin are produced in South America. The Far East, particularly the Netherlands Indies, is the chief source of supply.

Benzoin imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
France	4,264	2,181	7,906	4,290	3,579	2,962
United Kingdom	819	507	65	41	-	-
Netherlands Indies ...:	90,206	12,184	117,128	14,541	218,517	25,781
French Indochina	8,176	2,917	6,680	2,665	15,067	7,884
Thailand	2,198	1,532	3,382	1,822	19,836	19,364
Total	105,663	19,321	135,161	23,359	256,999	55,991

Harvest and Preparation for Market.- Gum benzoin is obtained from both wild and cultivated trees. Owing to the fact that these trees are not exploited until they are 8 or 10 years old, the cultivated ones are often propagated in a rather haphazard fashion. In French Indochina and Thailand the land is roughly cleared for planting, and the seed is simply scattered on the ground. The patches are then abandoned until nearly a decade has passed and the time for harvest arrives. As a result stands of trees that were fairly thick a few years after planting are severely thinned out by the competition of scrub growth.

Unless benzoin trees are tapped carefully, they will not survive more than 5 or 6 years after exploitation has begun. A common method is to cut V-shaped incisions through the bark in such a way as not to girdle the trunk. At the bottom of the V, bamboo joint or other cups are secured so as to catch the gum as it exudes. A crude method of indiscriminate slashing is occasionally followed, and the bark is sometimes torn off in removing lumps of gum. The best time to collect the gum is during the hottest season. Areas of successful production of benzoin are limited to altitudes between 2,500 and 5,000 feet above sea level. The mean annual temperature should be about 75° F. and the yearly rainfall approximately 70 inches.

Yields.- The yields of the benzoin tree are very uncertain. In French Indochina it has been determined that rough-barked trees will produce much higher yields than comparatively smooth-barked varieties. Fluctuations in yields by the same trees from year to year are common. Annual yields up to 11 pounds per tree are recorded, but it is said that 3 pounds is the usual limit.

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1931. LE BENJOIN. 17 pp., illus. Hanoi.
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1912. THE SOURCE OF SIAM BENZOIN. (STYRAX BENZOIDES, CRAIB). Kew Roy. Bot. Gard.
Bul. Misc. Inform. 1912: 391-392.

BUCHU

Botanical Source.-*Barosma betulina* (Thunb.) Bartl. and Wendl., *B. crenulata* (L.) Hook., and *B. serratifolia* (Curt.) Willd. Fam. Rutaceae.

Habitat.- South Africa.

Nature of Plants.- Perennial evergreen shrubs.

Part Used.- Leaves.

Commercial Uses, Sources, and Importance.- Extracts of buchu leaves have been used medicinally but are no longer considered important. The mintlike oil distilled from the leaves is reported to have been used to flavor dentifrices. The plant is also grown as an ornamental. The Union of South Africa, which is practically the only commercial producer of these leaves, supplies the United States market.

Buchu imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Union of South Africa	97,034	26,904	165,979	38,154	108,526	46,947
	:	:	:	:	:	:

Propagation and Culture.- The wild buchu is not found growing on free lime soils or on sands or clays. It prefers a sandy loam with a high organic-matter content. The average yearly rainfall of the wild buchu areas is about 30 inches, and the mean annual temperature is just over 60° F. To obtain the highest yields the buchu requires fertilizing with potash, superphosphate, and leafmold or barnyard manure. Commercial nitrogen fertilizers are also desirable.

The buchu shrub is usually propagated by seed, although it is possible to do so with cuttings or by layering. The seeds are planted either in shaded boxes or in nursery beds. The soil in either case should be a mixture of vegetable compost and sand or sandy loam. When dormant and before they are a year old the seedlings are set out in the plantation when the soil and atmosphere are damp. The soil should be plowed or turned over as deep as 2 feet, since the buchu has poor root development and its roots must be encouraged to penetrate the soil more deeply by careful preparation of the ground. The transplants are usually set 5 feet apart each way in the plantation. Weeding is necessary to check competition with other plants and to conserve moisture.

Harvest and Preparation for Market.- The leaves contain the most oil and are most desirable at the beginning of the dormant period when the seed has ripened. The cutting should be done with pruning shears in such a way as to leave sufficient buds for healthy growth the following season. The cut twigs should be immediately removed to sheds and spread out to dry. Drying in the sun will spoil the leaves by removing most of their valuable volatile oil. Rain or dew will damage the cut leaves by discoloring them. As soon as the leaves have dried they should be separated from the branches and packed in boxes or damp-proof bags.

Reference.-

WIELLIGH, G. R. VON.

1913. THE CULTURE OF THE BUCHU PLANT. Union So. Africa Agr. Jour. 6: [81]-87, 111us.

CALABAR BEANS

Botanical Source.- *Physostigma venenosum* Balf. Fam. Leguminosae.

Habitat.- Western coast of Africa.

Nature of Plant.- Perennial woody climber.

Part Used.- Seed.

Commercial Uses, Sources, and Importance.- The alkaloid, physostigmine, which is extracted from physostigma, or Calabar seed, is used medicinally. While the Calabar bean tree is said to thrive in Brazil, commercial supplies of its highly poisonous seed are obtained from the Niger and Calabar regions of Africa. In 1939 the United States imported 15,423 pounds of Calabar beans, valued at \$1,142.

Harvest and Preparation for Market.- Calabar beans are obtained from wild trees that have grown up along river banks from seeds carried by the streams. Where the tree thrives in Africa the temperature does not vary much from 80° F. the year around. The annual rainfall is about 125 inches. The easiest way to gather the seed pods is to collect them from the banks of the rivers, where they lodge after falling from the trees into the water.

While the Calabar bean tree drops mature pods the year around, the principal crop is gathered during the rainy season, which extends from June to September in Africa. The pods are from 6 to 7 inches long and contain 2 or 3 reddish-brown oblong seeds. These beans are separated from the pods, dried, and shipped in bags.

Reference.-

SHARP, GORDON.

1916. THE HISTORY OF CALABAR BEAN AND ITS INTRODUCTION INTO MEDICINE AS ILLUSTRATING THE GERMAN AND THE BRITISH METHODS OF USING NATURE'S GIFTS. Pharm. Jour. [London] 96:619-620.

CALUMBA

Botanical Source.- *Jateorrhiza columba* Miers (*Jateorrhiza palmata* (Lam.) Miers). Fam. Menispermaceae.

Habitat.- Eastern tropical Africa.

Nature of Plant.- Perennial vine.

Part Used.- Root.

Commercial Uses, Sources, and Importance.- Calumba is used medicinally in certain tonics and bitters. It is reported that the root is used in Africa and the East Indies for dyeing purposes. In 1939 the United States imported 20,047 pounds, valued at \$765. Most calumba root is produced in the Portuguese and British East African colonies.

Harvest and Preparation for Market.- The wild calumba, from which the commercial root is obtained, is a herbaceous vine that is found climbing over trees in the tropical forests of eastern Africa, particularly in the regions between the Zambezi and Rovuma Rivers in Mozambique. The mean annual temperature of that region is about 80° F. and the yearly rainfall approximately 50 or 60 inches.

The root is gathered during the dry season. The part gathered consists of a short rhizome from which grow a number of more succulent fleshy roots, which are sometimes several inches in thickness. The old rhizome is discarded and the roots are cut into transverse slices about one-half inch thick and slowly dried in the shade. When

dried, the disks of calumba root are a dull yellowish color and have roughly wrinkled brown edges. When these disks are ground into calumba powder, the color ranges from greenish brown to greyish yellow.

Both the crude dried root and the powder are frequently attacked by insects in storage. They are best preserved by keeping them thoroughly dry and by placing either carbon tetrachloride or chloroform in the storage container.

Reference.-

LLOYD, JOHN URI.

1898. JATEORHIZA CALUMBA. West. Drug. 20: 8-11, illus.

CAMPHOR

Botanical Source.- *Cinnamomum camphora* (L.) Nees and Eberm. Fam. Lauraceae.

Habitat.- Southeastern Asia and Japan. Introduced as a shade tree into the southern United States, where its commercial growing as a source of camphor was attempted but was not an economic success.

Nature of Plant.- Tree.

Parts Used.- Gum and oil obtained from wood, leaves, and twigs.

Commercial Uses, Sources, and Importance.- Camphor has a wide variety of uses. It is employed in a number of pharmaceutical preparations. The largest quantities of camphor, however, are consumed in the manufacture of nitrocellulose products, such as celluloid, photographic film, and smokeless powder. Although today the largest part of the world's supply of camphor is produced synthetically, *Cinnamomum camphora* is still an important source. Camphor oil, obtained with the camphor, is also an article of commerce.

Camphor imports into the United States, 1938-40

NATURAL, CRUDE AND REFINED

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
China	24	19	203	94	-	-
Japan	1,502,776	565,730	1,974,734	652,325	1,110,172	487,509
Total	1,502,800	565,749	1,974,937	652,419	1,110,172	487,509

SYNTHETIC

Germany	563,773	207,102	527,374	212,783	-	-
Other countries	-	-	656	180	-	-
Total	563,773	207,102	528,030	212,963	-	-

Propagation and Culture.- It is possible to raise the camphor tree in most subtropical regions where the minimum winter temperature does not fall below 15° F. and where the annual rainfall is 50 to 80 inches. Though it thrives on rich sandy loams, it is often more economical to plant the trees on poorer sandy soil.

The camphor tree can be propagated by stem or root cuttings, but seed is preferred for large-scale production. The seedbed should be a rich, well-drained sandy loam. It should be especially weed-free because cultivation of the ground is impossible for about 3 months after planting since it takes that long for the seed to germinate. In the United States the seedbed fields were plowed and well disked about September 1.

About the middle of October the ground was disked again and seeded with freshly picked ripe seed. Much better germination is obtained if the pulp is removed from the seed.

Planting the seed in hills spaced at intervals of 1½ feet in rows 3½ feet apart makes cultivation easier after the seed has germinated. When the plants are about 2 years old and 2 to 3 feet high, they are set out in the fields. In the United States transplanting was done either in December, so that the trees were well established before the hot spring weather arrived, or in the summer in those localities where a rainy season developed at that time.

A spacing of 6 by 15 feet was found satisfactory in the United States, since it facilitated cultivation and made the formation of long hedges possible.

Harvest and Preparation for Market.- While most natural camphor was formerly obtained from the wood of mature trees 50 years old or older, the modern and cheaper method is to obtain it from the leaves and twigs of small trees from the time they are 5 or 6 years old and 7 to 8 feet high. In the United States the clipped trees eventually grew together, forming solid A-shaped hedges about 8 feet high and 8 feet across the base.

Because of the climate in most of the growing areas in the southern United States where camphor was grown, the trees have two dormant and two growing seasons a year. The first growing period extends from February to early May when rainfall is adequate. Then follows a dry period extending to the latter part of June, during which the trees are dormant. Thereafter the usual summer rains cause new growth, which continues until the middle of September, when the fall and winter dormant period begins. At the end of each growing season the hedges were clipped and the leaves and twigs taken directly to the stills, where the camphor and camphor oil were removed by distillation with steam. To permit the clippings to lie in the sun or to be exposed to dew or rain reduces their camphor content. Clipping in the United States was accomplished by a special machine developed for the purpose.

In Taiwan, when the mature trees are felled for camphor, the trunk, limbs, and often the roots are cut up into chips with a sharp adze and these chips are distilled.

Yields.- There is a wide range in the crude-camphor content of twigs and leaves, but the average is between 1.75 and 2.25 percent of the green weight. The amount of pure camphor gum in the crude product is from 75 to 80 percent, the remainder being camphor oil. In the United States the camphor content was found to be highest at the beginning of the dormant periods. Camphor hedges have been reported to yield 8 tons of green material a year per acre.

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CASSIA FISTULA

Botanical Source.- *Cassia fistula* L. Fam. Leguminosae.

Habitat.- Although native to India, *C. fistula* has been introduced to most of the tropical regions of the world.

Nature of Plant.- Tree.

Part Used.- Pulp of the fruit.

Commercial Uses, Sources, and Importance.- Cassia pulp is used medicinally because of its laxative properties. The tree is widely planted as an ornamental and is known by the common name of golden-shower. Java, Dominica, India, and Egypt are important producers. In 1939 the United States imported 45,037 pounds of pods, valued at \$884.

Harvest and Preparation for Market.- The *Cassia fistula* tree frequently grows to the height of 50 feet. It requires a warm climate and thrives only in tropical or subtropical regions. It produces large golden-yellow flowers, which make it a desirable ornamental tree. In Egypt these flowers are used as a perfume for the clothes. The fruit consists of long cylindrical dark-brown pods. A small forest of these trees in Egypt has been reported to be several centuries old.

When they are ripe the pods are collected and shipped to central markets. They are exported from the West Indies in cane baskets. The pulp of the fruit is extracted by crushing the pods, macerating them in water, and dissolving out the pulp by percolation. The liquor containing the pulp is then filtered and thickened by evaporation.

Reference.-

LANDERER, X.

1851. ON CASSIA FISTULA. Pharm. Jour. [London] 11:201-202.

CASTOR-BEAN

Botanical Source.- *Ricinus communis* L. Fam. Euphorbiaceae.

Habitat.- Native to India. Widely introduced and grown in warmer regions of the world.

Nature of Plant.- Perennial herbaceous shrubs or trees.

