72D CONGRESS, 1st Session } SENATE { DOCUMENT No. 72

PRODUCTION AND TRANSPORTATION COSTS OF CERTAIN OILS

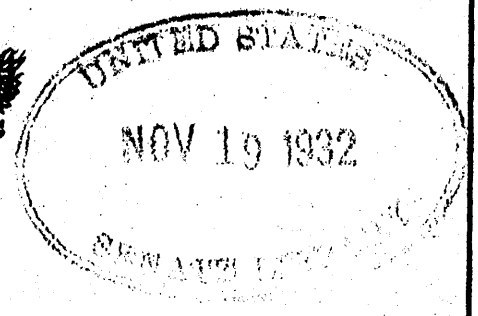
LETTER

FROM THE

CHAIRMAN OF THE UNITED STATES TARIFF COMMISSION

TRANSMITTING

IN RESPONSE TO SENATE RESOLUTION No. 328 (SEVENTY-FIRST CONGRESS), CERTAIN INFORMATION RELATIVE TO THE COSTS OF PRODUCTION AND TRANSPORTATION TO THE PRINCIPAL CONSUMING MARKETS OF THE UNITED STATES OF CERTAIN OILS AND THE PRINCIPAL USES THEREOF



MARCH 23 (calendar day, MARCH 24), 1932.—Referred to the Committee on Finance and ordered to be printed, with illustrations

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1932

UNITED STATES TARIFF COMMISSION

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LETTER OF TRANSMITTAL

UNITED STATES TARIFF COMMISSION,
Washington, March 24, 1932.

The PRESIDENT OF THE SENATE,
Washington, D. C.

SIR: In compliance with Senate Resolution No. 323, of the special session of the Senate during the Seventy-first Congress, I have the honor to transmit herewith the report of the United States Tariff Commission. The resolution reads as follows:

Resolved, That the United States Tariff Commission is hereby instructed and directed to prepare and submit to Congress a detailed study of the costs of production and of transportation to the principal consuming markets of the United States of the following commodities, namely: Coconut oil and copra from the Philippine Islands and other principal producing regions, palm oil, palm-kernel oil, whale oil, rapeseed oil, perilla oil, and sesame oil. Also a statement of the principal uses of these oils in the United States and of the kinds and amounts of domestic oils and fats replaced in domestic industry by such imports.

All of the material for the report transmitted herewith had been assembled and organized and preliminary draft of report made at the time the fifteenth annual report was submitted to Congress on November 30, 1931, as indicated on page 74 of that report. Since that date members of the staff of the commission have reduced the preliminary draft to a more satisfactory form, and have checked and verified all data.

Respectfully,

ROBERT L. O'BRIEN, *Chairman.*

PRODUCTION AND TRANSPORTATION COSTS OF CERTAIN OILS

PART I

INTRODUCTION AND SUMMARY

Section 1.—Introduction

History of the investigation.

This investigation was instituted under the provisions of section 332 of the tariff act of 1930, pursuant to Senate Resolution No. 323, special session of the Senate, Seventy-first Congress. The resolution reads as follows:

> *Resolved*, That the United States Tariff Commission is hereby instructed and directed to prepare and submit to Congress a detailed study of the costs of production and of transportation to the principal consuming markets of the United States of the following commodities, namely: Coconut oil and copra from the Philippine Islands and other principal producing regions, palm oil, palm-kernel oil, whale oil, rapeseed oil, perilla oil, and sesame oil. Also a statement of the principal uses of these oils in the United States and of the kinds and amounts of domestic oils and fats replaced in domestic industry by such imports.

Interpretation of the resolution—purposes of the investigation.

The Senate resolution calls for (1) a study of the costs of production and transportation of copra, whale oil, and six vegetable oils to the principal consuming markets of the United States, and (2) a statement of the principal uses of these oils in the United States and of the kinds and quantities of the domestic oils which have been replaced in domestic industry by such imports.

The resolution does not call for a comparison of the domestic and foreign costs of production of any of the oils mentioned; for example, between coconut oil produced in the United States and that produced in foreign countries. In fact, such a comparison would be impossible except for three of the eight commodities mentioned; namely, coconut, sesame, and whale oils. Of these, coconut and sesame oils are produced from imported raw material only, and whale oil is produced from whales caught in the Pacific Ocean, off the western coast from Alaska to Mexico, inclusive. Of the other five, copra, palm oil, and perilla oil are not produced at all in the United States, and palm-kernel and rapeseed oils are produced only sporadically and in comparatively small quantities. None of the eight commodities is produced from domestic grown materials.

The concluding sentence of the resolution indicates that it is the competitive position of the domestic producers of oil-bearing materials, rather than of the domestic oil crushers, that the commission was to investigate. From the point of view of these producers, it is of little consequence whether the foreign oil-bearing materials are crushed in the United States or in a foreign country, as long as the resulting product competes with the oils made from domestic materials. It is

assumed that the ascertainment of costs of production and of transportation to chief consuming markets is designed to establish a basis for comparison between domestic oils made from domestic materials and imported competing products, irrespective of whether the crushing is performed in the United States or in a foreign country.

For convenience of presentation in this report, the term "foreign oils" is used to include both oils imported as such and oils made in the United States from foreign materials. The term "oils" throughout the report includes "fats." (There is no clear distinction between oils and fats, except that the former are liquid, while the latter are solid, at ordinary room temperatures.)

Specific data obtained in the investigation.

Interpreting the resolution as outlined, this investigation has been conducted for the purpose of ascertaining the uses of the commodities mentioned and their interchangeability with domestic oils made from domestic materials, so far as such facts may be determined from a study of the technical properties of the oils concerned, their costs, prices, and other economic factors.

A study was made of the consumption of oils in soap, lard compound or substitute, margarine, and other products, and the reasons for the suitability of some oils rather than others for certain uses. For coconut, whale, and sesame oils in the United States and for a large part of the coconut oil produced in the Philippine Islands, the commission obtained costs of production, selling prices, transportation charges to chief consuming markets in the United States, and information as to marketing by territory and by industry. For the eight commodities the commission obtained prices landed at United States ports, transportation charges to chief consuming markets in the United States, and information as to distribution. These prices are presented as the best evidence available of foreign costs of production plus transportation charges. It was not practicable to obtain the actual cost of producing the raw material, and since this represents approximately 90 per cent of the total costs of production, conversion costs alone would have been more or less meaningless.

Tariff status of products of Philippine Islands.

For convenient reference the term "importation" is often used in this report in discussing the trade movement from the Philippines to the United States. The term is not strictly accurate, as the Philippines are not a "foreign" country. Under section 301, tariff act of 1930, goods which are the growth or product of the Philippines are not subject to duty when shipped to the United States.

Section 2.—General Summary Statement

General position of the oils specified.

In the approximate order of their importance in United States consumption during recent years, the seven oils listed in Senate Resolution No. 323 rank as follows: Coconut, palm, palm-kernel, whale, rapeseed, sesame, and perilla oils.

Coconut oil is expressed from copra, the dried meat of coconuts. About half of the domestic consumption of coconut oil is imported as such, and the remainder expressed in the United States from imported copra. No copra is produced in the United States. Part

of the sesame oil consumed is imported as such, and part expressed in this country from imported sesame seed; no domestic production of sesame seed is reported. As a rule, the rapeseed and palm-kernel oils consumed in the United States have been imported, but from time to time small quantities of rapeseed have been crushed here, and in the last few years there has been an increasing tendency to crush palm kernels. The consumption of the other two vegetable oils mentioned in the resolution consists almost entirely of oil imported as such. About five-sixths of the consumption of whale oil is imported and the remainder represents production from whales taken by United States vessels.

Uses.

Practically all animal and vegetable oils will combine with caustic soda or caustic potash to make soap, but by no means all of them can be used in substantial quantity in making the kinds of soap now generally consumed in the United States. A more limited number of oils can be used for food—at least without expensive processes of refining—and a still more limited number for paints and varnishes and for other technical purposes. In the United States perilla oil is used mainly for varnishes and enamels; rapeseed oil, mainly for marine-engine lubricants and rubber substitutes; palm oil, mainly for soap but to some extent for other technical uses and for food; whale oil, almost entirely for soap, although in Europe it is used to a considerable extent for food. The other three oils—coconut, palm-kernel, and sesame—are used partly for soap and partly for food.

Table 1 gives for 1929 statistics of consumption in specified uses of all the oils specified in the Senate resolution.

TABLE 1.—*Uses of coconut, palm-kernel, palm, whale, sesame, perilla, and rapeseed oils, 1929*

[In thousands of pounds]

Use	Coconut	Palm-kernel	Palm	Whale	Sesame	Perilla	Rapeseed
Food uses:							
Margarine	171,411	15	1,349	----	----	----	----
Lard compounds	20,000	----	1,191	809	5,215	----	----
Other food—salad and cooking oil, confectionery, etc.	53,598	11,392	----	----	[1] 20,000	----	----
Total food	245,009	11,407	2,540	809	25,215	----	----
Technical uses:							
Soap	[2] 344,205	[3] 72,920	192,331	59,580	4,835	----	----
Tin plate	----	----	15,512	----	----	----	----
Paints and varnishes	----	----	----	----	----	5,508	----
Other	72,703	----	20,597	----	26	66	16,848
Total technical	[4] 416,908	72,920	228,440	59,580	4,861	5,574	16,848
Grand total	662,007	84,327	230,780	60,389	30,076	5,574	16,848

[1] This is the difference between total apparent consumption and the reported factory consumption; it may include some oil used either in lard compounds or soap.

[2] Estimate obtained from the trade for 1929. It probably does not include coconut-oil foots. It is used here for uniformity with Table 117, Pt. IV, where it was used because of the incompleteteness of the Census of Consumption, 1929, on certain items and because trade estimates were all that could be obtained for other recent years. The Census of Consumption shows a use of 393,914,000 pounds of coconut oil in 1929, or 49,708,000 pounds more than the trade estimate. This includes foots.

[3] Census of Consumption, 1929, shows only 44,532,000 pounds.

[4] This quantity represents the difference between total apparent consumption and the sum of the figures given above. The size of the figure probably results from an underestimate of the coconut oil used in food and soap, particularly in soap. (See notes 2 and 3). As far as is known the only important technical use of coconut oil other than in soap making is in the preparation of "lotions" and toilet preparations of various sorts.

Duties.

Copra is free of duty. Coconut oil is dutiable at 2 cents per pound, but practically the entire import comes from the Philippines, from which goods are admitted free of duty. Palm oil and perilla oil are free of duty. Palm-kernel oil and sesame oil were free under the act of 1922, and if inedible (denatured), are free under the act of 1930. Edible palm-kernel oil is dutiable at 1 cent per pound and edible sesame oil at 3 cents per pound under the present tariff act. Rapeseed oil was dutiable at 6 cents per gallon (about 0.9 cent per pound) under the act of 1922, and is so dutiable under the act of 1930 when not denatured but is free of duty when denatured. Whale oil has been dutiable at 6 cents per gallon (about 0.9 cent per pound) in the last two tariff acts.

COSTS OF PRODUCTION AND LANDED PRICES

Imported oils.

The resolution calls for "costs of production and transportation to the principal consuming markets of the United States." The several vegetable oils covered by the resolution are all expressed from seeds or nuts which are the products of the agriculture or forestry of tropical and oriental countries. Much the greater part of the cost of the oil is represented by these raw materials, which are produced under such conditions as to make it impracticable to ascertain their costs of production. In the case of oil expressed in foreign countries, the commission was of the opinion that, owing to its minor importance in total costs, the crushing cost alone is not of sufficient value to warrant the expense of obtaining it for purposes of this investigation, except for domestic companies with crushing plants in the Philippines. Therefore, in the case of such oils and of imported whale oil, the commission decided to present data as to landed prices of oil imported into the United States as the best evidence available of costs of production. This is done in the table below for the year 1929 and for the first six months of 1930. The costs of transportation of imports of each of the oils covered by the resolution from the principal port of entry to the principal consuming market in the United States are also shown in the table.