Part Used.- The oil expressed from the seed.

Commercial Uses, Sources, and Importance.- Castor oil has been used medicinally since ancient times, but the bulk of the oil produced is used for technical purposes. It enters into the manufacture of artificial leather and, when properly processed, it is used in dyeing cotton fabrics and in the manufacture of paints, varnishes, linoleum, and oilcloth. Formerly it was important as a lubricant of certain types of high-speed engines.

India and Brazil are the two most important producers of castor-beans, which are widely grown throughout the warmer regions of the world. The press cake is used as fertilizer.

Propagation and Culture.- While the castor-bean plant is a perennial where it is not killed by frost, it is commonly cultivated as an annual. To obtain good yields the plant must be grown on well-drained soil, preferably a silt loam of moderate fertility. Excessive nitrogen stimulates growth at the expense of seed production.

Castor-bean imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Haiti	818,035:	18,106:	326,865:	6,039:	1,321,131:	28,853
Argentina	224,000:	4,082:	- :	- :	- :	-
Brazil	113,029,831:	2,023,858:	161,926,809:	2,864,378:	163,116,892:	3,470,380
Nicaragua	- :	- :	38,693:	1,158:	674,724:	15,135
Cuba	- :	- :	45,640:	1,095:	85:	10
Portuguese Africa	- :	- :	270,824:	9,093:	226,964:	6,993
El Salvador	- :	- :	- :	- :	65,689:	1,260
Mexico	- :	- :	- :	- :	90,765:	2,001
Ecuador	- :	- :	- :	- :	101,384:	3,168
British India	- :	- :	- :	- :	71,531,064:	2,120,362
Netherlands	- :	- :	- :	- :	658,724:	16,915
Other countries	700:	117:	2,030:	324:	1,250:	175
Total	114,072,566:	2,046,163:	162,610,861:	2,882,087:	237,788,672:	5,665,252

The crop is grown in much the same way as corn. The ground should be well prepared. The seed may be planted by hand or with a corn or cotton planter fitted with special plates. It is spaced at various distances, depending on the length of the growing season. The range may be from intervals of 3 feet in rows 4 feet apart in the cooler areas to 8 feet in rows 8 feet apart in frost-free regions. Cultivation is necessary only until the plants have grown sufficiently to suppress weeds by shading.

The castor-oil plant does well at altitudes up to 5,000 feet above sea level. Regions where it is grown must have a minimum frost-free growing period of about 5 months and a minimum of about 20 inches of rain for profitable production unless irrigation is possible. Most of the moisture must be available during the early growing period. There are many varieties more or less adapted to a wide range of conditions.

Harvest and Preparation for Market.- In most places mature bean spikes are cut by hand, since no very satisfactory mechanical harvester has been designed. After the spikes are cut, they are hauled to drying sheds or sun-drying floors until the pods are dry enough to thresh. The beans of some varieties of the castor-oil plant shell out easily when the pod dries. There may even be serious loss in the fields if gathering is not done at the proper time. A simple means of threshing such beans consists of piling them on an elevated slatted floor. By occasional turning of the spikes with a fork the beans will fall out and drop through the slatting. Nondehiscent varieties, which are preferred for cultivation, require special machines to remove the beans from the hulls. After they are threshed, the beans are cleaned in a fanning mill and sacked for market.

Yields.- With favorable growing conditions in regions where a long growing season is possible, a yield of 25 bushels per acre is considered high. The oil content of the seed ranges between 35 and 55 percent, depending on varieties, maturity, and other factors.

CINCHONA

Botanical Sources.- *Cinchona officinalis* L. and *C. pubescens* Vahl. Fam. Rubiaceae. (In the literature and the trade *C. ledgeriana* Moens and *C. calisaya* Wedd. are usually considered species, but they are in fact merely forms or strains of *C. officinalis*. Likewise *C. succirubra* is no more than a form of *C. pubescens*.)

Habitat.- Ecuador, Peru, Bolivia, Colombia.

Nature of Plants.- Trees.

Part Used.- Bark of trunk, branches, and roots.

Commercial Uses, Sources, and Importance.- Cinchona bark is the source of quinine and other alkaloids used medicinally, particularly in the treatment of malaria. To a much less important extent they are used in hair tonics and in several industrial processes.

Though in recent years approximately 90 percent of the world's supply of cinchona bark has been produced in the Netherlands Indies, particularly in Java, the cinchona tree is a native of the eastern slope of the Andes Mountains of South America. Native trees in that area are still exploited and commercial plantations are now increasing.

Cinchona imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Ecuador	6,423	615	25,582	2,920	19,366	2,062
Ceylon	99	16	6,720	958	0	0
Netherlands Indies ...	1,342,564	587,673	1,984,272	851,433	5,210,074	2,271,302
Guatemala	0	0	2,100	105	135,195	10,943
Colombia	0	0	10,974	1,190	51,436	6,083
Hicaragua	0	0	0	0	2,200	220
Total	1,349,086	588,304	2,029,648	856,606	5,418,271	2,290,610

Propagation and Culture.- The cinchona is difficult to cultivate. It not only is subject to several serious diseases and other hazards but grows very slowly when it is young and most susceptible to them. The cinchona requires a well-distributed annual rainfall of about 100 inches and a mean annual temperature of about 70° or 80° F.

Though the strain or form generally referred to as *Cinchona succirubra* is capable of growing under a wider variety of soil and climatic conditions and is a hardier plant in general than the other forms of *C. officinalis*, its bark contains only 1 to 3 percent of quinine, whereas that referred to as *C. ledgeriana* may yield more than 6 percent. The first-mentioned is therefore most commonly used as rootstock and some other form of *C. officinalis*, such as that known as *C. ledgeriana*, is used as cion material.

A site for a quinine plantation should be sheltered from wind and should be on well-drained soil, rich and friable, with a high content of organic matter. Although the most desirable altitude varies with the latitude, it should fall within the range of 3,000 to 7,000 feet. The atmosphere should be humid.

Seeds are planted in nursery beds with overhead protection from direct sun and rain. The seeds are slow germinating, but most of them sprout within 3 or 4 weeks. During this time the soil must be maintained uniformly moist but not wet. The young seedlings are extremely susceptible to damping-off fungi. When they are 4 to 6 months old and 2 or 3 inches high, the plants are removed to shaded and protected transplant beds until they have grown to a height of 5 or 6 feet. During this time they are gradually accustomed to direct sunlight. When the trees have reached the proper size, they are side-grafted.

Cinchona grafts easily, and 75 to 90 percent success may be expected with good care. The grafts must be made during the rainy season but not when the rains are particularly heavy. About a year after grafting the trees should be ready to set out in the grove, where they are spaced usually 4 by 4 feet with the purpose in mind of thinning them and utilizing them as they grow.

Harvest and Preparation for Market.- Cinchona bark is gathered during the rainy season when it is easy to remove it from the tree. In the past, several methods of

harvesting the bark were used, such as careful shaving of the outerbark or partial stripping in such a way that the tree was not girdled and the bark was allowed to renew itself. The most common method followed at the present time is to uproot the whole tree in order to obtain the bark of trunk, limbs, and roots. The plantation is thinned in this way as the trees grow. In Java the tree is cut into short lengths and the bark is removed by pounding with wooden mallets. After being dried in the sun or in ovens, the bark is crushed in a mill and packed in gunny sacks. The first harvest is made when the trees are about 6 years old. Usually the whole plantation is cut by the time the trees are 10 or 12 years old.

A fine quality of bark is marketed as quills. It is obtained from trees that acquire a bushlike growth by being regularly cut back close to the roots. The sprouts are clipped and stripped of their bark, which, when dried, assumes the form of quills. The quills are carefully packed and shipped in boxes.

Yields.- In Java in areas where growing conditions have been favorable, a 10-year-old plantation will ordinarily have yielded about 8 or 9 tons of bark by the time it has been completely cleared.

References.-

POPEHOE, WILSON.

1941. ILUSTRANDO AL AGRICULTOR: CULTIVO DE LA QUINA (CINCHONA) EN GUATEMALA. Guatemala Dir. Gen. de Agr., 39 pp., illus.

STOCKDALE, FRANK.

1940. CINCHONA CULTURE IN THE NETHERLANDS EAST INDIES. East African Agr. Jour. 5: 263-286.

COCA

Botanical Source.- *Erythroxylon truxillense* Rusby and *E. coca* Lam. Fam. Erythroxylaceae.

Habitat.- Eastern slope of the Andes Mountains.

Nature of Plants.- Perennial shrubs or small trees.

Part Used.- Leaves and alkaloids extracted from the leaves.

Commercial Uses, Sources, and Importance.- Coca leaves are the commercial source of the narcotic alkaloids cocaine and tropacocaine. In South America the leaves are chewed by the Andean Indians to help them withstand fatigue and hunger. United States imports consist of two commercial varieties of coca leaf corresponding to the two botanical species:

- (1) Huanuco coca, obtained from *Erythroxylon coca*, which is grown principally in the Department of Huanuco, Peru, and in Bolivia, Brazil, Argentina, the West Indies, Ceylon, and India.
- (2) Truxillo coca, obtained from *Erythroxylon truxillense*, which is produced chiefly in northern Peru and Java.

Coca imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	: Pounds	: Dollars	: Pounds	: Dollars	: Pounds	: Dollars
Peru	389,576:	69,037:	467,534:	79,578:	657,643:	116,419
Netherlands and Netherlands Indies	74,936:	13,947:	122,646:	30,574:	172,782:	39,021
Total	464,512:	82,984:	590,180:	110,152:	830,425:	155,440

Propagation and Culture.- In south America the coca plant thrives at altitudes of 1,500 to 6,000 feet when the rainfall is about 25 inches a year and the temperature averages between 60° and 65° F. without great seasonal variation.

The great bulk of coca leaves is obtained from plantation-grown coca, although wild plants may be found the length of the eastern Andes. The principal cocals, as the plantations are called, are in the northern Yungas region of Bolivia and the Department of Huanuco in Peru.

Coca shrubs are started from seed, which in South America is usually sown in shaded nursery beds in December or January. When transplanted later, the seedlings are spaced at approximately 2-foot intervals in rows about 3 feet apart. Under good growing conditions the plant will be sufficiently developed to yield a crop of leaves at 18 months.

Harvest and Preparation for Market.- The outer branches and twigs of the coca shrub are clipped every year in March so that it always remains small and bushy. Leaves are gathered by hand pickers three times a year: in March when the clipping is done, in June, and in November. The coca plant may continue productive 40 to 50 years or more. The picking must be carefully performed so as not to injure the young leaf buds or to break the leaves themselves. As the leaves must be immediately dried in the sun after picking, the harvesting is done only in bright, dry weather. After drying, the leaves are packed in sacks or bales and transported by mules and llamas over the mountain trails to shipping points.

Yields.- An acre of coca will yield approximately 500 pounds of dried leaves a year. The March harvest accounts for nearly half of the crop.

Reference.-

REID, Wm. A.

1936. COCA, A PLANT OF THE ANDES. Pan Amer. Union Commod. of Com. Ser., No. 20, 20 pp., illus.

COCOA

Botanical Source.- *Theobroma cacao* L. Fam. Sterculiaceae.

Habitat.- South and Central America. Widely cultivated in the tropical regions of the world.

Nature of Plant.- Tree.

Part Used.- Seed.

Commercial Uses, Source, and Importance.- The cacao seed, or bean as it is often called, is the source of cocoa, chocolate, and cocoa butter. Apart from its flavor, which makes some medicines more palatable, cocoa and chocolate are important medically for their high calorie content and the stimulant theobromine that they contain. Though cacao is a native of South and Central America, it is grown on a commercial scale in the tropical regions of Africa. United States imports of cacao beans are obtained largely from Western Hemisphere sources.

Propagation and Culture.- The cacao tree prefers a rich, well-drained soil, and must be protected from direct winds. Newly planted groves should be partially shaded to protect the young trees from direct sunlight. Banana trees are often used for this purpose. Ideal growing regions have a mean annual temperature of about 80° F. and a yearly rainfall of 80 inches or more. The cacao grows best at low altitudes, preferably between 300 and 500 feet above sea level.

Cocoa imports into the United States, 1938-40¹

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Netherlands	551,801:	3,173:	-	-	-	-
Portugal	106,455:	5,447:	-	-	-	-
Costa Rica	597,750:	34,737:	3,466,230:	172,052:	4,544,048:	246,015
Guatemala	86,552:	5,658:	-	-	65,700:	3,222
Nicaragua	28,766:	1,468:	150,018:	8,691:	129,324:	7,612
Panama	4,176,940:	246,606:	7,481,092:	398,324:	7,929,182:	453,880
Panama Canal Zone	660:	66:	50,000:	4,225:	19,928:	1,017
Mexico	184,800:	7,948:	46,200:	4,851:	-	-
Trinidad and Tobago	18,672,081:	1,094,554:	7,096,556:	540,282:	13,279,478:	1,099,776
Other British West Indies:	1,884,513:	74,946:	2,285,020:	154,055:	880,000:	73,358
Cuba	619,850:	28,201:	35,483:	1,904:	-	-
Dominican Republic	53,582,726:	2,060,374:	56,745,786:	2,092,434:	46,911,888:	1,875,289
Netherlands West Indies ..	85,850:	3,932:	46,860:	2,074:	-	-
Haiti	2,420,895:	96,644:	2,616,760:	97,679:	2,464,374:	102,618
Brazil	185,404,734:	8,258,343:	203,804,786:	7,920,465:	180,303,311:	6,632,117
Colombia	847,879:	69,359:	802,859:	68,951:	587,494:	49,208
Ecuador	8,438,801:	539,809:	13,818,212:	1,031,487:	20,142,112:	1,633,493
Venezuela	10,067,291:	758,980:	13,661,834:	1,356,665:	24,358,739:	2,118,413
Ceylon	250,764:	19,270:	394,644:	23,516:	152,600:	10,528
Netherlands Indies	714,409:	93,360:	618,654:	75,198:	1,846,385:	190,004
British Oceania	9,980:	680:	110,513:	8,368:	-	-
New Zealand	567,703:	45,297:	557,241:	36,733:	1,635,749:	99,341
Union of South Africa	224,000:	9,442:	-	-	-	-
Gold Coast	79,423,565:	3,125,864:	169,281,452:	6,793,859:	271,500,550:	11,339,442
Nigeria	54,382,572:	2,176,940:	120,726,926:	4,349,027:	138,157,835:	5,500,894
Other British West Africa:	3,024,000:	112,283:	7,093,736:	286,890:	1,120,000:	52,080
Madagascar	15,403:	869:	28,650:	2,774:	-	-
Other French Africa	25,003,740:	1,175,794:	49,490,944:	2,005,970:	10,772,533:	520,252
Liberia	225,166:	13,060:	-	-	11,200:	403
Portuguese Africa	1,496,901:	75,838:	3,368,029:	176,285:	1,803,001:	113,015
Japan	-	-	500:	70:	-	-
Curacao (N. W. I.)	-	-	-	-	310,213:	12,894
French West Indies	-	-	-	-	13,420:	684
Belgian Congo	-	-	-	-	11,220:	5,103
Total	453,096,547:	20,138,942:	663,778,985:	27,612,829:	728,950,284:	32,140,658

¹ Several million pounds of prepared cocoa are usually imported every year.

Planting stock is raised from seed selected from the best yielding trees. It is taken from tree-ripened pods and planted about a week after picking in fertile, well-prepared and shaded nursery beds or in bamboo joints or baskets. The young cacao plants grow rapidly. In a few months after planting, the seedlings are set out in the fields at distances of 15 to 18 feet on the best soils. On poorer hillside land or at altitudes above 1,000 feet, a spacing of 10 to 15 feet is often sufficient. Though the cacao tree may produce fruit in 3 years, the floral buds should be rubbed off and not permitted to develop until the cacao is about 5 years old. Premature fruiting is reported to weaken the tree.

Harvest and Preparation for Market.- The cacao tree yields fruit throughout the year, although there are usually two periods annually when many pods ripen simultaneously. At the proper time the fruit is cut from the tree and piled in heaps, where it is allowed to mellow for a few days. The pods are then cracked open with wooden clubs or machetes and the cacao beans removed. The husks are frequently burned to prevent the spread of the diseases to which the plant is subject.

The beans must undergo a fermenting process before they are dried. They are often placed in plantain- or banana-leaf-lined kegs, boxes, or large vats for 2 to 8 days during which they are stirred once or twice. The cacao seeds change from a purple to a rich brown color during this process and lose their bitter unpleasant taste and become more digestible.

After being taken from the fermentation vats, the wet cacao beans are exposed to the sun on mats or drying floors, which are frequently elevated on stilts for ventilation. Several days are required for drying, during which the beans are occasionally turned. When thoroughly dry, the cacao beans are bagged and shipped.

Yields.- Yields of dried cacao beans vary widely. From 1 to 20 pounds per tree annually is about the range. An average of 1 ton of beans per acre from a good plantation may be expected.

References.-

- REID, WM. A.
1932. CHOCOLATE (CACAO) IN THE AMERICAS. Pan Amer. Union Comod. of Com. Ser., No. 18, 21 pp., illus.
- SCHWARZ, LEONARD J.
1931. COCOA IN THE IVORY COAST. U. S. Bur. Foreign and Dom. Com. Trade Prom. Ser. 125, 36 pp., illus. Washington.

COLOCYNTH

Botanical Source.- *Citrullus colocynthis* (L.) Schrad. Fam. Cucurbitaceae.

Habitat.- Asia and Africa.

Nature of Plant.- Annual herbaceous vine.

Part Used.- Fruit.

Commercial Uses, Sources, and Importance.- Colocynth is the dried pulp of the unripe fruit of *Citrullus colocynthis*, which is employed medicinally because of its drastic cathartic properties. It is obtained from both wild and cultivated plants. The principal source of the United States supply is the Anglo-Egyptian Sudan. In the central Sahara region of Africa the seed of wild *C. colocynthis* is used as an article of diet after it has been removed from the poisonous pulp. It is reported that the fruit is employed in Morocco for the purpose of protecting woolen clothing from moths.

Propagation and Culture.- Wild colocynth was well known in biblical times and has been cultivated on the island of Cyprus since the fourteenth century. It is reported to grow where the mean annual temperature is from 75° to 80° F. and the yearly rainfall ranges from 10 to 15 inches. It thrives on sandy loam semidesert soils. The plant is easily cultivated, since it grows rapidly and requires no attention after the fields have been sown. In most regions where it is native, the crop is harvested from wild plants.

Harvest and Preparation for Market.- The fruit, which is round and about the size of a small orange, is gathered when it is fully grown but still unripe. It acquires a yellow color as it ripens. After the fruit is picked, its thin, hard, gourd-like outer rind is removed and the inner white spongy pulp, which is heavily loaded with seeds, is dried in the sun or in ovens. The seeds constitute about 75 percent of the weight of the dried product.

Commercial colocynth usually occurs in one of two forms: As pulp from which most of the seed has been separated and as bitter apples, or masses of pulp loaded with seeds that have been rolled into balls. Both forms are ordinarily shipped in boxes.

References.-

- LLOYD, JOHN URI.
1898. CITRULLUS COLOCYNTHIS. West. Drug. 20: 243-246, illus.
- WALLACE, EDWIN S.
1895. THE COLOCYNTH PLANT. U. S. Cons. Rpt. Jan. 15, 1895. Jerusalem. [Typewritten.]

COPAIBA

Botanical Source.- *Copaifera lansdorffii* Desf. and other species of *Copaifera*.
Fam. Leguminosae.

Habitat.- Brazil and northern South America.

Nature of Plants.- Tree.

Part Used.- Oleoresin obtained from trunk of tree.

Commercial Uses, Sources, and Importance.- Copaiba has a number of medicinal uses. Brazil and Colombia are the principal sources of this oleoresin.

Copaiba imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Brazil	196,169	30,244	212,302	33,905	203,920	36,078

Harvest and Preparation for Market.- Copaiba is obtained from wild trees, some of which are 100 feet tall. The regions where the tree is found have an annual rainfall of about 70 inches or more and a mean yearly temperature of about 80° F. The wood of the tree is honeycombed with a network of connected cavities in which the oleoresin forms. To tap the tree, a drainage reservoir is hollowed out near its base by cutting inward and downward into the center of the trunk. The cavities containing the oleoresin gradually drain into these hollowed-out wells. This process is repeated several times during the season. When first obtained, copaiba is thin and clear but on aging becomes thicker and acquires a yellowish tinge.

The most important commercial types of copaiba are Maracaibo and Pará, being named for the ports of shipping. It is usually exported in kegs, barrels, demijohns, or cans.

Yields.- The amount of oleoresin obtained from each tree varies considerably, but it has been reported to be as high as 14 gallons.

CROTON OIL

Botanical Source.- *Croton tiglium* L. Fam. Euphorbiaceae.

Habitat.- India, China, Ceylon, Philippines, and East Indies.

Nature of Plant.- Small tree or shrub.

Part Used.- Oil obtained from the seed.

Commercial Uses, Sources, and Importance. Croton oil is used medicinally because of its strong cathartic qualities. Croton seeds are frequently processed for their oil in Europe, most of the commercial supply of seed being obtained from Ceylon and India.

Croton-oil imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Germany	931	789	1,753	1,498	-	-
United Kingdom	1,186	952	900	672	2,972	3,132
Total	2,117	1,741	2,653	2,170	2,972	3,132

Preparation for Market. *Croton tiglium* is a dry-land plant found growing wild in many regions of the Far East. The oil, which is expressed from the seed of this plant, is a powerful irritant poison and should not be allowed to come in contact with the hands or any part of the body or even the clothing. It is extracted by presses.

Reference.-

WEYNTON, O.

1887. THE COMMERCIAL PRODUCTS OF SIAM [ASSAM] Pharm. Jour. [London] 18:144-147.

CUBEB

Botanical Source.- *Piper cubeba* L. f. Fam. Piperaceae.

Habitat.- East Indies.

Nature of Plant.- Perennial climber.

Part Used.- Fruit.

Commercial Uses, Sources, and Importance.- Cubebs are the dried unripe fruit of *Piper cubeba*, formerly used as a spice. Because of their stimulating effect on mucous membranes, preparations of cubebs have a number of medicinal uses. They are employed in the manufacture of cigarettes for the relief of asthma. An essential oil of pharmaceutical value is distilled from the fruit. Cubebs are grown in the Far East and the West Indies.

Cubeb imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Netherlands Indies ...:	40,240	9,707	26,312	6,254	19,705	4,905
British Malaya	2,267	369	-	-	-	-
Total	42,507	10,076	26,312	6,254	19,705	4,905

Propagation and Culture.- *Piper cubeba* is a distinctly tropical plant, requiring an annual rainfall between 80 and 100 inches and a mean yearly temperature of about 80° F. It is a dioecious climbing vine, the cultivation of which is similar to that of ordinary black pepper. Wherever it is planted, trees are necessary to provide shade and to support the vine growth of the cubeb plant. In Java, where there are a number of cubeb groves, it is a common practice to set the vine at the base of shade trees in coffee plantations.

The best soil for cubeb production is a fairly level, rich, friable loam with a high content of organic matter. The plant may be propagated by cuttings or from seed.

Harvest and Preparation for Market.- Cubebs are small round berries about one-fourth of an inch in diameter, which grow in clusters on fruiting branches. The crop is harvested when the cubebs are fully grown but not ripe. They are stripped from the vine and dried in the sun. The drying process causes the fruit to wrinkle somewhat and to change from green to a dark gray.

Reference.-

Kew ROYAL BOTANICAL GARDENS.

1887. CUBEBS. (PIPER CUBEBA, L.) Kew Roy. Bot. Gard. Bul. Misc. Inform. 1887(12): [1]-4, illus.

ERGOT

Botanical Source.- *Claviceps purpurea* (Fries) Tul. Fam. Hypocreaceae.

Habitat.- Grain-growing regions of the world.

Nature of Plant.- Fungus.

Part Used.- Sclerotia.

Commercial Uses, Sources, and Importance.- The toxic effects of ergotized grain on man and animals have been known since ancient times. Ergot is used medicinally in certain obstetric cases. Portugal, Spain, and the Soviet Union are the principal commercial sources of ergot, but fungus causes some damage to rye in all grain-growing regions. In the United States, if not obtainable from the usual sources, it is picked out of rye or grain screenings.

Ergot imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Bulgaria	613	337	-	-	-	-
Germany	20,102	25,490	3,563	4,189	-	-
Hungary	1,984	1,974	4,925	7,047	15,692	34,735
Poland and Danzig	11,211	9,842	11,412	10,945	-	-
Portugal	81,188	102,289	66,302	111,029	251,414	364,898
Spain	15,887	19,722	3,840	5,107	30,924	74,898
United Kingdom	13,776	18,048	6,720	8,400	2,205	2,720
Rumania	-	-	1,008	1,282	4,481	10,852
Belgium	-	-	-	-	9,503	24,196
Total	144,761	177,702	97,770	147,999	314,219	512,299

Harvest and Preparation for Market.- Individual rye flowers are infected by ascospores of the fungus *Claviceps purpurea* borne by wind or insects. The infected flower does not produce a normal seed but a sclerotium, consisting chiefly of the fungus and the outer coat of the grain. The sclerotia are about two to three times the length of the normal grain and dark brown or black in color.

Ergot may be gathered by hand in the field or picked out of grain screenings that remain after the rye is threshed and cleaned. It deteriorates in storage unless it is thoroughly dried and placed in airtight containers. Stored ergot is sometimes attacked by insects, which can be destroyed by adding small amounts of carbon tetrachloride or chloroform at the time the crude material is sealed in storage containers.

GAMBIR

Botanical Source.- *Uncaria gambir* (Hunter) Roxb. (*Ourouparia gambir* (Hunter) Baillon). Fam. Rubiaceae.

Habitat.- Southeastern Asia.

Nature of Plant.- Perennial climbing shrub.

Part Used.- Extract of leaves and twigs.

Commercial Uses, Sources, and Importance.- Gambir is widely used as a tanning material and is employed medicinally as an astringent. It is obtained from both wild and cultivated plants. Malaya and the Netherlands Indies produce most of the world's supply.