TABLE 2.—*Landed cost of imported oils specified in the resolution and delivered cost to principal markets*

[Cents per pound]

Oil	Quantity of imports, 1929	Principal market	Cost of importations					
			1929			1930 (6 months)		
			United States landed cost	Transportation to principal market	Total	United States landed cost	Transportation to principal market	Total
	1,000 lbs.							
Coconut	411,980	New York	7.63		7.63	6.86		6.86
Palm-kernel	69,909	do	7.83		7.83	6.95		6.95
Palm	261,816	do	7.75		7.75	6.75		6.75
Perilla	5,574	Mid-West	12.22	0.75	12.97	10.25	0.75	11.00
Rapeseed	18,801	New York	9.64		9.64	8.74		8.74
Whale	56,552	Mid-West	[1] 6.24	.75–1.00	7.00–7.25	[1] 5.77	.75–1.00	6.50–6.75
Sesame:								
Crude	21,585	New York						[2] 7.95
Refined								[2] 10.28

[1] Foreign invoice value.

[2] 1929 and 1930 (6 mos.).

Copra.

No special investigation was undertaken with respect to the cost of producing copra in the Philippine Islands, but information obtained from official Philippine sources is included in the report. The cost of production of copra in the Province of Tayabas, in which is produced about 30 per cent of the total output of the islands, is stated in the report of the United States Trade Commissioner at Manila to have been about 3.7 cents per pound during the season of 1929–30. Transportation and other charges would bring the landed cost at San Francisco on this basis to a little over 4 cents per pound. The average price paid for copra by mills in the United States, including delivery to their plants, during 1929 and the first six months of 1930, was 4.6 cents per pound. This last figure includes cost of transportation and landing charges. Moreover, it is for copra averaging lower in water content than the mill run of copra produced in the Philippines.

Sesame seed.

The average price, delivered at mill, paid for sesame seed by the domestic crushers from whom cost data were obtained was 4.16 cents per pound for 1929 and the first six months of 1930.

Other seed used in making the oils covered by the resolution.

Palm kernels and rapeseed have been crushed sporadically in the United States, but no costs of production or landed costs of these materials are available. So far as could be learned no perilla seed has ever been crushed in the United States.

The pericarp, or outside fleshy portion of the palm fruit, from which the palm oil is obtained, is perishable. For that reason there are no exports from the tropical countries of production.

Oils expressed in the United States from foreign materials.

The costs of expressing coconut and sesame oils from imported materials in domestic factories were ascertained together with a total cost of oil produced by such factories on the basis of the prices paid by them for copra and sesame seed. The costs of domestic whale oil were also ascertained, but since they are for only two firms, they can not be disclosed. Neither can costs obtained for two Philippine mills engaged in making coconut oil. Their average conversion cost was higher than that for the domestic mills from which costs were obtained.

Table 3 shows the domestic factory costs of coconut and sesame oils on the basis above described. It also shows costs of transportation from domestic factories to the principal consuming markets of the United States.

TABLE 3.—*Cost of production at mill of coconut and sesame oils expressed in the United States from imported materials and delivered cost at principal market*

[Cents per pound]

Oil	Amount produced, 1929	Principal market	Cost of production					
			1929			1930 (6 months)		
			Cost of production at domestic plant	Transportation from plant to principal market	Total	Cost of production at domestic plant	Transportation from plant to principal market	Total
	1,000 lbs.							
Coconut	352,654	Mid-West	7.01	0.56	7.57	6.78	0.57	7.35
Sesame, crude	[1] 8,436	Los Angeles						[2] 8.25

[1] Estimated.

[2] Average for 1929 and first 6 months of 1930.

PERILLA AND RAPESEED OILS IN RELATION TO DOMESTIC OILS

The second part of the Senate resolution calls for a statement of the kinds and amounts of domestic oils replaced by the foreign oils specified in the resolution. In the discussion of this subject it is advantageous to distinguish between perilla and rapeseed oils, on the one hand, and the other five oils mentioned in the resolution on the other hand. Perilla and rapeseed oils are confined to certain special uses. Coconut, palm-kernel, palm, sesame, and whale oils are practically all used for soap or for food purposes, or for both. They come into more direct and stronger competition with the major domestic oils than does either perilla or rapeseed oil. Moreover, the quantities of coconut, palm-kernel, palm, sesame, and whale oils imported into the United States or produced from imported materials are very much larger than the quantities of perilla and rapeseed oils imported.

Perilla oil.

Perilla oil, which is imported chiefly from Japan and China, is a drying oil, used mainly in making certain special types of enamels and varnishes; if perilla oil could not be obtained, linseed or tung oil might be used in its place, but the result would be a substantially different product. For most purposes, domestic paint and varnish manufacturers use linseed oil except when there is a distinct advantage in using perilla oil. This is partly due to the fact that the supply of perilla oil has been small and uncertain in quantity. Except in the last year or two the price of perilla oil has usually been somewhat higher than that of linseed oil.

Apart from the fact that perilla oil is used chiefly for special purposes, the question whether it can be considered as having displaced domestic oils should be judged in the light of the fact that this country supplies only about one-half of its requirements of linseed oil from domestic seed, the other half being supplied mainly from imported seed crushed in domestic mills. During the five years, 1926–1930, imports of perilla oil averaged 5,836,000 pounds annually.

In the same period the domestic production of linseed oil from domestic flaxseed averaged 340,914,000 pounds annually; imports and domestic production from imported seed, 369,247,000 pounds annually.

Rapeseed oil.

Rapeseed is produced chiefly in India and China, but the oil is imported chiefly from Japan and the United Kingdom. About 80 per cent of the domestic consumption is used in combination with mineral oils as a lubricant for reciprocating marine engines. So far as the commission could learn, no other oil has been discovered which gives as satisfactory results in this use, although attempts have been made to substitute such oils as cottonseed, corn, peanut, and fish. In this use, therefore, no replacement seems to have occurred. Most of the remainder of the rapeseed oil imported is used for making rubber substitutes. Corn oil is also used for this purpose, but the rubber substitutes made from the two oils differ materially, and to a large extent each has its own special uses. Rapeseed oil can not be said to replace corn oil except in the limited number of uses where there is little preference between rapeseed and corn substitutes. Such uses are ordinarily served by the rapeseed variety, because rapeseed oil has usually been obtainable at a lower price than corn oil.

COCONUT, PALM-KERNEL, PALM, SESAME, AND WHALE OILS IN RELATION TO DOMESTIC OILS

Consumption and exports of food and soap oils as a group.

It is not possible, for reasons hereafter set forth, to answer statistically the requirement of the Senate resolution for a statement of the replacement of the domestic oils of the food and soap groups by foreign coconut, palm-kernel, palm, sesame, and whale oils. As a basis for the discussion of the problem of replacement, data are presented, in several tables below, with regard to consumption and exports of the food and soap oils, both domestic and imported, but none of these statistics can be considered as a definite measure of the extent to which domestic oils have been replaced by foreign oils. That is a matter of interpretation.

The domestic oils, other than lard and butter, which enter to a greater or lesser degree into competition with the foreign oils, are cottonseed, corn, peanut, and soybean oils, oleo oil and neutral lard, edible and inedible tallow, greases, and fish and whale oils. These taken together are hereafter referred to as domestic food and soap oils. Data for lard are shown separately in several of the tables and totals are given including, as well as excluding, lard. Butter is excluded from summary Tables 4 and 5, but included in detailed Tables 6 and 7. All the tables show data not only for the five foreign food and soap oils specified in the Senate resolution but also for certain other foreign oils more or less similar in character and use; the most important of these other oils is inedible olive. Edible olive oil, like butter, is included only in the detailed tables for the reason that its price is so much higher than that of the other oils as definitely to put it into a separate class and makes it inadvisable to include it in tables showing only totals.

Table 4 presents a general summary of the statistics for 1914 and 1929 with respect to the consumption and exports of oils of the food and soap groups, classified into domestic oils made from domestic materials and oils either foreign or made from foreign materials. Table 5 shows the percentage distribution of consumption as between domestic and foreign oils, the percentages being derived from the absolute figures in Table 4. The data in the two tables may be taken only as approximations as they are based on a variety of sources, and in some instances, involve an element of estimate. However, they represent roughly the situation prevailing in the two years given, which in turn may be taken as typical of the immediate pre-war period and of very recent years, respectively. In the case of domestic oils made from domestic materials, consumption plus exports substantially equals production, although changes in stocks prevent an exact equivalence.

TABLE 4.—*Consumption and exports of principal domestic and foreign animal and vegetable oils, not including butter, edible olive oil, paint oils, and other specialized oils*

[In thousands of pounds]

	Domestic oils made from domestic materials			Five foreign oils covered by resolution	Total foreign soap and food oils [2]	All foreign and domestic oils	
	Lard (except neutral)	Other [1]	Total			Excluding lard	Including lard
Consumption in food:							
1914	1,152,197	1,533,860	2,686,057	5,280	12,645	1,546,505	2,698,702
1929	1,725,164	1,795,535	3,520,699	284,980	286,886	2,082,421	3,807,585
Increase	572,967	261,675	834,642	279,700	274,241	535,916	1,108,883
Per cent	49.7	17.1	31.1	5,297.3	2,168.8	34.7	41.1
Consumption in soap:							
1914	10,484	581,547	592,031	123,358	160,334	741,881	[3] 752,365
1929	.....	832,402	832,402	673,871	783,900	1,616,302	[3] 1,616,302
Increase	.....	250,855	240,371	550,513	623,566	874,421	863,937
Per cent	.....	43.1	40.6	446.3	388.9	117.9	114.8
Total consumption: [4]							
1914	1,162,681	2,118,171	3,280,852	168,987	234,816	2,352,987	3,515,668
1929	1,725,164	2,833,871	4,559,035	1,067,779	1,191,484	4,025,355	5,750,519
Increase	562,483	715,700	1,278,183	898,792	956,668	1,672,368	2,234,851
Per cent	48.4	33.8	39.0	531.9	407.4	71.1	63.6
Exports:							
1914	438,016	350,971	788,987	997	1,071	352,042	790,058
1929	829,328	174,419	1,003,747	29,532	29,532	203,951	1,033,279
Increase or decrease	391,312	−176,552	214,760	28,535	28,406	−148,091	243,221
Per cent	89.3	−50.3	27.2	2,862.1	2,522.7	−42.1	30.8

[1] Including cottonseed, corn, peanut, soybean, oleo oil, neutral lard, edible and inedible tallow, greases, fish and whale oils.

[2] Including, in addition to the 5 oils mentioned in the resolution, inedible olive oil and foots, soybean, and peanut oils, other animal oils, including fish.

[3] The difference between these totals and those shown in Table 115, p. 126, 66,308,000 pounds in 1914 and 75,488,000 pounds in 1929, is accounted for by soap stock, red oil, vegetable tallow, and miscellaneous oils, which are not included in this table.

[4] Exceeds food and soap consumption by quantities used in other industries.

TABLE 5.—*Proportion of the total consumption of principal oils for the specified purpose supplied by lard, other domestic oils, and foreign oils*

	Lard, domestic	Other domestic oils	Total foreign	Foreign oils covered by resolution
Consumption in food:				
Excluding lard—	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1914		99.2	0.8	0.3
1929		86.2	13.8	13.7
Including lard—				
1914	42.7	56.8	.5	.2
1929	45.3	47.2	7.5	7.5
Consumption in soap:				
1914	1.4	77.3	21.3	16.4
1929		51.2	48.8	42.1
Consumption in all industries:				
Excluding lard—				
1914		90.0	10.0	7.2
1929		70.4	29.6	26.5
Including lard—				
1914	33.1	60.2	6.7	4.8
1929	30.0	49.3	20.7	18.6

The situation in 1929.—Apart from lard, butter, and edible olive oil, the total consumption of domestic oils of the food and soap group during 1929 was about 2,800,000,000 pounds, the total exports nearly 175,000,000 pounds, and the sum of consumption and exports (substantially representing production) about 3,000,000,000 pounds. The consumption of the foreign food and soap oils covered by the resolution (coconut, palm-kernel, palm, whale, and sesame) was about 1,070,000,000 pounds and the consumption of all foreign oils of the group (not including edible olive oil) was approximately 1,200,000,000 pounds. Of the combined consumption of the domestic and foreign oils (not including lard, butter, or edible olive oil) in 1929 the domestic represented approximately 70 per cent and the foreign the remainder.