Gambir imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
British Malaya	1,244,883	74,255	1,780,720	106,719	1,641,257	93,852
Netherlands Indies ...	1,740,511	122,618	3,781,299	275,362	3,329,006	250,023
Nigeria	4,500	135	-	-	-	-
Total	2,989,894	197,008	5,562,019	382,081	4,970,263	343,875

Propagation and Culture.- The gambir shrub may be propagated either by seed or by cuttings. When seed is used, it must be sown in comparatively weed-free nursery beds, as it requires about 3 months to germinate. The gambir prefers a deep rich well-drained soil and produces best when rains are frequent. Most successful growing areas have a mean annual temperature of about 80° F. and a yearly rainfall of 80 inches or more. The gambir plants grow quickly and are moved to the field when they are about 9 inches high. A spacing of 8 to 12 feet each way is adequate.

A small crop of leaves may be clipped from the plants at the end of their first year in the field. Large yields are obtained at 18 months. At 2 years the plants are mature and produce a heavy foliage. While the gambir shrub has been reported to produce well for 20 to 30 years, the average plant becomes unprofitable after about 10 years.

Harvest and Preparation for Market.- While the gambir may be trimmed of its leaves and branches every 6 months or sometimes even as frequently as four times a year, the cutting should not be so severe as to injure the plant. When removed from the shrub, the leaves and young shoots are cut up, covered with water, and boiled for about an hour in an iron pan heated by direct fire. The leaves are then removed to a drainboard, and the boiling of the water and extract is continued. Liquor draining from the leaves on the drainboard trickles back into the boiling pot. When boiled down to a sirupy thickness, the water extract is poured into shallow wooden tubs. While cooling, it is churned until it solidifies into blocks, which have a claylike color. Before the second batch of leaves is extracted, those on the drainboard are immersed in fresh water and boiled again to remove their last traces of gambir. The next batch of leaves and twigs are extracted in this rinse water.

Yields.- Annual production is from 150 to 200 pounds of dried gambir per acre.

Reference.-

KEW ROYAL BOTANICAL GARDENS.

1889. GAMBIER. (UNCARIA GAMBIER, ROXB.) Kew Roy. Bot. Gard. Bul. Misc. Inform.
1889: 247-253.

GAMBOGE

Botanical Source.- *Garcinia hanburyi* Hooker f. Fam. Guttiferae.

Habitat.- Thailand and French Indochina.

Nature of Plant.- Tree.

Part Used.- Gum resin.

Commercial Uses, Sources, and Importance.- Gamboge was at one time an important cathartic. It is now seldom used in the United States.

Harvest and Preparation for Market.- The name "gamboge" is derived from Cambodia, where much of the drug is obtained. The annual rainfall of the region where the tree

is found is from 60 to 70 inches, and the mean yearly temperature approximately 80° F. The gum resin is gathered during the rainy season by making cuts in the larger branches as well as a spiral incision in the bark of the trunk from the ground to a height of about 10 feet. In the cortex and phloem of the tree there is a network of resin canals filled with the yellowish gamboge emulsion. This material flows from the wounded bark down the incisions into bamboo joints placed so as to collect it. From the collection receptacle the gamboge is poured into smaller bamboo joints, in which it gradually solidifies. This process is sometimes hastened by heating. The hardened material is removed from the bamboo containers by heating them over fires until the wood splits and can be peeled off. Gamboge trees are not tapped until they are about 10 years old.

Commercial types of gamboge are known as pipe, cake or lump, and coarse. Pipe, which is the best quality, is obtained from the clear emulsion dried in bamboo joints. Cake gamboge is made up of irregular masses of about 2 pounds in weight. The coarse is a low-grade material.

GOA POWDER

Botanical Source.- *Andira araroba* Aquiar (*Vouacapoua araroba* (Aguiar) Druce).
Fam. Leguminosae.

Habitat.- Brazil.

Nature of Plant.- Tree.

Part Used.- Powder obtained from the wood.

Commercial Uses, Sources, and Importance.- Goa powder, also known as araroba, is the source of chrysarobin, which has long been used as an ingredient in certain skin ointments. Brazil is reported to be the only commercial source of this material.

Harvest and Preparation for Market.- The *Andira araroba* from which the goa powder is obtained grows wild in the damp forests of Bahia, Brazil, where the average annual rainfall is about 75 inches and the mean yearly temperature nearly 80° F. The trees must be cut down to obtain the powder, which forms in cavities in the yellow wood. The trees, which grow as high as 100 feet, are felled and sawed into logs. These are split into smaller pieces to expose the cavities containing the yellow powder. The latter is extracted by scraping the irregular interspaces with an axe. The powder is dried, sieved to remove wood splinters, and powdered. When freshly prepared, araroba is pale yellow, but it gradually darkens with age.

GUARANA

Botanical Source.- *Paullinia cupana* H.B.K. Fam. Sapindaceae.

Habitat.- Amazon Valley, Brazil; Orinoco Valley, Venezuela.

Nature of Plants.- Climbing shrubs.

Part Used.- Paste prepared from crushed seed.

Commercial Uses, Sources, and Importance.- Guarana usually contains over 4 percent caffeine and 5 percent tannin. It is used medicinally and as a source of caffeine. It is employed in Brazil as an ingredient in a stimulating tonic beverage. Brazil produces about 80 metric tons of guarana paste a year and exports approximately 50 metric tons.

Culture and Propagation.- Guarana is obtained from both wild and cultivated sources. Since seeds require about 3 months to germinate, cultivated guarana is usually propagated by shoots. These young shoots are spaced about 20 feet apart and a triangular wooden bower is built over each to provide support for the climbing vine. Planting is usually in February or March. The guarana plant blossoms and produces a small quantity of fruit at 3 years of age. Production increases with maturity, and the vine lives about 40 years.

Although *Paullinia cupana* was originally a swamp creeper, it has been more successfully grown on well-drained black sandy soil. The plant does not do well when cultivation is attempted on yellow clay soils.

Harvesting and Preparation for Market.- The small guarana fruits, which grow in clusters like grapes, are picked in October, November, and December after they have ripened. As soon as the berries are harvested, they are thoroughly soaked in water and passed over a sieve to remove the seed from the white pulp that surrounds them. The seeds are then placed in the sun to dry. After drying, the seeds are immediately baked to prevent fermentation, which sets in rapidly after the fruit is picked from the vine. The roasting over a slow fire in clay ovens must be skillfully performed so that all seeds are equally toasted and not burned.

When the roasted seeds are removed from the ovens they are separated from their dry, paper-thin shells by rubbing them in the palm of the hands or by placing them in sacks and beating them with clubs. Afterwards the kernels are macerated in a mortar with a wooden pestle. The coarse powder produced is mixed with a little water and kneaded into a paste, which is shaped into cylindrical loaves about 1 inch in diameter and 6 inches long, weighing about half a pound each. To preserve them these cakes are dried and smoked for about 60 days in an open-fire drying house, where they acquire a dark chocolate-brown color and a metallic hardness. Crude guarana is sold on the market in this form.

Yields.- The yield of a mature guarana vine is 6 or 8 pounds of seeds a year.

References.-

- AGAN, JOSEPH E.
1920. GUARANÁ. Pan Amer. Union Bul. 51:268-275, 111us.
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GUM ARABIC

Botanical Source.- *Acacia senegal* Willd., and other African species of *Acacia*. Fam. Leguminosae.

Habitat.- Africa north of the Senegal River and in the upper Nile region.

Nature of Plants.- Small trees.

Part Used.- Gum exuded from the stem and branches.

Commercial Uses, Sources, and Importance.- Gum arabic has several important medicinal uses based on its colloidal properties. It is most commonly employed as a demulcent. The Anglo-Egyptian Sudan is the principal source of gum arabic, although considerable quantities are obtained from French West Africa.

Propagation and Culture.- *Acacia senegal* is a small thorny tree, which grows to a height of 10 or 15 feet. Though most of the trees are found growing wild in the

Gum arabic imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Egypt	8,699,589	537,129	9,080,300	624,894	13,891,750	911,158
French Africa	35,618	2,673	116,624	9,635	142,036	9,542
Nigeria	-	-	-	-	19,218	1,137
British East Africa ..	-	-	-	-	1,970	125
Other countries	240	112	2,699	81	441	50
Total	8,735,447	539,914	9,199,623	634,610	14,055,415	922,012

sandy soils of the semiarid thorn desert regions, they are often planted after cultivated crops in order to restore the productivity of the soil. The tree, which possesses a long taproot and extensive laterals, will grow on the poorest kind of desert soil. In Kordofan Province it grows on the red sand hills, some of which may contain no more than 8 percent silt and clay. The mean annual temperature there is about 75° F., and the variable yearly rainfall is between 8 and 18 inches. Practically all of the rainfall comes during the 5- or 6-month summer period.

Plantations are best established by burning over the land to eliminate grass competition. Seed that has been soaked in water for several hours is then scattered over the burned area. Reseeding is often necessary to obtain a full stand. Frequently the tree will grow from naturally dispersed seed if cultivated fields are abandoned. It will even invade poor sod lands and is considered a splendid plant to stabilize shifting sand dunes. The tree requires practically no attention after it has grown beyond danger of competition from grass. After 5 or 6 years it is ready for exploitation; and, if it is carefully tapped, it will live as long as 25 years.

Harvest and Preparation for Market.- The best gum arabic is produced by wild and plantation-grown trees in the Kordofan region. During the dry season from October to May the trunks and branches of the trees are wounded without injury to the cambium by removing strips of bark 1½ to 3 feet long and 1 to 2 inches wide. For a period of 2 to 4 weeks after stripping a viscus liquid exudes from the wounded tree and slowly hardens into tears of gum arabic. The gum exudes in greatest quantities when the weather is very hot. It ceases to form when the rainy season begins. The tears are gathered by the natives, who pick them from the trees. The gum is later spread in the sun to bleach. It is separated from adhering bark or sand, sorted, bagged, and transported by camel caravans to shipping points.

There are two principal commercial varieties of gum arabic: Kordofan, Gedaref, or Arabian gum, which is the finest, and Senegal or West African gum. Both of these are obtained from *Acacia senegal*.

Yields.- The annual yield of gum varies greatly. The average for young trees is about 900 grams and for old trees about 2,000 grams. Variations of from 188 to 2,856 grams in young trees and from 379 to 6,754 grams in old trees have been reported.

Reference.-

BLUNT, H. S.
1926. GUM ARABIC, WITH SPECIAL REFERENCE TO ITS PRODUCTION IN THE SUDAN. 45 pp.,
illus. Oxford University Press.

GUM TRAGACANTH

Botanical Source.- *Astragalus gummifer* Labill., and other Asiatic species of *Astragalus*. Fam. Leguminosae.

Habitat.- Iran and Asia Minor.

Nature of Plants.- Shrubs.

Part Used.- Gum.

Commercial Uses, Sources, and Importance.- Tragacanth gum has a wide number of medicinal uses, based largely on its colloidal properties. Considerable quantities are employed for general emulsifying and thickening purposes and in the preparation of troches. It has numerous technical uses, particularly in calico printing. World production is centered in Iran and Asia Minor.

Tragacanth imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Soviet Union	359,261	79,981	23,025	4,318	-	-
British India	8,122	5,339	-	-	95,152	25,703
Iran	649,434	467,786	2,917,616	1,195,400	3,323,680	1,446,847
Iraq	30,895	21,608	1,321	140	242,161	194,963
Turkey	19,559	14,210	90,241	46,233	35,973	20,182
Other countries	6,829	5,653	32,473	17,868	15,750	4,473
Total	1,074,100	594,577	3,064,676	1,263,959	3,712,716	1,692,168

Harvest and Preparation for Market.- Tragacanth gum is collected from wild shrubs, which grow in out-of-the-way places in those regions where the plant is native. Often, however, the gum gatherers must obtain concessions from the local authorities to make their harvests.

To get at the trunk of the shrub without being severely scratched, the collector cuts away the thorny branches. Deep incisions are made in the trunk of the plant just above the root. The gum gradually exudes over a period of days and hardens as it does so. If short incisions are made, the gum hardens in the form of threads; whereas, if the cuts are long, the gum runs together into lumps or tears. The root of the tragacanth shrub will also yield the gum; so often it, too, is cut at the crown.

The collected gum is sorted into three grades: White, blond, and yellow, which are sometimes qualified by such adjectives as "extra" and "regular." The gum is harvested during the hottest weather, and the cutting process is usually repeated several times. It is reported that the gum from the first cutting is white, and that it becomes progressively yellower with successive cuttings.

The quality of the gum is said to be distinctly affected by the environment, with the best obtained from the mountainous region of central Turkey and Kurdistan, where the mean annual temperature is about 60° F. and the average yearly rainfall is from 10 to 15 inches. The best grade of tragacanth is shipped in cases, whereas inferior grades are packed in bags.

Reference.-

JACOB DE CORDEMOY, [HUBERT].

1911. LES PLANTES À GOMMES ET À RÉSINES. 412 pp., illus. O. Doin et fils, Paris.

HENNA

Botanical Source.- *Lawsonia inermis* L. Fam. Lythraceae.

Habitat.- Northern Africa and southern Asia.

Nature of Plant.- Perennial evergreen shrub.

Part Used.- Leaves, flowers, and roots.

Commercial Uses, Sources, and Importance.- Henna leaves are the source of a golden-yellow stain used in hair dyes of that name. They are also credited with some medicinal properties. The flowers are the source of a volatile oil, which is reported to be used in certain countries in cosmetics. The chief sources of supply for the United States are Egypt and India. Henna is also cultivated in Libya and in a minor way as an ornamental in the West Indies, Florida, and California.

Henna imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
British India	14,615	522	16,910	779	85,340	3,807
Iran	1,818	216	-	-	-	-
Egypt	360,141	16,096	384,704	17,920	348,014	18,685
Total	376,574	16,834	401,614	18,699	433,354	22,492

Propagation and Culture.- The most successful henna plantations are on irrigated land where the crop can be watered every 4 to 7 days during the growing season. The mean annual temperature of the best growing regions is between 60° and 70° F. Commercial henna is propagated by seed and cuttings, depending on the preference of the growers. In Libya when seed is used it is planted in nursery beds, which are kept well-watered. In the spring the young seedlings are transplanted to the fields, where they are set at intervals of 1½ feet in rows 1½ feet apart. Cuttings used in Egypt consist of new sprouts clipped from mature plants. They are planted directly in the fields. The most desirable soil for henna is well-drained sandy silt loam. If kept properly weeded and trimmed, a henna field will produce well for 10 or even 20 years.

Harvest and Preparation for Market.- Henna plants are not cut until they are 2 years old. In Libya harvest takes place semiannually. The whole plant is cut off near the ground and dried in the sun. After drying, the leaves are removed and ground into the commercial henna powder. When the roots of old henna plants are eventually pulled from the soil, they too are dried and ground into a powder, which is also used as a dye material.

Yields.- Depending on growing conditions and the possibility of two harvests annually, yields of dried leaf range from 1,000 to 2,000 pounds per acre.

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1910. LA CULTURE DU "HENNÉ" ET DU "SÉSAME." Union des Agr. d'Égypte, Bul. 6(63): 38-41.

IPECAC

Botanical Source.- *Cephaelis ipecacuanha* (Brot.) A. Rich. and *C. acuminata* Karst. Fam. Rubiaceae.

Habitat.- Brazil, Colombia, Bolivia, Venezuela, and Central America.

Nature of Plants.- Perennial herbaceous shrubs.

Parts Used.- Dried rhizome and root, the cortex of which contain most of the active ingredients.

Commercial Uses, Sources, and Importance.- Ipecac has amoebicidal and emetic qualities and is one of the important drugs imported by the United States.

Ipecac imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Brazil	5,539	8,083	12,519	14,582	52,436	77,746
Colombia	756	756	-	-	-	-
Costa Rica	9,153	9,404	13,685	12,172	50,889	48,070
Nicaragua	44,852	35,559	41,506	34,110	46,555	40,197
Total	60,300	53,802	67,710	60,864	149,880	166,013

Culture and Propagation.- Most ipecac is obtained from wild sources, although the British have succeeded in cultivating the plant in Malaya. It requires a deep, moist, friable topsoil with a high humus content and a clay subsoil. A dense shade must be provided. It is a tropical plant and is found in regions where the rainfall is between 60 and 80 inches or more annually.

When the plant is gathered in the wild, enough root and rhizome usually remains in the ground to produce a new plant. Under cultivation, root or rhizome cuttings are spaced from 1 to 4 feet apart in soil that has been thoroughly loosened to a depth of a foot and a half or more. Ipecac is very slow growing, requiring 2 to 4 years to attain a marketable size, at which time it should have developed 10 or 12 good roots weighing 3 or 4 ounces when dried.

Harvesting and Preparation for Market.- Ipecac may be gathered at any time of the year but harvesting is usually suspended during periods of heavy rainfall because of the difficulty of drying the roots properly. Wild ipecac is gathered by natives, who grasp all the stems of a clump of the plant, pry with a sharp pointed stickshoved under the roots, and then tear the plant from the soil. The roots are shaken free of dirt, stuffed into a bag, and sorted at night. The roots are dried in the sun for several days, being protected at night from the dew. When sufficiently dry, they are broken into small pieces, separated from any remaining dirt by being passed over sieves, and finally packed in shipping bags. Ipecac is exported to the United States in bales.

Yields.- In Malaya, where ipecac has been grown on new rubber plantations, yields of 50 to 60 pounds per acre have been reported. Theoretical yields, calculated from greenhouse experiments, are as high as 600 pounds per acre.

JABORANDI

Botanical Source.- *Pilocarpus jaborandi* Holmes, *P. microphyllus* Stapf, and other species of *Pilocarpus*. Fam. Rutaceae.

Habitat.- *P. jaborandi* and *P. microphyllus* are both natives of Brazil. Plants of the genus *Pilocarpus* are widely distributed in tropical and subtropical America.

Nature of Plants.- Woody shrubs.

Part Used.- Leaves.

Commercial Uses, Sources, and Importance.- The leaves of the *Pilocarpus* are the crude drug jaborandi. The principal alkaloid, pilocarpine, contained in this drug produces certain physiological reactions opposite to those of atropine. South American

countries, Brazil in particular, are producers of jaborandi. In 1939 the United States imported 87,615 pounds of leaves, valued at \$3,112.

Harvest and Preparation for Market.- *Pilocarpus jaborandi* is found in north-eastern Brazil, particularly in the States of Ceará and Piauí, where the mean annual temperature is about 80° F. and the yearly rainfall ranges from 25 to 50 inches. The shrub grows to a height of 5 or 10 feet and is found on hillsides or in openings in the forest. It is reported that the leaves lose most of their pharmaceutical properties after the rainy season. In the spring they are most effective and are usually collected at that time.

Reference.-

HARDY, ERNEST.

1876. LE PILOCARPUS PINNATUS (JABORANDI). Soc. Natl. d'Agr. de France, Bul. 23: [671]-683.

JALAP

Botanical Source.- *Ipomoea purga* (Wender.) Hayne (*Exogonium jalapa* (Nutt. and Coxe) Baillon). Fam. Convolvulaceae.

Habitat.- Mexico.

Nature of Plant.- Herbaceous perennial vine.

Part Used.- Root.

Commercial Uses, Sources, and Importance.- Jalap root was used as a laxative by the Indians of Mexico before the Spanish conquest. It was one of the first drug plants introduced to Europe from the Western Hemisphere. Mexico is the major source of the wild root, but the drug is cultivated in India. The name of the plant is derived from that of the city of Jalapa in the State of Vera Cruz, Mexico.

Jalap imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Mexico	89,549	8,807	39,224	3,729	116,433	21,305
	:	:	:	:	:	:

Propagation and Culture.- Jalap is cultivated on a commercial scale near Calicut, India. It may be propagated with seed and with root or stem cuttings. The ground selected for jalap should be sheltered from winds. Growth of the plant is said to be best at altitudes of 4,000 to 4,500 feet in India. Mexican wild jalap, which grows along the eastern slopes of the Sierra Madres, is found at altitudes between 5,000 and 8,000 feet. The most desirable soil is a fertile, well-drained, friable sandy loam. Planting takes place at the beginning of the rainy season. Jalap prefers a mean annual temperature of about 65° F. and a yearly rainfall of about 65 inches.

The fields where jalap is to be grown should be carefully worked up and then ridged. Cuttings are planted several inches deep at 2-foot intervals on the ridges, which are about 3 feet apart and several inches high. The ridging provides adequate drainage for the young plants. If the rains fail before the roots are well started, watering is necessary. Since jalap is a climbing vine, supporting wires or trellises should be provided for the plants. The stems die down annually, but the roots produce new growth after a 2- or 3-month dormant period.

Harvest and Preparation for Market.- The roots of the jalap plant are usually dug and dried after they are several years old. They may be dug at any season of the year. Because of the succulence of the roots, they are difficult to dry in the sun before they begin to mold. Drying with artificial heating is usually resorted to after the roots have been thoroughly cleaned. In Mexico they are dried in nets stretched above the hearth in the homes of the gatherers. Large roots are cut lengthwise so as to facilitate the escape of moisture. Smoke permeates the jalap, giving it a characteristic odor. When ready for shipping, the roots are packed in bales.

Yields.- In India an acre of 3-year-old plants yields about 1,000 pounds of dried roots.

Reference.-

WATT, GEORGE.
1890. THE JALAP PLANT. In A Dictionary of the Economic Products of India, v. 4,
pp. 488-491.

KINO

Botanical Source.- *Pterocarpus marsupium* Roxb. Fam. Leguminosae.

Habitat.- India and Ceylon.

Nature of Plant.- Tree.

Part Used.- Gum obtained from the trunk.

Commercial Uses, Sources, and Importance.- Kino has a number of medicinal uses because of its astringency. Only very small quantities are used in the United States. India and Ceylon are the most important producing countries.

Harvest and Preparation for Market.- *Pterocarpus marsupium* is a large deciduous tree of southern and central India and of Ceylon. It is found in greatest numbers in the north Malabar district of Madras Presidency. The rainfall of the areas where it is found is quite variable, but the mean annual temperature is about 80° F.

The best time for collecting kino is in the dry weather during February and March. When the tree is tapped during the rainy season, the gum is of inferior quality. V- or fishbone-shaped incisions 1 to 1½ feet long are made with an axe or knife through the bark to the cambium. A joint of bamboo or other receptacle is attached to the bottom of the incision. The gum ceases to flow after about 24 hours, and the bamboo cups are collected. The juice flows more readily at night than during the day. It is a good practice to tap the trees only every 2 years.

The collected juice is poured into a large cauldron and boiled. During the boiling, impurities, such as bark, wood, and leaves, rise to the top and are skimmed off. When the juice is thick, it is poured into shallow vessels and exposed to the sun until it is dry and hard. It is then broken into pieces and packed in wooden boxes. A system of shade drying has also been developed by which the trays are arranged on shelves in a bamboo shelter. Muslin is used to cover the doors of the shelter to prevent dust from covering the product.

Yields.- The yield per tree has been reported to average three-quarters of a pound of dried gum.

Reference.-

HOOPER, D.
1901. MALABAR KINO: ITS COLLECTION, COMPOSITION AND TRADE. Agr. Ledger 8: 377-
392, illus.

KOLA NUT

Botanical Source.- *Cola nitida* (Vent.) Chev. and other species of *Cola*. Fam. Sterculiaceae.

Habitat.- Western Africa.

Nature of Plants.- Trees.

Part Used.- Seed.

Commercial Uses, Sources, and Importance.- Kola nut is important for its caffeine content and flavor. Its principal use in the United States is in the manufacture of nonalcoholic beverages. In the tropical regions where it is grown, the fresh nut is chewed as a stimulant. The tree is valued for its wood and is planted as an ornamental. Though most kola nuts are harvested from wild trees of the West African coast, the United States imports most of its kola nuts from Jamaica. In 1939 total imports into the United States amounted to 347,159 pounds, valued at \$13,248.

Propagation and Cultivation.- The kola tree flourishes where the mean annual temperature is between 70° and 80° F. and the yearly rainfall is 100 inches or more. It is found at low altitudes ranging up to several hundred feet above sea level. On English plantations in Jamaica the trees are propagated from seed and are planted 20 feet apart each way. They come into bearing when they are 5 or 6 years old, and produce two crops of nuts each year. *Cola nitida* will grow 40 to 60 feet high and will produce good crops of nuts for over 50 years. The tree responds to fertilizers and produces the highest yields only when weeds are cut back regularly. It prefers a deep sandy loam soil with a high content of organic matter.

Harvest and Preparation for Market.- The harvests of kola nuts in Jamaica are made twice a year when the pods ripen, in May and June and again in October and November. The chocolate-colored pods, which are 2 to 4 inches long, are shaken from the trees and immediately gathered. The seeds are removed from the pods and the first coat is cut off, leaving bare cotyledons. The nuts are then very carefully graded, since only those that are sound and of the best quality will not deteriorate quickly. Fresh kola nuts tend to mold and spoil easily. They are packed and transported for local consumption in home-made baskets lined with leaves and wrapped with canvas or hide to prevent drying out. Kola nuts imported by the United States are split in half, sun-dried, and shipped in bags.

Yields.- After it is 10 years old, the kola tree may be expected to yield in two harvests about 125 pounds of dried nuts a year.

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KRAMERIA

Botanical Source.- *Krameria triandra* Ruiz and Pav. and *K. argentea* Martius.
Fam. Leguminosae.

Habitat.- South America.

Nature of Plants.- Shrubs.

Part Used.- Root.

Commercial Uses, Sources, and Importance.- Krameria, or rhatany root as it is commonly called, has a number of medicinal uses based on its astringent qualities. It is obtained from wild plants in several South American countries. The United States imported 39,361 pounds, valued at \$1,458, in 1939.

Harvest and Preparation for Market.- *Krameria triandra*, or Peruvian rhatany, grows on loamy as well as sandy soils. It is commonly found in the southern Provinces of Peru and in Bolivia where the mean annual temperature is about 55° F. and the yearly rainfall is between 10 and 20 inches. Krameria is dug and dried after the rains. The Peruvian root is tough and woody. The larger pieces have a rough scaly bark. The bark of *K. argentea*, or Pará rhatany root, is deeply checked but not scaly.

MANNA

Botanical Source.- *Fraxinus ornus* L. Fam. Oleaceae.

Habitat.- Southern Europe.

Nature of Plant.- Tree.

Part Used.- Saccharine exudate.

Commercial Uses, Sources, and Importance.- Manna is used medicinally because of its mild laxative qualities. It is also the source of the sugar mannite. Though the wild *Fraxinus ornus* is widely distributed over southern Europe, the tree is extensively cultivated only in Sicily, where the annual production of manna totals about 750 tons.