Lard differs from the other domestic oils under consideration in that a very large proportion of the total production is exported. Moreover, lard is used directly by consumers, whereas the other domestic oils, for the most part, become ingredients of manufactured food products or of soaps. The domestic consumption of lard in 1929 was about 1,725,000,000 pounds and the exports 830,000,000 pounds, total production being roughly 2,555,000,000 pounds.

The net imports of foreign oils, not including edible olive oil (substantially represented by the consumption shown in the table), exceeded the exports of domestic food and soap oils (including lard) by 87,000,000 pounds, or about 8½ per cent. The total domestic consumption of lard and other domestic oils of the group amounted to about 4,560,000,000 pounds, and the exports of these oils to 1,004,000,000 pounds, or a total of 5,564,000,000 pounds, whereas the consumption of foreign oils of the group was about 1,200,000,000 pounds. Of the combined domestic consumption of lard and of the food and soap oils in 1929 domestic products represented approximately 79 per cent and foreign products the remainder.

Changes since 1914.—The comparative figures for consumption of oils in 1914 and 1929 (Table 4) shows that, not counting lard, the total consumption in all uses of the oils of the food and soap group, including both domestic and foreign products, increased from about 2,350,000,000 pounds in 1914 to 4,025,000,000 pounds in 1929, a gain of about 1,675,000,000 pounds, or approximately 71 per cent.

The increase was much more rapid than that of the population of the country, which was about 28 per cent.

Between 1914 and 1929 the consumption in all uses of domestic food and soap oils, not including lard, increased by 715,000,000 pounds, or about 34 per cent. The exports of these domestic oils in 1929 were less than half as large as in 1914, the decline in exports being 176,500,000 pounds. The increase in foreign oils was approximately 957,000,000 pounds, or 407 per cent, most of the increase being in the five foreign food and soap oils listed in the resolution. Including lard, both consumption and exports of which increased, consumption of the domestic oils increased about 1,278,000,000 pounds, and exports increased by 215,000,000 pounds.

The change in the relation between domestic and foreign oils in consumption between 1914 and 1929 is further brought out in Table 5, which shows percentages. Excluding lard from consideration, foreign oils represented 10 per cent of the consumption in 1914 and 30 per cent in 1929, with a corresponding reduction in the proportion supplied by domestic oils. Of the total consumption, including lard, the proportion of foreign oils rose from 7 per cent to 21 per cent.

Consumption and exports of the major individual oils.

Table 6 shows the consumption of the principal individual domestic and foreign food and soap oils and the exports of the domestic products. Table 7 shows, by percentages, the relative importance of the several oils in consumption.

TABLE 6.—*Summary of consumption and trade in oils used primarily for food and soap*

[In thousands of pounds]

	1914				1929			
	Food	Soap	Total consumption in all industries	Exports	Food	Soap	Total consumption in all industries	Exports
Domestic from domestic materials:								
Butter	1,641,309	.....	1,641,309	3,694	2,177,297	.....	2,177,297	3,724
Lard, except neutral	1,152,197	10,484	1,162,681	438,016	1,725,164	.....	1,725,164	829,328
Oleo oil, neutral lard, and edible tallow	106,617	.....	106,617	106,943	171,744	.....	171,744	85,566
Inedible tallow and greases	.....	330,931	330,931	9,980	.....	655,271	[1] 839,018	61,279
Fish oil	.....	11,221	11,221	1,340	14,921	38,443	[1] 64,271	.....
Whale oil	.....	632	632	.....	.....	11,084	11,084	.....
Cottonseed oil	1,362,090	119,254	1,481,344	216,410	1,462,006	12,000	1,474,006	19,292
Cottonseed-oil foots	.....	108,141	108,141	.....	.....	108,904	108,904	.....
Corn oil	64,243	11,368	75,611	16,199	133,070	5,000	[1] 138,434	315
Peanut oil	910	.....	910	96	13,701	1,700	15,401	.....
Soybean oil	.....	.....	2,761	3	93	.....	[1] 11,009	.....
Imported or made from imported materials:								
Oils named in resolution—								
Whale	.....	4,023	4,023	.....	809	59,580	60,389	.....
Coconut and palm-kernel	5,280	109,335	114,615	864	256,416	417,125	746,334	29,532
Palm	.....	10,000	[1] 48,959	133	2,540	192,331	[1] 230,980	.....
Sesame	.....	.....	1,390	.....	25,215	4,835	[1] 30,076	.....
Oils not named in resolution—								
Other animal and fish oils	.....	24,355	[1] 27,256	.....	.....	50,000	[1] 59,820	.....
Inedible olive oil and foots	.....	8,046	[1] 18,580	74	.....	53,629	53,629	.....
Edible olive oil	50,805	.....	50,805	52	91,836	.....	91,836	222
Soybean oil	.....	4,499	[1] 12,552	.....	.....	6,400	[1] 8,350	7,967
Peanut oil	7,365	76	7,441	.....	1,906	.....	1,906	.....

[1] Exceeds food and soap consumption by quantities used in other industries.

TABLE 7.—*Percentage of consumption of domestic and foreign food and soap oils*

Item	Percentage of total consumption excluding lard, butter, and edible olive oil		Percentage of total consumption including lard, but excluding butter and edible olive oil		Percentage of total consumption including lard, butter, and edible olive oil	
	1914	1929	1914	1929	1914	1929
Butter					31.5	27.1
Lard			33.1	30.0	22.3	21.5
Domestic oils:						
Cottonseed oil	63.0	36.6	42.1	25.6	28.5	18.4
Cottonseed foots	4.6	2.7	3.1	1.9	2.1	1.4
Oleo oil, neutral lard, edible tallow	4.5	4.3	3.0	3.0	2.0	2.1
Inedible tallow and greases	14.1	20.8	9.4	14.6	6.4	10.5
Fish oil	.5	1.6	.3	1.1	.2	.8
Whale oil		.3		.2		.1
Corn oil	3.2	3.4	2.2	2.4	1.5	1.7
Peanut oil		.4		.3		.2
Soybean oil	.1	.3	.1	.2	.1	.1
Total domestic	90.0	70.4	93.3	79.3	94.6	83.9
Foreign oils:						
Coconut and palm-kernel	4.9	18.6	3.3	13.0	2.2	9.3
Palm	2.1	5.7	1.4	4.0	.9	2.9
Whale	.2	1.5	.1	1.1	.1	.8
Sesame		.8		.5		.4
Other animal and fish	1.2	1.6	.8	1.0	.5	.8
Inedible olive and foots	.8	1.3	.5	.9	.4	.7
Edible olive					1.0	1.1
Soybean	.5	.2	.4	.2	.2	.1
Peanut	.3		.2		.1	
Total foreign	10.0	29.6	6.7	20.7	5.4	16.1

Predominant position of lard and cottonseed oil.—Lard and cottonseed oil, which are strongly competitive products owing to the use of the bulk of production of cottonseed oil in making lard compounds, together formed 81 per cent of the consumption of domestic oils and lard for food and soap in 1914 and 73 per cent in 1929. In 1914, 10,000,000 pounds of lard, probably off-grade, and 119,000,000 pounds of cottonseed oil were used in soap; in 1929 no lard was reported as so used and only 12,000,000 pounds of cottonseed oil exclusive of foots, principally damaged or off-grade oil not suitable for food. Of the domestic oils, except butter used for food, lard and cottonseed oil combined formed 93 per cent in 1914 and 91 per cent in 1929. These two oils are thus the principal domestic food oils and are used almost exclusively for edible purposes. The other domestic food oils are edible animal fats, suc has oleo oil, neutral lard, edible tallow, and two vegetable oils, corn and peanut. Most of the increase in consumption of domestic oils, other than lard, in food from 1914 to 1929 was: (1) In cottonseed oil, owing to a shift in consumption of about 100,000,000 pounds from soap to food uses, total consumption of cottonseed oil being approximately the same in 1929 as in 1914; (2) in edible animal oil; and (3) in corn oil.

Composition of exports.—The oils used primarily in foods are responsible for the great bulk of the exports of domestic food and soap oils, including lard but excluding butter. Exports rose from 789,000,000 pounds in 1914 to 1,004,000,000 pounds in 1929. Excluding lard, they fell from 351,000,000 to 175,000,000 pounds, and excluding nonfood oils from 341,000,000 to 113,000,000 pounds.

This decline was mainly in cottonseed oil, which to an increased extent has been absorbed in domestic food uses, particularly in lard compounds, in salad oil, and in salad dressings. Oleo oil exported for use in making margarine accounts for most of the remaining exports.

Position of domestic and foreign oils in food uses.—In food uses domestic oils, including lard but excluding butter, greatly predominated both in 1914 and 1929, but their percentage of the total consumption in foods fell from 99.5 per cent in the former to 92.7 per cent in the latter year. The increased proportion of the foreign oils used was due almost entirely to the increased use of coconut and palm-kernel oils—an increase from 5,000,000 pounds in 1914 to 319,000,000 pounds in 1929. Practically this entire increase went into the manufacture of nut margarine, made largely of coconut oil, and into the candy and baking trades, uses for which these oils were specially adapted.

Position of domestic and foreign oils in soap manufacture.—In the soap industry domestic oils also predominated in the entire period under consideration, and the quantity of them actually used increased about 240,000,000 pounds, or 41 per cent, from 1914 to 1929. Nevertheless, their predominance greatly declined, for the total consumption of oils in soap making increased over 100 per cent, or by about 864,000,000 pounds. In 1914 foreign oils were 21 per cent of all oils consumed in soap; by 1929 they had increased to 49 per cent.

The increase in foreign oils used in soap making was mainly in coconut, palm, and whale oils. Throughout the period the principal foreign oil was coconut oil. In both years the major domestic soap-making oils were inedible tallow and animal greases; between 1914 and 1929 their consumption in this industry increased almost two-fold, from 331,000,000 pounds to 655,000,000 pounds. This was the only important increase in the consumption of domestic oil in the soap industry.

Imports and exports of food and soap oils compared.—Both in 1914 and 1929 the imports of oils for use in soap making were not offset by any large exports of domestic oils used primarily for that purpose. Therefore, the United States may be said definitely to be upon an import basis with respect to oils for use in soap making.

The situation with respect to principal oils used primarily for food is not so simple. Including lard and butter in both 1914 and 1929, exports of domestic oils, which go primarily into food, exceeded imports of oils for that use. Excluding lard and butter, exports led in 1914, but imports led in 1929. In 1914, exports of food oils, not counting butter or lard, amounted to 341,000,000 pounds and net imports to 13,000,000 pounds, excluding edible olive oil, and including such oil to 63,000,000 pounds. In 1929, exports, now confined largely to oleo oil and neutral lard, amounted to 113,000,000 pounds and net imports, principally coconut oil, to 287,000,000 or 379,000,000 pounds, according to whether or not edible olive oil is included.

Summary.

The tables which have been given indicate that imports have supplied an increasing proportion of domestic consumption in both food and soaps, but that domestic products consumed in both uses have increased in actual quantity. Including lard, domestic exports of

oils have increased; excluding lard, they have decreased. The increased imports have consisted mainly of coconut, palm, palm-kernel, and whale oils, all of which are covered by the resolution.

General aspects of the question of replacement.

As already stated, the preceding statistics regarding consumption and exports of oils do not furnish a basis for a definite measuring of the replacement of domestic by foreign oils. The fact that a given quantity of foreign oil is used does not necessarily mean that corresponding quantities of domestic oil would have been used if the foreign oil had not been imported. Nor does the fact that there has been a given increase in the use of foreign oils necessarily indicate that, without the increase, the consumption of the domestic product would have increased by like amount. Under certain conditions imports of a commodity are in the nature of a supplement to, rather than a replacement of, the domestic product. To what extent this is to be considered the situation with respect to the food and soap oils is a question to which no certain answer can be given, for analysis can not be carried far without getting into matters which in their very nature are speculative.