Manna imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Italy	18,294	2,907	30,001	7,536	19,781	5,241
Other countries	-	-	466	133	-	-
Total	18,294	2,907	30,467	7,669	19,781	5,241

Harvest and Preparation for Market.- In Sicily commercial groves are established on both fertile and rocky soils. Coastal areas near Palermo have been reported to be the best sites. This region has a mean annual temperature of between 60° and 65° F. and a yearly rainfall of about 30 inches.

Manna exudes spontaneously during dry hot weather, but its flow is increased by cutting short oblique slits in the bark up and down one side of the trunk. As the manna forms it hardens into tapered candlelike pieces, which are picked from the bark. During rainy weather manna often continues to flow, but, being more watery, it drips to the ground where it is collected in crude receptacles. In Sicily the manna harvest is made between July and October. Young trees are not tapped until they are 6 to 10

years old; thereafter the operation is repeated annually. Each year the manna tree is tapped the oblique incisions are made in the bark on the opposite side of the trunk from that exploited the previous season.

The manna tree will yield well for 4 to 12 years under this treatment. When production becomes uneconomical the trunk is cut back and sprouts are permitted to develop from the stump. In another 6 to 10 years the same process is repeated. The tree is said to live as long as 100 years under this system of management.

The two principal commercial grades of manna are known as flake and sorts. Flake manna, picked from the bark, is the highest grade product. Sorts is made up of the material that drips from the trees and is more or less mixed with impurities.

Yields.- In good seasons each tree is said to yield about 1 pound of manna.

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1921. SICILIAN MANNA AND MANNITE. U. S. Cons. Rpt., June 1, 1921, Palermo, Italy.
[Typewritten.]

MYRRH

Botanical Source.- *Commiphora abyssinica* (Berg) Engler, *C. molmol* (Engler) Tschirch, and other species of *Commiphora*. Fam. Burseraceae.

Habitat.- Arabia and Somaliland.

Nature of Plants.- Small trees.

Part Used.- Gum resin.

Commercial Uses, Sources, and Importance.- Myrrh was highly regarded in ancient times as a constituent of incense and perfumes, and it is still used in such products. Its most important use in the United States is in mouth washes. Arabia and north-eastern Africa are the principal sources of the world supply.

Myrrh imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
British East Africa ...	38,416	9,250	33,670	9,177	44,128	12,990
British India	-	-	-	-	1,960	530
Saudi Arabia	-	-	-	-	22,914	6,406
Total	38,416	9,250	33,670	9,177	69,002	19,926

Harvest and Preparation for Market.- Myrrh is gathered from the thorny myrrh trees, which grow wild in Africa and Arabia. They are usually found on poor sandy soil in regions where the average annual rainfall is between 10 and 20 inches and the mean yearly temperature is about 75° F. In Arabia they are occasionally found growing interspersed in thickets of species of *Acacia* and *Euphorbia*.

Though myrrh exudes spontaneously from beneath the bark of the tree, the natives commonly make incisions in the trunk to stimulate the formation of large quantities of the gum. The gum exudes during the dry hot season between October and January and, as it hardens, turns from a yellow to a reddish-brown color. It accumulates in small irregular tearlike masses, which are picked from the tree by the natives, placed in goatskins, and sent to market. Before the gum is exported, it is sorted to remove impurities and packed in bags or cases. Commercial myrrh is commonly classified as Somali, Arabian, Fahdi, and Yemen, the first two of which are the best.

NUX VOMICA

Botanical Source.- *Strychnos nux vomica* L. Fam. Loganiaceae.

Habitat.- India, Ceylon, Indochina, East Indies.

Nature of Plant.- Tree.

Part Used.- Seed.

Commercial Uses, Sources, and Importance.- *Nux vomica* seed is a source of strychnine and other alkaloids that are valuable for their medicinal properties. The principal sources of the world's supply are India and French Indochina.

Nux vomica imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
French Indochina	66,202	1,842	1,368,599	36,913	1,179,605	28,526
British India	1,017,128	14,704	1,089,448	12,739	2,288,224	33,561
Total	1,083,330	16,546	2,458,047	49,652	3,467,829	62,087

Harvest and Preparation for Market.- *Nux Vomica* seed is gathered from wild trees, growing 40 to 50 and even 100 feet tall. These have been able to supply all of this product that the market has demanded.

Getting the seed is a spare-time enterprise for the natives of the regions where the trees grow. In India they go into the forests when the fruit ripens during the summer rainy season. The bright brownish-yellow fruit is about the size of an orange. It contains a gelatinous pulp in which are embedded a small number of thin buttonlike seeds about an inch in diameter. The seeds are separated from the pulp, washed, and dried in the sun. They are sold by the natives to small merchants, who accumulate sufficient quantities to market to exporters. After they are graded by the exporters to eliminate broken and light-weight seeds, they are put in bags for shipping.

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UNITED STATES BUREAU OF MANUFACTURES.

1911. PRODUCTION OF STRYCHNINE AND NUX VOMICA. U. S. Dept. Com. and Labor Daily Cons. and Trade Rpts. No. 246, pp. 350-352.

ORRIS

Botanical Source.- *Iris florentina* L., *I. germanica* L., *I. pallida* Lam., and other species of *Iris*. Fam. Iridaceae.

Habitat.- Mediterranean countries. Varieties of these species are widely grown as ornamentals in the United States.

Nature of Plants.- Perennial herbs.

Part Used.- Rhizomes.

Commercial Uses, Sources, and Importance.- Orris is most commonly used as a perfuming and flavoring material in cosmetics and dentifrices. Italy and France are the most important commercial producers of orris and the essential oil obtained from them.

Propagation and Culture.- The orris iris are hardy plants and are commonly grown on stony hillsides or other waste ground. Though well-developed rhizomes are obtained on rich soil, they possess less fragrance. The soil is prepared by deep plowing. It is good practice to precede the planting with a green-manure crop. The mean annual

temperature of the Tuscany region in which orris is commonly grown is between 55° and 60° F., and the yearly rainfall is 25 to 30 inches.

Orris imports into the United States, 1938-40

ORRIS							
SOURCE	1938		1939		1940		
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	
Italy	364,609	19,676	566,898	29,705	298,890	37,513	
Morocco	10,008	498	8,872	421	7,000	635	
United Kingdom	-	-	224	28	-	-	
Yugoslavia	-	-	6,478	437	-	-	
Total	374,617	20,174	582,472	30,591	305,890	38,148	
ORRIS OIL							
France	241	7,700	428	16,334	596	39,533	
Germany	4	279	-	-	-	-	
Switzerland	6	370	9	418	3	81	
United Kingdom	12	790	11	908	-	-	
Total	263	9,139	448	17,660	599	39,614	

Orris iris is propagated by a small portion of rhizome with attached leaves. This planting material is gathered at the same time the commercial rhizome is dug at the end of the growing season. It is usually kept in a cellar or other damp place until cool rainy fall weather sets in, when it is planted in the fields.

Shallow planting of iris offsets is necessary for good growth and makes subsequent digging easier. The shoots are set at intervals of about 1 foot in rows spaced far enough apart to permit hoeing. The young iris take root quickly and are sufficiently developed for harvest in 2 or 3 years. The fields are kept well-weeded by periodic hoeing.

Harvest and Preparation for Market.- At the end of the growing season, orris rhizomes are dug with a fork. As soon as harvested they are cleaned and peeled by hand with special knives. Peeling is sometimes facilitated by first immersing the rhizomes in water. The prepared rhizomes are then carefully washed and laid out in the sun on bamboo matting to dry. After several days in the sun the roots are spread out in sheds to complete the drying process. Throughout these operations, precautions are taken to avoid any bruising, for discoloration will develop if the rhizomes are injured.

When first dug from the soil, the orris rhizomes have no odor and possess an acrid taste. The taste diminishes and the characteristic fragrance develops during the drying process. The crude dry orris is carefully sorted and graded and then sold to powdering plants and distilleries for processing. Its quality improves with storage, but it is subject to insect damage.

Yields.- Five to six tons of dried orris root is obtained per acre in 2 or 3 years. Orris is reported to yield about one part of essential oil to one thousand of crude rhizome.

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PERU BALSAM

Botanical Source.- *Myroxylon pereirae* (Royle) Klotzoch (*Toluifera pereirae* (Royle) Baillon). Fam. Leguminosae.

Habitat.- Central America.

Nature of Plant.- Tree.

Part Used.- Gum exuded by the trunk and limbs and extracted from the bark.

Commercial Uses, Sources, and Importance.- Although Peru balsam is not produced in Peru, it acquired that name because it was originally assembled and shipped to Spain from the port of Callao, Peru. It has a number of medicinal uses, the most important of which is the dressing of wounds. Almost the entire world supply comes from Central America.

Peru balsam imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Nicaragua	11,655	6,231	14,184	6,435	6,198	2,764
El Salvador	76,896	43,238	53,614	26,662	96,801	54,311
Other countries	-	-	15	30	-	-
Total	88,551	49,469	67,813	33,127	102,999	57,075

Harvest and Preparation for Market.- Peru balsam is obtained from wild trees, which grow singly and in groves in the forests of Central America, particularly in El Salvador. The tree grows well on poor but well-drained soils and at altitudes up to 1,000 feet above sea level. The mean annual temperature of the Peru balsam forest region in El Salvador is about 70° F., and the yearly rainfall is 80 to 100 inches.

Balsam may be obtained at any time during the year, but the dry season is preferred. In El Salvador the harvest begins in December and may continue until May. The trees can be tapped when they are 5 to 6 years old, and they have been reported to withstand severe treatment for many years. The gatherers climb the trees to various heights with the aid of ropes and cause the gum to exude by pounding patches of the bark with wooden mallets. The outer bark of the pounded patches is then removed. After 4 or 5 days the gum begins to flow and is soaked up with cotton or linen rags applied to the wound. The flow is then further stimulated by firing the wood with torches. When the rags are well soaked, they are put through crude presses and then boiled in water to remove the remainder of the gum. When the balsam ceases to flow, fresh cuts are made in the bark and the process is repeated. A lower grade balsam is obtained by cutting up the bark that is removed in the wounding process and boiling it in water to extract the gum. The two products obtained by these methods are known as rag and bark balsams. The balsam is poured into gourds or tin cans with screw lids for shipment.

Yields.- The yields from individual trees are reported to average 3 to 5 pounds per week during a season, which extends for 3 or 4 months.

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- MARTÍNEZ, ALFREDO, ET AL.
1940. EL BÁLSAMO NEGRO DE EL SALVADOR. *Café de El Salvador* 10: 5-72, illus.

POMEGRANATE

Botanical Source.- *Punica granatum* L. Fam. Punicaceae.

Habitat.- Mediterranean region and southern Asia. Widely grown in all tropical areas of the world for the fruit. There are many pomegranate groves in the southern United States.

Nature of Plant.- Large shrub or small tree.

Part Used.- Bark of stem and root.

Commercial Uses, Sources, and Importance.- Pomegranate bark has been used since very ancient times as a vermifuge, particularly to expel tapeworm. A tannin extracted from the bark is used to tan morocco leather. The pomegranate is highly regarded as a hedge plant, and its crimson flowers are used as a dye in North Africa. The fruit is a popular article of diet. United States imports of the bark are very small.

Propagation and Culture.- Pomegranate grows best where the mean annual temperature is about 70° F. and the yearly rainfall is 15 to 25 inches. Though the pomegranate will grow on sandy soil, it produces more abundantly on well-drained rich, deep loam. It is very easy to propagate by seed, cuttings, or layering. In the United States cuttings are usually made from shoots or suckers. They are planted in early spring in nursery beds at intervals of 8 to 10 inches in rows about 3 feet apart. The cuttings, which are about a foot long, are set deep, leaving only the top bud exposed. They quickly take root and in 1 year are ready to transplant to the field in the early spring. The land should be thoroughly plowed and harrowed in preparation for planting. In the United States pomegranates are planted both as hedges and in orchards. In hedges they are spaced 6 to 8 feet apart. In orchards they are planted 14 to 18 feet apart each way.

The pomegranate will produce fruit more satisfactorily if it is manured annually and if irrigation is provided in regions having long dry periods. Regular pruning of the tree is said to improve the fruit. It is well adapted to drought conditions but will not bear fruit heavily unless adequate rainfall is available or irrigation is provided.

Harvest and Preparation for Market.- The root bark contains more of the active substances than the stem bark, but both deteriorate rapidly with age. The white-flowered plants are reported to yield the richest bark. Information on the method of harvesting the bark and preparing it for market is lacking.

Reference.-

HODGSON, ROBERT W.
1917. THE POMEGRANATE. Calif. Agr. Expt. Sta. Bul. 276, pp. 161-192, illus.

PSYLLIUM

Botanical Source.- *Plantago psyllium* L., *P. arenaria* Waldst. and Kit., and *P. ovata* Forsk. Fam. Plantaginaceae.

Habitat.- *P. psyllium* and *P. arenaria*, countries of the Mediterranean region; *P. ovata*, India, Persia, and Mediterranean region.

Nature of Plants.- All three species are herbaceous plants, the first two are annuals. *P. ovata* is a perennial but produces seed the first year.

Parts Used.- The seed; also the mucilage extracted from the epidermal cell walls of the seed.

Commercial Uses, Sources, and Importance.- Psyllium seeds are used in medicine as an aid in cases of chronic constipation. The mucilage extracted from the seed is employed as a bandoline and cloth-sizing material. The United States imports most of its psyllium seed from India and France. The plant is grown on a commercial scale in a number of European countries.