In the body of the report the question of replacement, as apparently contemplated by the resolution, is dealt with historically. But in a brief survey the subject may perhaps best be approached by asking what changes would follow from a drastic reduction or elimination of the imports of foreign food and soap oils and oil-bearing materials. These changes might be qualitative or quantitative. From the qualitative standpoint, it might be necessary to make important technical changes in the types of products made from oils. From the quantitative standpoint, the effects might relate (*a*) to the total consumption of oil-containing foods and of soap; (*b*) to the exports of domestic oils, including lard; and (*c*) to the production of domestic food and soap oils, including lard. There might also be effects on butter and other fat-containing foods and even on nonfatty foods.

The interpretation of the word "replacement" as used in the Senate resolution turns in considerable part on the attitude taken with respect to qualitative changes in the products derived from oils. As shown further in this report, to a certain extent very difficult to measure, domestic oils if available could be substituted for foreign oils without materially changing the characteristics of the resulting products. In so far as this could be done and in so far as domestic production would be sufficiently increased, by reason of a reduction of imports, replacement, under any interpretation, may be said to have occurred. But a great reduction or the entire elimination of foreign oils would necessitate material changes in the character of many domestic products, particularly domestic soaps. It must be a matter of judgment whether so much foreign oil as may be involved in the production, in approximately the present proportions of the various types of products now being made in the United States, is to be considered as replacing domestic oils, assuming that domestic production could be increased correspondingly. The commission expresses no opinion on this point but merely calls attention to the problem.

The discussion below of the technical factors affecting interchangeability roughly indicates the nature of the qualitative changes which would result from a drastic reduction or the entire elimination of

foreign oils from foods and soaps. The succeeding discussion shows the problems in connection with the expansion of domestic production of oils to take the place of foreign oils.

Technical factors affecting interchangeability.

Points relating to the technical characteristics of oils and to the effects of changes in the proportions of different oils used on the character of food products and soaps are discussed at length in the body of the report and may be here briefly summarized.

Each oil differs somewhat from every other oil in characteristics. Certain oils are not interchangeable at all; others so closely resemble one another that they may be interchanged in certain uses without appreciably affecting the character of the product into which they enter. There are various gradations, however, between these extremes. Some oils may be rendered interchangeable to a considerable extent by processing at least one of them. Other oils may be substituted for one another, only in a very different sense, the substitution involving a decided change in the character of the product.

Sesame oil.—Sesame oil is used in the United States mainly as a salad and cooking oil and in lard compounds. In all these uses it makes products substantially similar in characteristics to those made with domestic cottonseed, peanut, and corn oils. Most of the 25,215,000 pounds of sesame, which were used largely for food purposes in 1929, may be considered as technically interchangeable with the three domestic oils named.

Palm and whale oils.—Both palm oil and whale oil are used in the United States mainly in soaps. In that use both of them have characteristics similar to inedible tallow with which they are technically interchangeable in making certain types of soap.[1] An exception is the use of palm oil in making some soaps for the textile industry. Practically the whole of the 253,000,000 pounds of these oils used in the soap industry in 1929, however, may be taken as technically interchangeable with domestic inedible tallow.

In its use in the manufacture of tin plate, for which purpose about 15,000,000 pounds are used annually, no satisfactory substitute for palm oil has so far been developed on a commercial scale.

Coconut and palm-kernel oils.—The question of technical interchangeability of coconut and palm-kernel oils with domestic oils is much more involved. From 55 to 60 per cent of the quantity of these oils consumed in the United States enters into soap; from 25 to 30 per cent into margarine; and from 10 to 15 per cent into other food products, principally into the manufacture of confectionery and certain baking products. The most difficult, as well as quantitatively the most important, question of replacement occurs in soap making, in which these oils are almost always used in combinations in varying proportions with one or more domestic oils. The most common combination is with tallow. The proportions of coconut and palm-kernel oils as compared with the proportions of the domestic products can be varied within moderate limits without much change in the character of the resulting soap. A great reduction or the entire elimination of these foreign oils, however, would make a material change in the character of the soap.

[1] For a discussion of the relation of color and other factors to interchangeability see Sec. 4, pp. 35 and 56, also Pt. iv, p. 145, and Pt. v, p. 213.

Hard toilet and most white laundry soaps, including flakes, chips, granules, and other similar forms, now constituting a large proportion of the total output of soap, contain a large fraction of coconut or palm-kernel oil. These types of soap, which lather quickly and profusely even in cold hard water, have increased greatly in use in recent years. Any great reduction in the use of coconut and palm-kernel oils—necessitating an increased use of animal oils, particularly inedible tallow; of soft vegetable oils, hydrogenated and unhydrogenated, such as cottonseed, corn, and soybean; and of rosin—would involve a reversal of this trend. Details regarding such characteristics as hardness, color, odor, lathering quality, solubility, and cleansing quality of soaps made from different oils and combinations of oils are set forth in the body of the report, with particular reference to the effect of including and excluding coconut and palm-kernel oils.

Coconut oil is used in the margarine industry as a principal ingredient of vegetable-oil margarine, and no other oil which has been tried on a commercial scale has proved as satisfactory in making this type of margarine. But vegetable-oil margarine is to a large degree interchangeable with animal-oil margarine and therefore coconut oil may be said to be interchangeable with the principal ingredients of such margarines—that is, with oleo oil, neutral lard, and cottonseed or peanut oil. But questions of personal preference and price are involved as the flavor of the two types of margarine differ and as the vegetable-oil margarine ordinarily sells for the lower price.

Approximately enough oleo oil, neutral lard, and cottonseed oil are exported each year to make the same quantity of margarine as is made from coconut oil mixed with a small proportion of cottonseed or peanut oil—a smaller proportion than is generally used in animal-oil margarine. Economic as distinguished from technical questions are involved in considering what effect the shift in production from vegetable oil to animal oil margarine would have on the total consumption of that product, on the demand for domestic oils for use in margarine, on the demand for butter, and on the demand for other fatty or nonfatty foods.

The consumption of coconut oil in certain confectionery and baking products could be reduced for the most part only by distinct changes in characteristics of the products.

Economic factors involved in the question of replacement.

Effects of reduction of oil imports.—The quantitative results of a substantial reduction or the elimination of the imports of the five foreign oils under discussion will be treated under the three headings already suggested.

(a) *On total consumption of oils.*—One result of an important reduction or the elimination of imports of foreign oils may be to cut down the total consumption of oils in the United States. Presumably such a change would lead, temporarily at least, to an increase in the price of domestic oils and of the foreign oils that might continue to be imported; also to a corresponding increase in the cost and probably the price of the products made from them. This in itself would have some tendency to reduce consumption and to bring about an increased use of nonoil substitutes, particularly for cleaning purposes. Then, too, in the case of soap, the technical changes necessary to accom-

modate the product to a great reduction in the content of coconut and palm-kernel oils might influence aggregate consumption. So, too, the reduced use of coconut oil in margarine and in confectionery and baking products might to some degree reduce the consumption of oil-containing foods. In connection with these possibilities a question might be raised as to the effect of any lessening of the consumption of oils in foods upon the consumption of other food products of domestic or foreign origin.

It is certain, however, that a reduction in imports of oils would not cause anything like an equal reduction in total consumption of oils, the decrease in imports being to a considerable extent offset by an increase in domestic production or a decrease in domestic exports, or both.

(*b*) *On exports of domestic oils and lard.*—Another direction in which a reduction or the elimination of the use of foreign oils might exert an influence is upon the exports of oils from the United States. Apart from lard these exports are relatively small and their entire elimination would not add greatly to the supply available for domestic consumption, except in the case of oleo oil for use in margarine. But exports of lard are very large, and by their reduction the consumption in the United States of domestic oils could be greatly increased. An increase accomplished in this way, however, would cause a shift in the uses of the domestic oils, particularly in cottonseed oil about 73 per cent of which was used in lard compounds during 1929 in direct competition with lard. Lard could be diverted from export channels only by an increased demand for it in the United States, arising from a decline in the domestic production and consumption of lard compounds. But such a decline is apt to occur only in consequence of the absorption of a considerable volume of cottonseed oil in soap manufacture at a price sufficiently high to attract it from the lard compound and other food industries. Strong competition would result between lard and lard compounds for the market for cooking and shortening fats and between the lard compound and soap industries for cottonseed oil. The results of this competition would be difficult to predict, as the effect of increased prices for soap and for shortening fats upon the volume of demand could not be known in advance.

The diversion of cottonseed oil into the soap kettle would reverse the tendency which has prevailed for three decades. Originally produced as an oil for use in soap making because of its cheapness compared with other available oils, cottonseed oil, after the appropriate method of refining had been developed, was progressively absorbed into lard compounds. This was accomplished both by a diversion from soap making and by an increase in production, brought about through a greater utilization of cottonseed in oil manufacture. As far back as 1914 when the importation of foreign food and soap oils amounted to only 234,000,000 pounds, and when cottonseed oil was still lower in price than most soap oils, domestic or foreign, particularly lower than tallow or coconut oil, the consumption of cottonseed oil for soap amounted to only 119,000,000 pounds as compared with 1,362,090,000 pounds for food. During the period of the World War when, because of its limited supply compared with the more expansible supply of certain other oils, its price rose above those of other soap oils, cottonseed oil practically disappeared from the

soap kettle except for damaged lots and off grades. It has remained out of the soap kettle largely because its price has been almost continuously higher than that of domestic inedible tallow and usually higher than that of coconut oil.

(*c*) *On domestic production of oils and other products.*—To the extent that the reduction of total consumption of oils or of exports of oils should fail to equal the reduction in imports of oils and oil-bearing materials, an increase of domestic production would take place. The increase in domestic production might be (1) in butter, (2) in lard, (3) in oils of the type which ordinarily enter into soap, margarine, and lard substitutes, or (4) in other fat-containing foods, such as milk, and fat in meats, especially pork meats.

It is impossible to estimate with any approach to accuracy the relative effect of any reduction in imports of oil in the three directions mentioned, namely, decreased consumption, decreased exports, and increased domestic production. Certain points bearing on the possibilities of increasing domestic production, more fully set forth in the body of the report, may be briefly summarized here.

General factors in the problem are (1) climatic and soil conditions affecting the possibility of producing oil seeds and oil nuts, (2) the relation of certain oils to other commodities of which they are by-products, and (3) the relation of certain oils to oil cake and other joint products of the oil-bearing materials. The significance of these factors may best be considered by taking up separately the major individual oils or groups of oils which are, or might be, produced in the United States.

Butter.

Foreign oils, in the form of margarine, compete with butter to a certain extent in the markets of the United States. The domestic production of butter is about 2,000,000,000 pounds annually. The quantity of foreign oils used in margarine is somewhat less than 200,000,000 pounds. Points bearing on the question as to how far, if this use of foreign oils should be greatly reduced or eliminated, domestic animal or vegetable oils would take their place in margarine have already been discussed. To the extent that margarine from domestic materials replaced that from foreign materials, there would evidently be no addition to the demand for butter. There remains the question as to what effect any reduction which might occur in the total consumption of margarine would have upon the consumption of butter. The answer would be largely a matter of opinion. Butter has normally been much higher priced than margarine, and the difference would undoubtedly remain very considerable even if domestic materials alone were available for use in margarine. To what extent consumers, with margarine available only at prices relatively higher than at present, would demand more butter as against more fat meats, lard, and other fatty products, or against a reduction in their total consumption of fatty foods, depends both on the tastes of consumers and on their buying power.

Lard.

The possible effect upon the exports of lard of a reduction in the domestic consumption of foreign oils has already been discussed. A shifting of cottonseed oil from lard substitutes to soap, should it take place, might result in reducing lard exports; how far it would

also bring about an increase in lard production is problematical. There is relatively little waste of hog fat, that which is not now converted into lard or grease being mostly consumed as meat. Although lard constitutes a substantial proportion of the total value of hog products it is essentially a by-product of meat, and the effect of increased production of lard on the prices of pork meats would be the major consideration in connection with the expansion of lard production. It would be possible, of course, without increasing the number of hogs raised, to fatten them more, with a consequent increase in the quantity of caul fat (from which most of the lard is obtained), but this would probably involve, for a given number of hogs, an increase also of the fat in other parts of the carcass, both adding to the total supply of pork and to the proportion of fat to lean.

Oleo oil, tallow, and animal greases.

Oleo oil is a by-product of beef production; tallow is a by-product chiefly of beef production but also of mutton production; and the greases are a by-product of beef, mutton, and pork production.

It is not likely that an increased demand for oleo oil, tallow, or greases would be met merely by increasing the production of cattle, sheep, and hogs, carrying with it a corresponding increase in meat production. The price of meats, the major product, would be a more important consideration than that of oils. Increased demand for these oils might, however, cause such changes in the methods of feeding animals as would result in a greater proportion of fat. To what extent this would prove profitable or would actually take place in case of a marked reduction in imports of foreign oils, it is entirely impossible to judge; it should be noted that such a change would affect the character of the meat sold as such, and not merely add to the quantity of oleo oil, tallow, and greases available.

A third means of increasing the domestic supply of these animal oils lies in the reduction of waste of animal fats. There is probably little room for expansion of the output of oleo oil by this means but the limits in the case of inedible tallow and greases are apparently wider. The output of these products has increased much more during recent years than the output of meat, largely by reason of greater effort to collect waste fats from the smaller slaughtering establishments and from meat dealers. There are undoubtedly still large quantities of animal fats which are practically wasted and from which more tallow and greases could be obtained if the prices were high enough to justify the effort. Any large increase in their use in soap could be accomplished only by increase in production, as they are little used for other purposes or for export.

Whale oil and fish oils.

The supply of whales in the North Atlantic and the North Pacific regions, to which American whalers confine their operations, appears to be approaching exhaustion. For this reason, little or no increase in domestic production of whale oil may be expected unless domestic whalers should share in the exploitation of the Antarctic waters. The domestic production of fish oils, however, may be increased, but the maximum increase which could be expected would still leave fish oils as a minor source of supply of the animal and vegetable oils consumed in the United States. In the five years 1926 to 1930, average domestic production of fish oils amounted to only 96,636,000 pounds

compared with a domestic consumption of animal and vegetable oils amounting to more than 5,000,000,000 pounds annually, excluding butter and edible olive oil.

Cottonseed oil.

Cottonseed is a by-product of cotton production and cottonseed oil is a joint product of the seed along with cake and meal, which are used for animal feed. At the prices which have prevailed in recent years for cotton and cottonseed products, the oil has represented only about 6 per cent of the total value of the products of cotton growing. Any increase in the production of cottonseed would involve a corresponding increase in that of cotton and would thus affect the price of cotton. It would be possible to increase somewhat the output of the oil, without adding to the cotton crop, by subjecting the maximum proportion of the seed to crushing, but the proportion already crushed is not far below the maximum, and the increase in this direction would be limited. Moreover, higher prices might possibly stimulate the introduction of processes which would make a more nearly complete recovery of the oil in cottonseed. Complete recovery would add approximately 20 per cent to the oil production.

Corn oil.

Corn oil is derived from the germ of the corn grain. As produced in the United States in the past, it has been in the nature of a by-product of only two of the alternative uses of corn. The great bulk of the corn produced is fed as such to animals and another considerable quantity is ground whole for use as food. A limited quantity of corn is treated for the primary purpose of producing cornstarch from which corn sugar is made. For this purpose it is necessary to remove the germ, and from the germ, as a by-product, corn oil is expressed, the residue of which is cake. Corn oil is also expressed from germs removed in the production of corn meal and corn hominy.

An increased demand for domestic oils, under these circumstances, would not be expected to result in greater production of corn. Nor would it have much effect upon the proportion of the corn which is treated for starch and corn sugar, with corn oil as an incidental product. Any considerable increase in the production of corn oil would have to come from some other source. It might be technically possible to devise an economical method of separating the corn germ for oil purposes, leaving the remainder of the kernel for animal feed. To what extent such a process could be applied would depend both on its cost and on the relative demand for degerminated corn, as against whole corn, for animal feed.

It is thus impossible to estimate, even in the roughest fashion, the effect of a reduction of imports of oils upon the domestic output of corn oil.

Peanut oil.

In the United States at the present time peanut oil is a by-product, but this is not the case in certain foreign countries where peanuts are grown chiefly for the oil. In this country peanuts are grown chiefly for use directly as food or for conversion into peanut butter, and ordinarily only the culls of the crop are crushed for oil, although when prices of oil are exceptionally high a larger proportion of the peanuts are crushed.

There is abundant land suitable for the production of peanuts in the United States. The question whether it would be profitable to grow large quantities for the primary purpose of extracting oil depends upon the price obtainable for peanut oil and on the price situation with respect to the joint product, oil cake. This subject is further discussed below.

Other vegetable oils.

In the United States there is little production of vegetable food and soap oils other than cottonseed, corn, and peanut. The question arises whether, in case of a great reduction or elimination of imports of oil, there might be a marked expansion of the domestic production of other kinds of vegetable oils.

Apart from the cotton, peanut, and corn plants, the most important of the Temperate Zone plants from which food and soap oils can be derived are soybean and sunflower. Although there are large areas suitable for producing it, the sunflower has been grown in the United States only in small quantities and not for oil, but as an oil crop it is of considerable importance in certain foreign countries, principally Russia.

Soybeans in the United States are grown chiefly as a cover crop and for animal feed. The quantity of beans crushed, although small in proportion to production, has risen in recent years and resulted in an output of 14,387,000 pounds of oil in 1930, and of 39,128,000 pounds in 1931. The quantity crushed could be still further increased, as also could the total production of soybeans. Whether this would be profitable depends again primarily on the price obtainable for it and on the matter of disposal of oil cake.

Linseed oil in the United States is used almost exclusively for paints. It is possible technically to use it in soap, and also to use it for food by proper methods of refining. In view of the fact that the duty on linseed oil has not resulted in a domestic production sufficient to supply the paint requirements, it is doubtful whether even the entire elimination of imports of the primarily food and soap oils would have much effect on the production of linseed.

The problem of oil cake and other residues.

To whatever extent the domestic production of vegetable oils should be increased, there would result an increase in the production of oil cake, oil meal, and other residues which must be used for animal feed. These residues form, judging from the census figures for 1930, from 30 to 50 per cent of the combined value of oil and cake obtained from crushing the different domestic raw materials. Of those domestic seeds which are now, or which would be most likely to become, important sources of oil, cottonseed and soybean yield five and one-half times as much cake and meal as oil, sunflower seed three and one-half times as much, peanuts two and one half times as much, and flaxseed twice as much; from corn germs the weight of cake and meal is only equal approximately to that of the oil, but from whole corn it is from twelve to twenty-six times as much.

Including production of oil cake and oil meal from imported materials, principally flaxseed and copra, domestic production amounted to 6,400,000,000 pounds in 1929, of which about 4,500,000,000 pounds were from cottonseed and about 1,500,000,000 pounds from flaxseed, domestic and imported. This quantity is

equal—disregarding food value, which is higher than that of corn—to about 115,000,000 bushels of corn, or roughly, 5 per cent of the corn crop. Because of the abundance of other animal feeds in the United States, especially corn, as against the relative scarcity of such feeds in western Europe, a considerable portion of the oil cake and meal is exported; the relatively high feed value of this product per unit of weight favors its export in preference to that of feed grains. More than half of this export is linseed-oil cake made from imported flaxseed and exported with benefit of the drawback. The export in 1929 amounted to about 1,278,305,000 pounds, including linseed cake, and to about 544,000,000 pounds, excluding linseed cake. This compares with an import in that year of about 334,000,000 pounds, leaving a net export of 210,000,000 pounds of meal and cake made from domestic materials. Imports are used principally in the Pacific Coast and Rocky Mountain States, which have a deficiency of feeding material of this kind. Partly because of lower transportation costs by water than by rail, producers of cottonseed and linseed meal in the Eastern and Southern States find a more advantageous market in Europe than in the far Western States, while farmers in the far Western States find it more advantageous to buy in various Asiatic countries and in near-by Mexico.

If all imports of foreign food and soap oils should cease, and if the domestic production should increase correspondingly and be entirely in cottonseed and soybean oils, the present output of oil cake and oil meal would be increased about 80 per cent.

In considering whether it is advantageous to increase the production of any oil-bearing plant, farmers must take into account both the prices of oil and the prices of oil cake and meal; likewise, the relation of the production of these forms of animal feed to the demand for corn and other feed grains, both in this country and in export markets. The uncertainty as to the actual reaction of domestic producers to these considerations renders more or less insoluble the question how much the output of vegetable oils in the United States might increase as the result of any reduction in the imports of such oils.

Other fatty foods.

The possible effects of a reduction in the imports of oils upon the consumption of fatty meats and similar forms have already been touched upon. To the extent that other substitutions failed to make up for that reduction, it might cause increased demand for fat pork, bacon, and other similar products. It is obviously impossible to make even the roughest estimate of what would happen.

Rosin.

Rosin is an important ingredient in most yellow laundry soaps. Reduction or elimination of coconut and palm-kernel oils as ingredients in soap, by diminishing the materials for white laundry soaps, might cause a reversal of the trend from yellow to white soaps and cause an increased use of rosin. This would presumably reduce exports of rosin, which in 1929 amounted to 718,000,000 pounds, or 58 per cent of domestic production in that year. The extent to which the production of rosin in the United States could be increased is discussed in the body of the report.

Section 3.—Statistical and Cost Data on the Oils Specifically Covered by the Resolution (Summary of Part III)

COPRA

Copra is the dried meat of the coconut. It is the principal raw material for coconut oil.

Under the tariff acts of 1922 and 1930 copra has been duty free.

The Philippine Islands, the Netherland East Indies, Ceylon, British Malaya, the South Sea Islands, and India are the chief countries producing copra in commercial quantities. No official figures are available as to their output, but exports (in terms of copra) may, in general, be taken as a rough measure of production. In the years 1923 to 1930, inclusive, exports of copra and of coconut oil in terms of copra from the first four countries named averaged 2,495,000,000 pounds annually. This is equivalent to approximately 1,570,000,000 pounds in terms of oil. Exports from all sources were about 2,760,000,000 and 1,740,000,000 pounds, respectively.

In recent years (1928 to 1930, inclusive) imports of copra into the United States have been between 500,000,000 pounds and 600,000,000 pounds annually. The Philippine Islands, the chief source of imports, have supplied from 50 to 80 per cent of the total since 1921. The principal sources in 1929 and 1930 and imports from each source are shown in the following table:

TABLE 8.—*Copra: Imports into the United States by country of shipment*

[In thousands of pounds]

	1929	1930
Philippine Islands	310,194	336,554
British Malaya	84,532	60,254
Australia	69,579	35,582
British Oceania	44,825	53,030
French Oceania	24,097	18,307
Netherlands East Indies	29,162	61,569
Other countries	8,542	30,043
Total	570,931	595,339

Costs of production of copra were not readily ascertainable except for certain provinces in the Philippine Islands. In the Province of Tayabas, producing about 30 per cent of the total output of the islands, the cost, allowing the producer a return of 10 per cent on his investment, was stated[1] to be 3.68 cents a pound for the season 1929–30. Adding a sales tax of 1½ per cent, ocean freight of $6 per long ton to San Francisco, and miscellaneous charges, brings the landed cost to approximately 4 cents a pound.

In Manila the average price of two principal grades of copra in 1929 was 3.38 and 3.78 cents a pound respectively, and in 1930, 3.10 cents a pound and 3.45 cents a pound; the average price of all copra delivered to domestic mills was 4.6 cents a pound in the 18-month period, 1929 and first 6 months of 1930.

[1] Report of United States trade commissioner at Manila.

COCONUT OIL

Coconut oil has been dutiable at 2 cents per pound under both the tariff acts of 1922 and 1930. Shipments from the Philippine Islands enter duty free.

In the United States coconut oil is used chiefly in the manufacture of soap, this industry ordinarily accounting for more than 60 per cent of the total domestic consumption; 300,000,000 pounds were used in 1930 in the soap industry. The margarine industry is the second largest consumer, accounting for about 180,000,000 pounds; and the next largest are the confectionery and baking industries, accounting for about 50,000,000 pounds, and lard substitutes for about 20,000,000 pounds in the same year.