Psyllium imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
British India	1,819,494	210,054	1,455,482	134,037	2,111,504	214,070
France	803,639	65,858	728,260	65,786	260,959	34,261
Spain	13,228	917	-	-	65,412	14,619
Total	2,636,361	276,829	2,183,742	199,823	2,437,875	262,950

Propagation and Culture.- *Plantago psyllium* is commonly grown in the region about the city of Carpentras in the southeastern part of France. The plant prefers light friable soils, and the land must be well prepared. Seeding may be done in the fall, but spring sowing is preferable.

A successful crop usually requires a heavy application of a complete fertilizer especially high in phosphorus. Psyllium is seeded shallow at the rate of 6 or 7 pounds to the acre in rows 2 feet apart. The crop is cultivated twice during the early growing season. The plant has a semitrailing habit of growth. In France it is usually sown before March 15 and harvested before the middle of August at a time when about three-quarters of the field has a light golden color. Psyllium has a tendency to shatter; so harvesting is done early in the morning to avoid as much loss as possible.

Preparation for Market and Common Classifications.- Psyllium mucilage is extracted from the seed by boiling it in water, in which the mucilage is readily soluble. *Plantago psyllium* and *P. ovata* produce a superior clear colorless mucilage.

Commercial psyllium seed may be purchased in grades classified as "imported," "cleaned," "triple cleaned," and "cleaned and sterilized." There are two standard types of the commercial seed.

- (1) Seed known commercially as black, French, or Spanish psyllium seed derived from *P. psyllium* and *P. arenaria*.
- (2) Seed produced in India and known in trading circles as white or blond psyllium seed, Indian plantago seed, and ispaghula seed derived from *P. ovata*.

The mucilage content and consequently the demulcent qualities are highest in *P. ovata*, followed by *P. psyllium* and *P. arenaria* in the order given.

Yields.- Yields of *P. psyllium* in France range between 800 and 1,400 pounds per acre according to the season and the care the crop has had.

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1932. WHAT IS PSYLLIUM SEED? *Drug. Cir.* 76 (4): 14-15, illus.
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1931. PSYLLIUM AND SOME OTHER SEEDS. *Drug Markets* 29: 236-237, 297-299, illus.
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SANDALWOOD

Botanical Source.- *Santalum album* L. and other species of *Santalum*. Fam. Santalaceae.

Habitat.- *S. album* is native to India, Malaya, and the East Indies. Other species are found in other tropical regions of the world.

Nature of Plant.- Tree.

Part Used.- Volatile oil extracted from wood of trunk, limbs, and roots.

Commercial Uses, Sources, and Importance.- Oil of sandalwood has been prized as a perfume since ancient times. It also has a number of medicinal uses. Fine ground sandalwood is used in incense and sachets. India is the largest producer of sandalwood.

Sandalwood imports into the United States, 1938-40

SANDALWOOD

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Germany	-	-	2,183	179	-	-
British India	1,140,360	191,353	581,289	81,939	1,840,502	261,780
Other Asia	22,427	1,838	-	-	-	-
China	-	-	240	54	-	-
Hong Kong	-	-	100	16	-	-
Total	1,162,787	193,191	583,812	82,188	1,840,502	261,780

SANDALWOOD OIL

France	528	2,729	564	2,881	405	2,500
Germany	203	443	138	1,008	-	-
United Kingdom	31	128	71	186	224	107
British India	2,370	8,421	4,520	16,972	3,700	10,300
Australia	56	162	3,304	8,662	1,120	2,867
Netherlands Indies	-	-	25	89	-	-
Total	3,188	11,883	8,622	29,798	5,449	15,774

Propagation and Culture.- Sandalwood trees thrive on the poor rocky soils of mountainsides, which have a low humus content. While they grow faster on richer land, less oil accumulates in the wood. Being a comparatively dry-land plant, the tree is found in regions where the yearly rainfall is between 20 and 50 inches and the mean annual temperature from 70° to 80° F. It generally grows at altitudes between 2,000 and 4,000 feet above sea level.

The sandalwood is semiparasitic. Although it is capable of obtaining all necessary water and nourishment directly from the soil, it has roots that grow into those of adjoining trees and obtain some of their nourishment in that way. Plantations of sandalwood are started with seed in forest clearings where sufficient shade trees are left for the protection of the delicate young plants. The casuarina is said to be one of the most satisfactory nurse trees.

The soil of the spots selected for seed plantings should be well loosened to the depth of 1 foot and 3 to 6 feet around the seed. The young sandalwood forest must be protected from grazing animals. Underbrush is regularly cut back until the trees are large enough to hold their own. Then only overtopping scrub trees should be cut. The young seedlings are reported to grow about 3 inches the first 2 years and about a foot the third year. By the time they are 5 or 6 years old they have a trunk about 1 inch through. When the tree is 30 to 50 years old, it is considered mature and may have a girth of 2 to 3½ feet and considerable heartwood.

Harvest and Preparation for Market.- Since the wood of the roots as well as the trunk contains the oil, the whole tree is uprooted when it is mature. The bark is removed, and the logs and roots are cut into pieces about a yard long. The heartwood, which is yellow in color, contains much more oil than the white wood. The oil is obtained from the wood by distillation.

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MASSELMAN, G. H. A.

1929. SANDALWOOD, THE SPIRIT OF THE EAST. *Aromatics* 10(1): 22-23, illus.

SARSAPARILLA

Botanical Source.- *Smilax aristolochiaefolia* Mill. (*S. medica* Chamisse and Schlechtendal) and other species of *Smilax*. Fam. Liliaceae.

Habitat.- Tropical America.

Nature of Plants.- Perennial climbers.

Part Used.- Root.

Commercial Uses, Sources, and Importance.- Sarsaparilla has a number of medicinal uses. It is cultivated to some extent, but most sarsaparilla root is obtained from wild plants. Mexico, Honduras, Peru, Ecuador, Costa Rica, and Jamaica are important producing countries.

Sarsaparilla imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Honduras	1,879	357	7,708	1,444	4,300	641
Mexico	80,768	7,313	83,137	7,609	143,093	13,823
Jamaica	572	94	2,333	290	2,240	271
Guatemala	-	-	181	36	-	-
Other countries	1,200	100	473	40	-	-
Total	84,419	7,864	93,832	9,419	149,633	14,735

Propagation and Culture.- Sarsaparilla plants grow best on well-drained sandy loams high in humus content. They require a hot moist climate. The mean annual temperature of the growing regions is from 70° to 80° F., and the yearly rainfall is 60 inches or more.

The plant is propagated by seed, cuttings, layers, or suckers. The suckers with a portion of the root attached may be transplanted directly in the field during the rainy season. Seeds are sown in well-prepared nursery beds and the plants set out in the fields when they are about 6 inches high. Spacing the young plants 6 by 7 feet facilitates weeding and harvesting. As sarsaparilla is a vinelike plant, stakes or trellises of some sort should be provided for the climbing stems.

Harvest and Preparation for Market.- While it is necessary to wait 2 or sometimes 3 years before the first roots should be dug, harvests are made annually thereafter. The slender roots of the plant grow out horizontally from the rhizome and creep for some distance only a few inches below the surface of the ground. When ready to cut, they are exposed close to the crown and severed from the plant. After removing

the larger roots, earth is well packed around the base of the plant and new roots quickly develop. When wild plants are exploited the whole mass of roots attached to the rhizome is usually pulled from the ground.

The freshly dug roots are cleaned of earth adhering to them. Occasionally this is accomplished by washing. When properly cleaned they are dried in the sun and then baled for transport. Different commercial types of root derive their names from ports or countries of origin, such as Mexican, Honduras, and Guayaquil.

SCAMMONY

Botanical Source.- *Convolvulus scammonia* L. Fam. Convolvulaceae.

Habitat.- Greece, Asia Minor, and southern Soviet Union.

Nature of Plant.- Perennial climber.

Part Used.- Gum resin.

Commercial Uses, Sources, and Importance.- Scammony resin is used medicinally because of its cathartic properties. It is obtained from wild plants in its native habitat. The United States imports negligible amounts of Mediterranean scammony. It does import large quantities of what is known as Mexican scammony, obtained from *Ipomoea orizabensis*, which has replaced scammony in the United States market.

Harvest and Preparation for Market.- Scammony is a poor-land plant frequently found growing on hillsides among arbutus and juniper bushes, on which it climbs for support. Its twining stems sometimes grow to a length of 15 feet. It has a root 3 or 4 feet long and 3 or 4 inches in diameter. It requires a yearly rainfall between 20 and 30 inches and a mean annual temperature of about 60° F.

The resin is obtained from the root of the plant and is gathered during the summer when the vine is in flower. To get at the root 3 or 4 inches of soil are scraped away. The root is cut early in the morning on a slant an inch or more below the crown. Mussel shells are commonly used as receptacles to catch the resin, which flows instantly from the severed root. The gum flows most freely in the morning and late in the evening. At night the shells are collected and the surface of the root wound is scraped so as to remove partially dried juice adhering to it. The best quality resin is obtained by drying the juice the following day. This may be done in the sun or in an airy room, as is the practice in Greece. The finest commercial scammony has a golden-brown color and is exported in flat pieces about 1 inch thick and 4 inches long.

Yield.- The yield of a 4-year-old root is about one-eighth of an ounce or less.

SCAMMONY, MEXICAN

Botanical Source.- *Ipomoea orizabensis* (Pelletan) Ledenois. Fam. Convolvulaceae.

Habitat.- Mexico.

Nature of Plant.- Climbing vine.

Part Used.- Root.

Commercial Uses, Sources, and Importance.- This species of *Ipomoea* is commonly known as Mexican scammony. It is used medicinally because of its cathartic qualities. Mexico is the largest commercial producer of *Ipomoea*. The United States imported 112,680 pounds, valued at \$2,778, in 1939.

Harvest and Preparation for Market.- *Ipomoea orizabensis* is a climbing vine indigenous to Mexico. Most of the roots are gathered from the wild plants growing in the

Sierra Madres near Orizaba. They are cut into transverse disks and dried in the sun as soon as gathered.

SENNA

Botanical Source.- *Cassia senna* L. and *C. angustifolia* Vahl. Fam. Leguminosae.

Habitat.- Anglo-Egyptian Sudan, southern Arabia, and India.

Nature of Plants.- Shrubs.

Parts Used.- Leaves.

Commercial Uses, Sources, and Importance.- Senna leaves are used medicinally in large quantities, being especially valued because of their cathartic qualities. Though most of the world's supply of senna comes from plants cultivated in southeastern India, it is still widely grown in the upper Nile region of Africa.

Senna imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
British India	960,473	35,137	1,762,032	64,129	3,071,823	126,808
Egypt	539,999	33,912	208,450	12,509	531,833	47,986
Other countries	422	40	9,143	554	21,830	2,183
Total	1,500,894	69,089	1,979,625	77,192	3,625,486	176,977

Propagation and Culture.- The cultivated senna of India is propagated by seed, which is planted in nursery beds usually in December. The young plants are transplanted in February, when they are 6 inches high, and are spaced 3 by 3 feet in raised beds or well-prepared patches of open ground. The soil in which they are set should be thoroughly worked and completely free of weeds. Vegetable compost or manure should be incorporated with the soil. To obtain vigorous leafy plants they must be watered during the hottest days of April and May, but shading is not recommended. New plantings are made each year. The plants flower in April and throughout the summer until the cold weather begins in October. The average yearly rainfall in the best growing districts is about 30 inches and the mean annual temperature about 75° F.

Harvest and Preparation for Market.- In the Sudan the leaves are gathered during the winter. In India, where the plant is stripped three times during the season, the picking begins in May. The leaves are immediately spread out in the sun to dry. In careful packing, the leaves are kept as free as possible of all foreign material, such as twigs, seed pods, and other kinds of leaves. Senna leaves are graded into whole- and broken-leaf lots. The cleanest and most uniform quality of leaf is obtained from the Tinnevely regions of India. Trade lots of senna leaves are generally known as Alexandrian, which is *Cassia senna* wherever grown, Tinnevely, which is *C. angustifolia* grown in the Tinnevely region, and Indian, which is *C. angustifolia* grown elsewhere.

Yields.- Occasional yields as high as 700 to 1,400 pounds per acre are recorded, but Tinnevely senna yields about as follows: First picking, 70 to 100 pounds per acre; second, 150 to 200 pounds per acre; and third, 75 pounds per acre.

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SOAPBARK (QUILLAJA)

Botanical Source.- *Quillaja saponaria* Molina. Fam. Rosaceae.

Habitat.- Chile and Peru.

Nature of Plant.- Tree.

Part Used.- Inner bark.

Commercial Uses, Sources, and Importance.- Ground soapbark has long been used by the natives of Chile and Peru as a shampoo and for washing silk and wool. It has some medicinal uses. Chile is the chief source of the world supply.

Soapbark imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Chile	401,441	13,400	792,921	31,331	1,460,970	103,390

Harvest and Preparation for Market.- The quillaja, or soapbark, tree is an evergreen, which commonly grows 30 to 50 feet tall. It is found growing on rocky soils along the western slopes of the Andes Mountains at elevations up to 6,000 feet above sea level. The mean annual temperature of the regions in which it is found is about 60° F. and there are only 10 or 12 days of rain a year.

The wood of the quillaja is white and very hard. It is used for mine timber, building construction, and charcoal. The bark is stripped from the wood. The coarse outer cork layer is ground into a powder, which is the common commercial product.

The tree has been successfully grown experimentally both from seed and from cuttings. The bark of 10-year-old trees has a high saponin content.

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SQUILL (WHITE)

Botanical Source.- *Urginea maritima* (L.) Baker. Fam. Liliaceae.

Habitat.- Mediterranean countries.

Nature of Plant.- Perennial herb.

Part Used.- Bulb.

Commercial Uses, Sources, and Importance.- White squill is the white variety of the plant that also produces the cheaper red squill, commonly used as a raticide. White squill has been used medicinally as a diuretic and for certain cardiac treatments. Italy is the largest producer of white squill, although Algeria and France also export it. The United States imported 85,963 pounds, valued at \$3,143, in 1939.

Harvest and Preparation for Market.- The plant *Urginea maritima* is popularly known as the sea onion because it grows wild on the sandy shores of the Mediterranean. The mature squill bulb is sometimes as large as a coconut and weighs 4 or 5 pounds. Planted from seed, it requires 5 or 6 years to reach marketable size, whereas 4 or 5 years are necessary if bulblets are used.

The commercial supplies of squill are obtained from wild plants, which are gathered in the early autumn after the leaves have withered. The bulb is taken up and, when the dry outer scales are removed, it is cut into four parts. The core is cut out and the quarters are then sliced. These are dried in the sun or by the heat of a slow fire. The wild squill is said to require no attention, such as weeding. It prefers a sandy soil. The mean annual temperature of the native growing regions is about 60° F., and the yearly rainfall is from 20 to 25 inches. It has been grown with limited success on experimental plots in the southern United States where both the temperature and the rainfall are higher. Experimental plantings in the United States indicate that squill probably could be planted in rows 30 inches apart and at intervals of 18 to 24 inches in the row. Cultivation would be similar to that of onions.

Yields.- Yields of experimental plots in the United States indicate the possibility of producing 20,000 to 30,000 pounds per acre every 5 or 6 years.

STROPHANTHUS

Botanical Source.- *Strophanthus hispidus* DC. and *S. kombe* Oliver. Fam. Apocynaceae.

Habitat.- Tropical Africa.

Nature of Plant.- Woody vines.

Part Used.- Seed.

Commercial Uses, Sources, and Importance.- *Strophanthus* is one of the sources of African arrow poisons. It is employed medicinally because of its heart-stimulating properties. Only very small quantities enter commercial channels.

Harvest and Preparation for Market.- *Strophanthus* seed is obtained entirely from wild vines. It is contained in long slim double-husked pods about 10 inches in length and 1 inch wide. When they are ripe the pods are gathered by natives, who remove the coarse outside husk. The product they market consists of the seed enclosed in the smooth leathery endocarp. Before shipment from the African ports the seeds are removed from this inner husk.

When used as arrow poisons the seeds are simply ground and mixed with the mucilaginous sap of some other plant. The paste obtained is smeared along the point of the arrow.

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STRAMONIUM

Botanical Source.- *Datura stramonium* L. Fam. Solanaceae.

Habitat.- Asia. The plant is found growing wild in many of the temperate and warmer regions of the world.

Nature of Plant.- Annual herb.

Part Used.- The leaves and seed are most commonly used, although all parts of the plant are medicinally active.

Commercial Uses, Sources, and Importance.- In many sections of the United States stramonium occurs as a barnyard weed, especially in the East and South. It is commonly known as Jimson or Jamestown weed. It is used medicinally and as a source of atropine. Most of the stramonium leaves used in the United States are imported.

Stramonium imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Germany	18,777	1,648	-	-	-	-
Hungary	204,505	15,968	391,590	28,493	156,190	16,235
Italy	58,270	4,018	61,734	3,886	12,773	1,315
Soviet Union	12,125	728	-	-	-	-
Yugoslavia	26,135	2,041	56,919	3,902	2,303	152
Belgium	-	-	6,976	392	-	-
Mexico	-	-	-	-	3,209	272
Egypt	-	-	-	-	4,259	221
Total	319,812	24,403	517,219	36,673	178,734	18,195

Propagation and Culture.- Although stramonium grows well on a variety of soils, it thrives best under cultivation on rich and rather heavy loams. In the regions of Europe where most commercial stramonium is produced, the yearly rainfall is between 25 and 30 inches and the mean annual temperature is about 50° F. Stramonium, however, grows well under a wide range of climatic conditions. It is readily propagated by seed, which may be sown directly in the field in rows 3 feet apart. The seed is planted just deep enough to obtain sufficient moisture for germination. When the plants are well established, they are thinned to 12 or 15 inches apart. The seedlings can be readily transplanted, and gaps occurring in the rows may be filled in with the plants removed in thinning. Cultivation sufficient to kill weeds is necessary for good growth. In most localities the leaves are attacked by insects, the common potato beetle being especially destructive. These often attack when the plant is still small, and spraying or dusting with insecticides may be necessary to protect the crop.

Harvest and Preparation for Market.- The leaves, small stems, and flowers may be picked by hand when the plants are in flower. This method requires much hand labor and is expensive. A more economical way is to cut the plants below the branching point and dry them on a barn floor or in an artificially heated curing room. When the leaves are dry, they can readily be stripped from the stems, or, if the buyer does not object to broken leaves, they can be threshed or flailed from the stems. In regions where continuous clear hot weather prevails at harvesttime, the crop could probably be cured in the field. If there is some ripe seed, it can be threshed from the capsules after the leaves have been stripped or it can be separated from the mechanically threshed material by a fanning mill. If the leaves are hand-picked in the field, the seed capsules may be left to ripen. The cured leaf should be baled, if baling equipment is available. If not, it may be packed tightly in clean burlap bags.

Yields.- Under good conditions yields of 1,000 to 1,500 pounds of dry leaf per acre, or 500 to 2,000 pounds of seed, may be expected. The seed yield depends on the method of harvesting the leaves. If only leaves are harvested, a substantial seed crop can be obtained; but if the tops are cut, a small amount of seed will be produced.

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TAMARIND

Botanical Source.- *Tamarindus indica* L. Fam. Leguminosae.

Habitat.- Upper Nile region of Africa.

Nature of Plant.- Tree.

Parts Used.- Fruit pulp, wood, and seed.

Commercial Uses, Sources, and Importance.- The fruit of the tamarind is used medicinally, as a beverage ingredient, and to flavor confections, curries, and sauces. The seed is used as a food in India. The wood of the tamarind is very hard and durable and is used locally for tool handles, rice pounders, etc. It is said to produce the finest grade of gunpowder charcoal.

Though the tamarind is widely grown in tropical regions, the principal sources of supply for the United States are India and the West Indies.

Tamarind imports into the United States, 1938-40

SOURCE	1938	1939	1940
	Dollars	Dollars	Dollars
British West Indies	1,633	2,604	5,371
British India	1,520	2,419	3,384
French West Indies	-	254	-
Netherlands Indies	-	5	-
Total	3,153	5,282	8,755

Propagation and Culture.- The tamarind will grow on poor soils and withstand drought or frequent flooding, but it thrives best and produces most on deep friable loams that are fairly fertile. It will do well on an annual precipitation of 40 to 50 inches and a mean annual temperature that does not drop below 70° F.

Young trees are raised from seed in a nursery. The seed is soaked 4 or 5 days in water and then planted about 2 inches deep in the nursery bed. When the seedlings are 2 or 2½ feet high, they are transplanted during a rainy season to groves, where they are spaced 10 to 20 yards apart each way. The richer the soil the greater the distance between the trees. Groves must be kept clean of weeds and vines until the trees have grown sufficiently to suppress other vegetation.

Harvest and Preparation for Market.- Under good growing conditions the tamarind will come into bearing at 5 years of age. It is a long-lived tree, which frequently grows to a height of 80 feet. It is reported to have grown 150 feet high in the Philippines.

The pods of the tamarind are 3 to 6 inches long, about an inch in width, and one-half inch thick. They are gathered when ripe, and the hard pod shell is removed. The pulp of the fruit is preserved by placing it in casks and covering it with boiling sirup or by packing it carefully in stone jars with alternate layers of sugar. When used for food in India, the seeds are roasted and soaked in water until the hard seed coat splits and comes off. The cotyledons are then boiled and eaten.

Yields.- The average yield of tamarind in British India is about 200 pounds of prepared fruit pulp per mature tree.

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TOLU BALSAM

Botanical Source.- *Myroxylon toluiferum* H.B.K. (*Toluiifera balsamum* L.) Fam. Leguminosae.

Habitat.- Colombia.

Nature of Plant.- Tree.

Part Used.- Gum.

Commercial Uses, Sources, and Importance.- Tolu balsam is an ingredient in a number of medicinal preparations, particularly cough sirups. Colombia, where the tree is native, is the chief source of this gum.

Tolu balsam imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Colombia	55,297	18,126	82,098	25,522	100,071	52,843
Other countries	4,889	1,118	1,338	314	-	-
Total	60,186	19,244	83,436	25,836	100,071	52,843

Harvest and Preparation for Market.- The tolu balsam trees of Colombia grow wild, scattered in the forests of the Magdalena and Cauca Valleys. The mean annual temperature of this region is between 70° and 80° F., and the yearly rainfall about 80 inches. To obtain the gum, a tree is tapped by cutting a V-shaped notch through the bark. Below the point of the notch the bark and wood are hollowed out to insert a cup for the drippings. The incisions are made at many points up and down the trunk but in such a way as not to girdle it. When the tree is scarred as far as can be reached from the ground, scaffolds are sometimes rigged around it so that the same process can be repeated farther up. The gum is collected from the cups by gatherers, who make rounds of their trees with a pair of rawhide bags slung over the backs of burros. The contents of the cups are emptied into the bags and the cups put back in their niches to refill. The hide bags are later emptied into tin export containers. The collecting season continues over an 8-month period from July to March or April.

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TONKA BEAN

Botanical Source.- *Dipteryx odorata* (Aubl.) Willd. (*Coumarouna odorata* Aubl.) Fam. Leguminosae.

Habitat.- Northern coast of South America.

Nature of Plant.- Tree.

Part Used.- Seed.

Commercial Uses, Sources, and Importance.- The tonka bean is a source of coumarin, a vanilla-flavored substance which is used to add fragrance to tobaccos, perfumes, soaps, liqueurs, and bakery products. Brazil, Venezuela, Trinidad, and Tobago are the principal sources of the tonka bean supply.

Tonka bean imports into the United States, 1938-40

SOURCE	1938		1939		1940	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Venezuela	19,096	30,595	29,514	43,497	158,657	143,048
Trinidad and Tobago ..	363,626	610,416	516,802	862,738	126,609	182,334
Brazil	233,934	152,135	80,638	37,972	125,071	51,288
Colombia	2,060	2,001	254	345	841	1,661
Other countries	210	250	500	574	-	-
Total	618,926	795,397	627,708	945,126	411,178	378,331

Propagation and Culture.- Though most of the supply of tonka beans is obtained from wild trees, which may attain heights of 90 feet or more, there is an increasing number of plantation-grown tonka bean trees.

The tree thrives on many kinds of soil, but it is usually found along the banks of rivers or on flood lands where the soil is either a friable loam or even somewhat sandy or gravelly. Whatever the texture, the soil must be well drained. A high humus content is preferred. Heavy impervious land is not desirable.

The tonka bean tree is able to resist short drought periods, but it requires an annual rainfall of 60 to 100 inches and a mean yearly temperature of about 80° F. Although the tree is a tropical plant, it does not require a humid atmosphere or moist soil. The tonka bean tree has been found to grow well, although not at its best, where cacao has failed because of poor soil.

The tonka bean may be planted with seed directly in the plantation or in nursery beds. The nursery-grown seedlings should be transplanted as soon as the first few leaves have formed, since success with transplanting diminishes as the seedlings grow larger. Sometimes the tree is propagated by layering or by grafting on seedlings.

The young trees should have moderate shade until they are 5 or 6 feet tall. This may be accomplished by growing corn, cassava, bananas, or some other temporary crop between the trees. Tonka bean trees may be spaced as closely as 10 feet each way, with the object in mind of thinning as the stand grows older. Eventually the trees may stand 50 feet apart. Tonka bean trees have been known to require 10 to 15 years before bearing fruit. Where the plantations are shaded when the seedlings are young and where mulching, fertilizing, and weeding are practiced, the trees bear within 1½ to 2 years.

Harvest and Preparation for Market.- The fruit of the tonka bean tree is gathered from March to May in Trinidad. It is picked up from the ground by gatherers, who go through the plantations two to three times a week. The pods are spread out and allowed to dry for a few days in order to complete ripening. The proper stage is indicated when the surface of the pods shrivel and turn a dark mahogany color.

The tonka kernel, which is 1½ to 2 inches long, is extracted by pounding the shell with a stone or hammer. The beans are dried in the shade for another day or two, after which they are packed in barrels and cured by soaking with strong rum for several days. When the rum is drawn off, the beans are ready for export. As the nuts dry they become frosted with a white crystalline deposit of coumarin, the most important constituent of the bean.

Yields.- The tonka bean tree tends to produce biennially, triennially, or even with no regularity at all, which makes the crop uncertain for any given year. Trees have been reported to yield as much as 50 pounds in 1 year, but the average is 2 or 3 pounds per tree per year.

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