The chief primary producing and exporting countries are the Philippine Islands, Ceylon, Netherland East Indies, and British Malaya. The principal secondary producing countries, i. e., those producing from imported copra, are the United States, Germany, France, and the Netherlands.

The primary producing countries named above exported in 1930 467,140,000 pounds, of which 324,880,000 pounds were from the Philippine Islands; the secondary producing countries mentioned above produced 999,548,000 pounds, of which 378,214,000 pounds were produced in the United States.

In general, the surplus producing countries are the Netherlands, Germany, Denmark, and France, in Europe; the Philippine Islands, Ceylon, Netherland East Indies, and British Malaya, in the Orient. Areas into which imports are relatively large are the United States, the United Kingdom, Sweden, and Belgium.

The consumption of coconut oil in the United States in 1930 was about 660,000,000 pounds. Of this, some 350,000,000 pounds were produced in this country from copra imported largely from the Philippines. In 1930 imports of coconut oil, as such, were about 318,000,000 pounds, practically all of which came from the Philippine Islands, and exports were about 25,000,000 pounds.

The following table shows production, free and dutiable imports, and exports of coconut oil in the years 1926 to 1930, inclusive.

TABLE 9.—*Coconut oil: Production, dutiable and free imports, and exports*

Year	Production	Imports		Exports
		Dutiable	Free	
	Pounds	*Pounds*	*Pounds*	*Pounds*
1926	260, 712, 073	326, 771	245, 129, 333	15, 952, 287
1927	281, 654, 384	38, 014	293, 369, 704	20, 418, 143
1928	311, 180, 693	60, 269	290, 636, 702	24, 652, 602
1929	352, 654, 322	43, 453	411, 936, 213	29, 532, 396
1930	352, 727, 286	32, 559	317, 919, 253	25, 106, 817

The Tariff Commission obtained data on the cost of producing coconut oil from eight companies in the United States for the year 1929 and the first six months of 1930. These companies produced about 99 per cent of the total output during the 18-month period. The commission also obtained costs from two important Philippine

producers having offices in the United States, but the figures can not be published without disclosing confidential information. Costs for the eight producing companies in the United States are summarized in the following table:

TABLE 10.—*Coconut oil: Costs per short ton of copra crushed and per pound of oil produced in the United States, 1929 and 6 months of 1930*

Cost item	Dollars per ton of copra	Cents per pound of oil
Cost of copra	$91.87	6.53
Total factory, general and administrative expense	4.78	.34
Imputed interest on plant assets and inventories	1.02	.07
Total copra and conversion costs	97.67	[1] 6.94
Copra crushed ..... tons	405,265	
Coconut oil produced ..... pounds	512,192,152	

[1] 7.01 cents for 1929 and 6.78 cents for 1930 (6 months).

For the companies for which costs were obtained in the United States, the weighted average net sales price of coconut oil was 7.64 cents a pound for 1929 and 6.85 cents per pound for the first six months of 1930. The weighted average landed price of imported coconut oil at the principal ports of importation was 7.69 cents a pound for 1929 and 6.86 cents per pound for the first six months of 1930. To these prices are added transportation charges to the principal consuming markets in the Mid-West, averaging, when weighted, about one-half cent a pound for the domestic product and about one-third cent a pound for the imported product. The price of the domestic and imported coconut oil delivered to the principal consuming markets in the United States is shown in the following table.

TABLE 11.—*Coconut oil: Delivered cost or price at principal consuming markets in the United States*

[In cents per pound]

Period	Based on—		
	Cost of production	Sales price	Import price
1929	7.57	8.14	8.06
1930 (6 months)	7.35	7.32	7.20

PALM-KERNEL OIL

Palm-kernel oil has been free of duty under the tariff acts of 1922 and 1930, except under the latter act the edible grade (not denatured) was assessed 1 cent a pound.

The oil palm tree furnishes the raw material for both palm-kernel oil and palm oil, the kernel producing the one and the outside or fleshy part of the nut the other. Palm-kernel oil has much the same characteristics and uses as coconut oil. In the United States the soap industry consumed in 1930 about 30,000,000 pounds, the

confectionery and biscuit industries about 10,000,000 pounds, and the margarine industry smaller quantities.

The average annual world output of palm-kernel oil is approximately 550,000,000 pounds. Germany and the United Kingdom are the principal producers and exporters. They obtain the kernels chiefly from West Africa, and to a small but increasing extent, from Sumatra, and export the oil not consumed locally to the United States and other countries.

The following table shows the estimated production in and the exports from the United Kingdom and Germany in recent years.

TABLE 12.—*Palm-kernel oil: Estimated production and exports of chief producing and exporting countries*

[In thousands of pounds]

Year	Estimated production		Exports	
	United Kingdom	Germany	United Kingdom	Germany
1926	223,300	236,704	62,392	41,174
1927	185,210	271,545	39,086	66,072
1928	165,558	295,010	42,358	84,224
1929	153,228	302,060	37,488	94,234
1930	126,977	304,322	18,952	97,884

Up to 1931 the production of palm-kernel oil in the United States was negligible. With palm kernels on the free list and the edible grade of oil taxed 1 cent a pound under the act of 1930, the domestic industry began to increase the output of oil.

Imports of palm-kernel oil increased materially in 1925, and reached their maximum in the following year when nearly 75,000,000 pounds came in. They originated principally in Germany and the United Kingdom, the former country ranking first since 1927.

Imports for consumption in the United States, 1926 to 1930, were as follows:

TABLE 13.—*Palm-kernel oil: Imports into the United States*

Year	Quantity	Year	Quantity
	Pounds		*Pounds*
1926.....free..	74,979,912	1930 (June 18-Dec. 31).....dut..	9,866,934
1927.....do...	43,127,657	1930 (June 18-Dec. 31).....free..	12,062,291
1928.....do...	53,812,482		
1929.....do...	69,999,169	Total, 1930.....	38,970,785
1930 (Jan. 1-June 17).....do...	17,051,560		

The weighted average landed price of palm-kernel oil imported at New York, the principal consuming market, was 7.83 cents a pound in 1929 and 6.95 cents a pound in the first six months of 1930. The landed price at the chief ports of entry, plus transportation charges to Cincinnati, an important consuming market, was 8.17 cents a pound in 1929 and 7.13 cents a pound in the first six months of 1930.

PALM OIL

Under the tariff acts of 1922 and 1930 palm oil has been free of duty.

The outside fleshy portion of the ripe fruit of the oil palm tree is the raw material for palm oil. The oil produced in Africa appears in grades known as hard, medium, and soft, and under various names, such as Lagos and Niger. That produced in Sumatra is uniform in quality and is suitable for edible uses.

In the United States palm oil is consumed chiefly in the manufacture of soap, about 190,000,000 pounds having been so used in 1930. The tin-plate industry accounted for approximately 15,000,000 pounds in the same year. Very little palm oil is used for edible purposes in the United States.

Estimated on the basis of exports, the world production of palm oil was about 595,000,000 pounds in 1930. British Nigeria, the chief producing country, exported 304,000,000 pounds in 1930, and the Belgian Congo, French West Africa, and the Netherland East Indies most of the remainder. The greatest relative increase in output has occurred in Sumatra, in the Netherland East Indies, where large plantations have been planted in oil palms.

The United States and the United Kingdom are the principal importers of palm oil, taking over 400,000,000 pounds in 1930. Imports of palm oil into the United States, which reached a maximum of 287,000,000 pounds in 1930, originated chiefly in British West Africa, the Netherland East Indies, and the Belgian Congo. Imports for consumption from 1926 to 1930 were as follows:

TABLE 14.—*Palm oil: Imports into the United States*

Year	Quantity	Year	Quantity
	Pounds		*Pounds*
1926	130,746,694	1929	261,816,442
1927	159,911,079	1930	287,492,589
1928	169,227,565		

The weighted average landed price of palm oil imported at New York, the chief consuming market, was 7.75 cents a pound in 1929 and 6.75 cents a pound in the first six months of 1930. The weighted average landed price at the chief ports, plus transportation charges to Chicago, an important consuming market, was 8.08 and 7.20 cents a pound in 1929 and the first six months of 1930, respectively.

SESAME OIL

Sesame oil, free under the tariff act of 1922, was made dutiable at 3 cents per pound in the act of 1930, but remains free when denatured so as to be unfit for edible use.

In the United States sesame oil is used principally as an edible oil, largely in salad dressings and in lard substitutes. For technical purposes it is used chiefly in the soap industry.

India and China are the chief producers of sesame seed, but India has a very small surplus for export. In 1930, the output in India was

1,019,000,000 pounds, of which only 24,000,000 pounds were exported. Exports from China in the same period were 256,000,000 pounds.

In the production of sesame oil, India and China predominate as they are the chief producers of the raw material. No other country produces in great quantity, and international trade does not bulk large.

Until 1931 no official statistics were available as to production in the United States, but production may be measured by the quantity of seed imported. The oil equivalent of the sesame seed imported increased to nearly 26,000,000 pounds in 1930. The importation of seed into the United States is favored by the low rate of exchange for silver in China and by the duty of 3 cents a pound on the edible grade of oil imposed by the tariff act of 1930. Production is mainly on the west coast, where crushing is favored by the shortage of oil and oil cake.

Imports of sesame oil into the United States reached a maximum of nearly 22,000,000 pounds in 1929. They originated principally in the Netherlands and the United Kingdom. Since the imposition of duty under the act of 1930, imports have become practically negligible, the seed being imported and the oil produced in the United States. Imports from 1926 to 1930, inclusive, were as follows:

TABLE 15.—*Sesame oil: Imports into the United States*

Year	Quantity	Year	Quantity
	Pounds		*Pounds*
1926.....free..	8,861,947	1930 (Jan. 1-June 17).....free..	10,669,397
1927.....do....	1,704,129	1930 (June 18-Dec. 31).....dut..	87,761
1928.....do....	6,264,113	1930 (June 18—Dec. 31).....free..	26,457
1929.....do....	21,585,211		
		Total, 1930.....	10,783,615

Costs of production of sesame oil in the United States for 1929 and the first six months of 1930 were obtained from four companies. The weighted average cost of production is shown in the following table:

TABLE 16.—*Sesame oil: Cost of production in the United States, 1929 and first six months of 1930*

Cost item	Dollars per ton of seed	Cents per pound of oil
Cost of sesame seed	83.23	7.20
Total factory, general, administration expense	9.43	.82
Imputed interest on plant assets and inventories	2.61	.23
Total seed and conversion cost	95.27	8.25
Sesame seed crushed.....short tons..	6,723	
Sesame oil produced.....pounds..	8,072,092	

The weighted average net sales value of sesame oil at the plant for three of the companies (one did not sell its oil on the market) was 7.88 cents a pound for the same period.

Los Angeles is the principal producing center and the leading market for domestic sesame oil. Imported sesame oil comes chiefly through the port of New York and is consumed principally in that area.

The weighted average price of crude sesame oil landed at New York in 1929 and the first six months of 1930 was 7.95 cents a pound, and of refined oil 10.28 cents a pound.

PERILLA OIL

Perilla oil has been free of duty under the tariff acts of 1922 and 1930.

Because of its pronounced drying properties, perilla oil is consumed in the United States almost entirely in the manufacture of paints, varnishes, linoleum, printing inks, and in foundry core oils. Its most important use is in enamel paints and varnishes for application to articles which frequently come in contact with water.

Neither perilla seed nor perilla oil is important in international trade. China is the principal producer and exporter of the seed; Japan is the principal importer of the seed and exporter of the oil. Factors militating against the exportation of seed to the United States and to Europe are the limited and uncertain supply of perilla seed and the unfitness of the by-product, oil cake, for cattle feed. In Japan, however, the cake finds ready use as a fertilizer for mulberry trees.

Imports of perilla oil into the United States in the last 10 years (1921–1930) have fluctuated from less than 1,000,000 pounds to nearly 9,000,000 pounds. They originate chiefly in Japan and China.

Imports from 1926 to 1930 were as follows:

TABLE 17.—*Perilla oil: Imports into the United States*

Year	Quantity	Year	Quantity
	Pounds		*Pounds*
1926	7,400,569	1929	5,574,319
1927	5,358,160	1930	8,837,921
1928	2,010,967		

Perilla oil is imported principally through the port of San Francisco and is consumed largely in the Middle West. The weighted average landed price of the oil imported into the United States, plus transportation charges to the Middle West, was 12.97 cents a pound in 1929 and 11 cents a pound in the first 6 months of 1930.

RAPESEED OIL

Rapeseed oil has been dutiable at 6 cents per gallon under the tariff acts of 1922 and 1930. Under the latter act, however, it is free of duty when denatured so as to be unfit for edible use.

In the United States rapeseed oil is used principally in the manufacture of lubricants (especially for marine engine oils), rubber substitutes, and textile soaps. It is estimated that lubricants and rubber substitutes account for about 80 per cent and 15 per cent, respectively, of the total consumption.

India and China are the chief producers and exporters of rapeseed, India usually ranking first as an exporter. Exports from India and China in 1930 amounted to 99,000,000 pounds and 109,000,000

pounds, respectively. Japan is generally the chief importer of rapeseed.

Rapeseed oil is exported chiefly from Japan and the United Kingdom, shipments in 1930 from the former country amounting to 32,000,000 pounds and from the latter 8,000,000 pounds. The United States and the United Kingdom are the principal importers of rapeseed oil.

No production of rapeseed oil has been reported in the United States since 1926, and prior to that year the output was of minor importance. Imports into the United States during the last 10 years (1921–1930) have ranged from a minimum of 7,000,000 pounds in 1921 to a maximum of 21,000,000 pounds in 1926. They originated chiefly in the United Kingdom and Japan. The following table shows imports for consumption in the United States from 1926 to 1930, inclusive.

TABLE 18.—*Rapeseed oil: Imports into the United States*

Year	Quantity	Year	Quantity
	Pounds		*Pounds*
1926.....dutiable..	20,767,778	1930 (June 18–Dec. 31).....dutiable..	2,474,670
1927.....do....	19,223,932	1930 (June 18–Dec. 31).....free..	5,294,513
1928.....do....	16,875,675		
1929.....do....	18,801,405	Total, 1930.....	14,959,343
1930 (Jan. 1–June 17).....do....	7,190,160		

Rapeseed oil is imported chiefly through the port of New York and is consumed principally in that area. The weighted average landed price of the imported oil at that port was 9.64 cents a pound in 1929, and 8.74 cents a pound in the first 6 months of 1930.

WHALE OIL

Whale oil has been dutiable at 6 cents per gallon in the last two tariff acts.

Whale oil is obtained by rendering the blubber, flesh, and bones of all species of whale, except the sperm. Practically the entire quantity consumed in the United States is in the soap industry, which used about 60,000,000 pounds in 1930. Small quantities of low-grade whale oil are used in the production of fruit-tree and fly sprays, in treating leather, and as an illuminant.

World production of whale oil has increased rapidly in the last few years and in 1930 exceeded 1,000,000,000 pounds. The increase is due primarily to the use of modern methods of catching and rendering whales and to the exploitation of Antarctic waters. The output, chiefly in this region, is principally by Norwegian and British vessels. Production during the 1931–32 season, however, is being restricted.

Domestic production of whale oil averages about 10,000,000 pounds annually; recent output is by two companies on the west coast, operating in Alaskan, west coast, and Mexican waters.

Imports into the United States average about 50,000,000 pounds annually, Norwegian and British ships being the principal sources. The following table shows production and imports for consumption in the United States for 1926 to 1930, inclusive.

TABLE 19.—*Whale oil: Production and imports into the United States*

Year	Production	Imports	Year	Production	Imports
	Pounds	*Pounds*		*Pounds*	*Pounds*
1926	9,494,692	39,249,150	1929	11,084,302	56,552,468
1927	11,406,750	53,130,952	1930	9,939,218	52,702,455
1928	10,233,735	48,426,495			

Costs of production were obtained by the commission from two domestic producers of whale oil for 1927, 1928, and 1929. The figures can not be published, however, without disclosing costs of individual companies. The costs, including imputed interest, exceeded the net sales value at the companies' plants.

Whale oil is imported chiefly through the port of New York, largely for consumption in the Middle West and in the New York area.

The landed price was obtained from the principal importer, but can not be published without disclosing the figures of an individual company. The foreign invoice price of whale oil imported into the United States averaged 6.24 cents a pound in 1929 and 5.77 cents a pound in the first six months of 1930. Transportation charges from foreign ports to the Middle West add approximately three-fourths of 1 cent to 1 cent per pound to these prices.

Section 4.—Statistical and Technical Information on Interchangeability (Summary of Part IV)

GENERAL INFORMATION

Senate Resolution No. 323 calls for a statement of the kinds and amounts of domestic oils made from domestic materials replaced in domestic industry by the oils, imported or made from the imported materials named in the resolution. Compliance with this request involves a study of the principal oil-consuming industries with a view to determining (1) the oils used, (2) the changes which have occurred in this respect in recent years, (3) the degree of interchangeability technically between the various oils used, and (4) the possibilities, technically, of using oils hitherto not used or of expanding the consumption of oils now used to a minor degree. It also involves a study of the economic factors affecting the interchangeability of the various oils. These factors are treated in the next section.

The following table indicates roughly the relative importance in domestic consumption of various oils, including those specifically named in the resolution, and their distribution among the principal oil-consuming industries, that is, the lard compound, margarine, miscellaneous food, soap, and paint and varnish industries. It also shows the remaining quantity, if any, of each oil, including the consumption in minor reporting manufacturing industries and the direct consumption in households and by consumers, industrial or other, making no reports to the census. The table indicates that the principal oils used in the several industries are as follows: In lard compounds, cottonseed oil; in margarines, coconut oil and oleo oil; in soaps, coconut oil, inedible tallow, animal greases, palm oil, and hydrogenated whale oil and fish oils; in paints and varnishes, linseed oil. The principal industries included in the miscellaneous food group are

those engaged in the production of salad oils and salad dressings, using chiefly cottonseed, corn, and sesame oils, in the order named, and in the production of certain confectionery and bakery articles mainly with coconut and palm-kernel oils.

TABLE 20.—*Apparent consumption of oils, by principal industries, 1929*

[In thousands of pounds]

Oil	Total apparent consumption [1]	Reported consumption in principal industries					Consumption in miscellaneous industries, households, etc.
		Lard compound or substitute industry	Margarine industry	Other food industries	Soap industry	Paint and varnish industry	
Primarily domestic materials:							
Butter	2,177,297			2,177,297			
Lard (except neutral)	1,725,164			1,725,164			
Lard (neutral)	47,312	23,123	24,189				
Oleo oil and animal fats	124,432	77,247	47,185				
Tallow, inedible	839,018				434,755		183,747
Greases					245,516		
Cottonseed oil	1,474,006	1,083,202	28,173	350,631	12,000		
Cottonseed-oil foots	108,904				108,904		
Corn oil	138,434			133,070	5,000	364	
Peanut oil	[2] 17,307		6,617	8,990	1,700		
Primarily imported materials:							
Sesame oil	30,076	5,215		20,026	4,835		
Coconut oil	662,007	20,000	171,411	53,598	344,205		72,793
Palm-kernel oil	84,327		15	11,392	72,920		
Palm oil	230,980	1,191	1,349		192,331		36,109
Olive oil, inedible, and foots	54,808				53,629		1,179
Perilla oil	5,574					5,508	66
Soybean oil	[3] 19,359	82	11		6,400	5,815	7,051
Olive oil, edible	[4] 91,836			91,836			
Tung oil	115,721					88,386	27,335
Rapeseed oil	16,848						16,848
Both domestic and imported materials:							
Fish oils	94,010	14,921			63,443	10,602	5,044
Whale oil	71,473	809			70,664		
Linseed oil	787,680				1,916	[5] 340,166	[6] 445,598

[1] Total apparent consumption represents in most cases the reported production plus imports (for consumption), less exports, plus or minus the differences in stocks on hand at beginning and end of year. Where the figure thus computed was less than the consumption reported by the above industries, the total reported by these industries has been substituted as the "apparent consumption." The basic data come from the Bureau of the Census and estimates by the trade.

[2] Includes some imported oil.

[3] Includes some domestic oil, but does not account for difference in stocks at beginning and end of year.

[4] Including domestic oil.

[5] Factory consumption only.

[6] The bulk of this probably used by painters for mixing and not included in factory consumption.

THE SOAP INDUSTRY

Oils used, 1912 to 1930.

The best available statistics, which are largely estimates, indicate that the consumption of oils in soaps more than doubled from 1912 to 1929 and underwent only a minor decline in 1930. The increase up to 1929 was accompanied by a greater reliance upon imported oils or oils produced from imported materials. The consumption of oils made from domestic materials increased in absolute quantity but declined from 81 per cent of the total in 1912 to 53 per cent in 1929, and 57 per cent in 1930. This is indicated by the following table.

TABLE 21.—*Consumption of oils in soap manufacture, according to source*

Calendar year	Total	Domestic made from domestic materials	Imported or made from imported materials	In percentages of total consumption in soap making	
				Domestic made from domestic materials	Imported or made from imported materials
	Pounds	*Pounds*	*Pounds*		
1912	741, 000, 000	601, 000, 000	140, 000, 000	81	19
1914	818, 000, 000	658, 000, 000	160, 000, 000	80	20
1917	1, 202, 000, 000	767, 000, 000	435, 000, 000	64	36
1919	908, 000, 000	587, 000, 000	321, 000, 000	65	35
1921	990, 000, 000	717, 000, 000	273, 000, 000	72	28
1923	1, 196, 000, 000	714, 000, 000	482, 000, 000	60	40
1925	1, 415, 000, 000	837, 000, 000	578, 000, 000	59	41
1927	1, 626, 000, 000	981, 000, 000	645, 000, 000	60	40
1929	1, 692, 000, 000	903, 000, 000	789, 000, 000	53	47
1930	1, 559, 000, 000	881, 000, 000	678, 000, 000	57	43

The increase in the total quantity of oils used in soap manufacture and the increase in the use of foreign oils were attended by changes in the importance of the different soap oils. These oils may be classified into three general groups, as follows:

(1) *Hard oils which yield quick-lathering soap.*—Hard oils are those which are solid at ordinary room temperature. Of the commercially available oils of this type, only two, coconut and palm-kernel, make a quick-lathering soap. These two oils are specially valuable in soap manufacture because, unlike other available oils, they impart to soap hardness as well as easy solubility and the capacity of lathering quickly and profusely. In addition, they yield a white soap of pleasing odor and of high cleansing power. The lather of soaps made solely of coconut or palm-kernel oils, however, although quick and abundant, is foamy and dries quickly and sometimes has an irritating effect on sensitive skins. Both these defects may be overcome by blending with one of the hard oils which make a slow-lathering soap, or with certain soft oils, such as cottonseed oil.

(2) *Hard oils which yield slow-lathering soap.*—This classification includes tallow, animal greases, palm oil, and hardened (hydrogenated) soft oils, particularly hardened whale oil and fish oils. These oils, which are the base of most soaps produced in the United States, when used alone make a hard, firm soap with slow solubility except in very hot water, and with a very slow but thick and lasting lather composed of small bubbles. They are interchangeable only to a limited extent with the hard oils which yield a quick-lathering soap. The two types supplement each other with respect to solubility and lather, and together make a better soap for most purposes than does either of them separately. Any large substitution of one for the other would change materially the character of the resulting soap.

(3) *Soft vegetable oils.*—Although showing considerable diversity in soap-making qualities, the soft vegetable oils (liquid at ordinary temperature), make a soap of softer texture than the hard oils of either type. As a rule, they make a readily soluble soap, which yields a quicker lather than soaps made of tallow or grease, and a thicker, more greasy, and more durable lather than those made of coconut or palm-kernel oils. To some extent, these soft oils are interchangeable with

hard oils of both types, but mainly with tallow or grease for blending with coconut oil in the production of laundry soaps. Any large substitution of soft oils for coconut oil would substantially change the character of the finished product.

The following is a list of the oils of the three classes described above, which have been used to a greater or lesser degree in soap making in the last two decades or which might be used should conditions change materially. Of these, the oils noted as principally imported, or made from imported materials but not specifically named in Senate Resolution No. 323, do not require further consideration. The oils in each group are listed in the approximate order of the quantity consumed in soap making in the United States in recent years.

Hard oils which yield quick-lathering soap	Hard oils which yield a slow-lathering soap	Soft vegetable oils
Coconut oil. Palm-kernel oil.	Inedible tallow. Greases. Palm oil. Whale oil, hydrogenated. Fish oil, hydrogenated. Vegetable tallow.[1]	Cottonseed-oil foots. Cottonseed oil. Corn oil. Soybean oil. Peanut oil. Olive-oil foots.[1] Inedible olive oil.[1] Sesame oil. Sunflower oil.[1] Linseed oil. Castor oil.[1]

[1] Mainly imported but not named in Senate Resolution 323.

Tables 22 and 23 below show the quantities and proportions of specific oils used in soap making in 1912, 1922, and 1929, grouped as in the foregoing classification.

TABLE 22.—*Consumption of specific oils in soap making*

[In millions of pounds]

Oil	1912			1922			1929		
	Imported [1]	Domestic	Total	Imported [1]	Domestic	Total	Imported [1]	Domestic	Total
Hard oils which yield quick-lathering soaps:									
Coconut	79	.....	79	238	.....	238	344	.....	344
Palm-kernel	21	.....	21	1	.....	1	73	.....	73
Total	100	.....	100	239	.....	239	417	.....	417
Hard oils which yield slow-lathering soaps:									
Inedible tallow	1	238	239	2	428	430	10	425	435
Animal greases and miscellaneous animal oils	15	106	121	20	171	191	15	266	281
Whale oil, hydrogenated	10	1	11	47	14	61	60	11	71
Fish oil, hydrogenated	.....	.....	.....	2	28	30	25	38	63
Palm oil	7	.....	7	30	.....	30	192	.....	192
Vegetable tallow	.....	.....	.....	.....	.....	.....	10	.....	10
Total	33	345	378	101	641	742	312	740	1,052
Soft oils:									
Cottonseed oil	.....	132	132	.....	20	20	.....	12	12
Cottonseed-oil foots	.....	89	89	.....	62	62	.....	109	109
Corn oil	.....	10	10	.....	5	5	.....	5	5
Peanut oil	.....	.....	.....	.....	7	7	.....	2	2
Miscellaneous	.....	25	25	.....	21	21	.....	35	35
Soybean oil	1	.....	1	2	.....	2	6	.....	6
Olive-oil foots	5	.....	5	20	.....	20	43	.....	43
Inedible olive oil	1	.....	1	1	.....	1	10	.....	10
Total	7	256	263	23	115	138	59	163	222
Grand total	140	601	741	363	756	1,119	788	903	1,691

[1] Under "Imported" are included oils made in the United States from imported materials.

TABLE 23.—*Consumption of specific oils in percentages of total consumption in soap making*

[In millions of pounds]

Oil	1912			1922			1929		
	Imported	Domestic	Total	Imported	Domestic	Total	Imported	Domestic	Total
Hard oils which yield quick-lathering soaps:									
Coconut	10.6	.....	10.6	21.2	.....	21.2	20.3	.....	20.3
Palm-kernel	2.8	.....	2.8	.1	.....	.1	4.3	.....	4.3
Total	13.4	.....	13.4	21.3	.....	21.3	24.6	.....	24.6
Hard oils which yield slow-lathering soaps:									
Inedible tallow	.1	32.1	32.2	.2	38.3	38.5	.6	25.1	25.7
Animal greases and miscellaneous animal oils	2.0	14.5	16.5	1.8	15.3	17.1	.9	15.7	16.
Whale oil, hydrogenated	1.3	.1	1.4	4.2	1.2	5.4	3.5	.6	4.1
Fish oil, hydrogenated	.....	.....	.....	.1	2.5	2.6	1.5	2.3	3.
Palm oil	1.0	.....	1.0	2.7	.....	2.7	11.4	.....	11.
Vegetable tallow	.....	.....	.....	.....	.....	.....	.6	.....	.6
Total	4.4	46.7	51.1	9.0	57.3	66.3	18.5	43.7	62.2
Soft oils:									
Cottonseed oil	.....	17.8	17.8	.....	1.8	1.8	.....	.7	.7
Cottonseed-oil foots	.....	12.0	12.0	.....	5.5	5.5	.....	6.4	6.
Corn, peanut, and miscellaneous oils	.....	4.7	4.7	.....	2.9	2.9	.....	2.5	2.
Soybean oil	.2	.....	.2	.2	.....	.2	.4	.....	.
Olive-oil foots	.7	.....	.7	1.9	.....	1.9	2.6	.....	2.
Inedible olive oil	.1	.....	.1	.1	.....	.1	.6	.....	.
Total	1.0	34.5	35.5	2.2	10.2	12.4	3.6	9.6	13.2
Grand total	18.8	81.2	100.0	32.5	67.5	100.0	46.7	53.3	100.0

Trends in types of soap.

The outstanding changes since 1912, as indicated by the foregoing table, are the larger use of coconut and palm-kernel oils and of the slow-lathering hard oils and the smaller use of the soft vegetable oils. These changes were connected, partly as cause and partly as effect, with a strong trend toward white soaps of hard texture yielding a quick but lasting lather. As a rule, such soaps are made with a substantial admixture of coconut oil. The general trend toward them brought with it the following more specific tendencies:

(1) *Toward the manufacture of yellow laundry soaps with rosin and tallow instead of with rosin and cottonseed or other soft vegetable oils.*—Although used to a considerable extent before the war, cottonseed oil is now rarely used, except foots and off-grade and damaged lots, as an ingredient of yellow laundry soaps; in its place tallow, greases, and palm oil are now used. In the shift the proportion of rosin in yellow laundry soaps, which usually runs from 15 to 20 per cent, may have increased, as it is possible to use more of it with tallow and greases than with cottonseed oil.

(2) *Toward a larger production of white and a smaller production of yellow laundry soaps.*—This tendency has been strong and has involved the substitution of coconut oil for rosin but also for part of the nonrosin ingredients of yellow soaps, whether cottonseed oil or tallow and grease. White laundry soaps are made of coconut (or palm-kernel) oil blended, as a rule, with about an equal amount of inedible tallow, white grease, or whale oil, but sometimes with a soft oil, usually cottonseed oil. The use of coconut oil permits of a large admixture of a solution of sodium silicate, which often forms

20 to 40 per cent of the weight of this type of laundry soap, whereas it usually forms a smaller proportion of yellow laundry soaps, as it can be used only sparingly with rosin.

(3) *Toward flakes, chips, granules, beads, and powdered soap instead of bar soaps.*—Such products designed for household use in constituents resemble white laundry bar soaps, except that they usually contain less water, less sodium silicate, and less coconut oil but more tallow or similar materials. Those designed for use by power laundries which wash clothes in extremely hot water are often made entirely of tallow or palm oil. In very hot water tallow and palm-oil soaps not only readily yield a thick abundant lather but one that stands up better than the lather of soaps made from other materials.

Technical position of specific oils in soap making.

The general soap-making properties of the three general classes of soap oils have been described, but individual oils in each group may differ materially in their technical availability for different types of soaps.

Hard oils which yield quick-lathering soap.—Coconut oil (or palm-kernel oil)is important in the production of most types of the hard, quick-lathering soaps now used in the United States. But by varying the other ingredients approximately the same results may be obtained with somewhat more or less coconut oil. If for any reason it should come to occupy a less advantageous price position, there is little doubt that domestic manufacturers would economize in its use. Whether they would be able to reduce the use of coconut oil to anything like the position it held in the period before the World War, without at the same time changing substantially the character of the soap produced, is more doubtful.

Hard oils which yield slow-lathering soap.—Of the oils of this class, inedible tallow may be regarded as the standard. It is suited to a much wider range of uses than the others, and in many uses is preferred. The animal greases are largely regarded as a cheap substitute for tallow. They, however, yield soap somewhat softer and more soluble than tallow and for that reason sometimes are preferred. Only white grease is used to a large extent in white soaps, although colored greases are sometimes bleached and used.

Compared with tallow, palm oil makes a slightly harder, more soluble soap, which yields a less dense lather. But in making colored soaps, except those with a characteristic palm-oil color, these two oils are freely interchangeable. Palm oil is not much used in white soaps, as its color can be completely removed only by expensive treatment. Its use in colored soaps increased greatly from 1927 to 1929, whether in replacement of or supplementary to domestic tallow will be a subject of consideration in the next section.

Also supplementary to or in replacement of tallow has been the increased use of hydrogenated whale oil and fish oils, which are normally regarded as inferior substitutes in that they make a soap which is harder and lathers less easily and less abundantly than a tallow soap. Their use is confined largely to white laundry soaps, dual-purpose (i. e., laundry and household) soaps, and cheap toilet soaps.

Theoretically it would also be possible to use hydrogenated soft vegetable oils in soaps, as they have characteristics similar to hydrogenated whale oil and fish oils, but so far they have not been sufficiently low priced to be used in this way.

Soft vegetable oils.—In pre-war years, cottonseed oil, unbleached, was much used in making yellow laundry soaps, and to some extent the bleached oil was used in making white laundry soaps. In recent years it has practically disappeared from the soap kettle. It gives a soap of quick, abundant, thick, and fairly lasting lather, with a tendency to rancidity. The tendency to rancidity prevents its use to any appreciable extent in toilet soaps but is no obstacle to its use in laundry soaps, particularly in white laundry soaps, in which the large admixture of sodium silicate acts as a preservative. In fact, coconut oil and cottonseed oil in combination make a good white laundry soap. The cottonseed oil substitutes not only for tallow or palm oil but also to a small extent for coconut oil, as a smaller amount of coconut oil is required in combination with cottonseed oil than with tallow.

Corn oil and sesame oil have soap-making properties similar to those of cottonseed oil. The same is probably true of sunflower oil. Peanut oil is probably somewhat better than cottonseed oil for certain soaps. It is used to some extent in Europe in making Marseille soap.

Soybean oil is not as well liked for soap purposes as cottonseed oil, owing to its greater tendency to rancidity, and its persistent odor. It is an acceptable material, however, for the production of laundry soaps, where it may form a substantial but limited proportion of the oil content.

Linseed oil, which is a drying oil, has an even greater tendency to oxidation and rancidity than soybean oil. Unless hydrogenated it probably would not be used to any considerable extent in ordinary hard soaps.

THE MARGARINE INDUSTRY

The trend of production, 1914 to 1930.

The production of margarine has more than doubled since 1914 and at the same time its character has changed considerably. This is indicated by the table below showing for specified years the production of margarine classified as vegetable-oil margarine and as animal-oil margarine made chiefly of animal oils. In consistency and taste, the vegetable-oil type resembles butter less than the animal-oil. As between the two types, consumers' preferences differ; some prefer the characteristic properties of the vegetable-oil type.

TABLE 24.—*Production of margarine in the United States, by classes*

[Quanity in millions of pounds]

Calendar year	Total quantity	Vegetable-oil margarine		Animal-oil margarine	
		Quantity	Per cent of total	Quantity	Per cent of total
1914	144				
1916	203	2	1.0	201	99.0
1918	356	89	25.0	267	75.0
1919	371	143	38.4	228	61.6
1920	370	196	52.8	174	47.2
1921	212	102	47.8	110	52.2
1922	185	76	40.8	109	59.2
1924	229	101	44.2	128	55.8
1926	239	121	50.8	118	49.2
1928	308	196	63.7	112	36.3
1929	342	222	64.8	120	35.2
1930	312	216	69.3	96	30.7

The vegetable-oil margarines, which include nut margarines, are made entirely of vegetable oils, usually of 90 to 96 per cent of coconut oil and 4 to 10 per cent peanut, cottonseed, or other soft vegetable oil. In recent years the animal-oil margarines for household use have been composed, as a rule, of from 40 to 70 per cent oleo oil, from 20 to 40 per cent of neutral lard, and from 10 to 30 per cent of a soft vegetable oil, most frequently cottonseed oil. Animal-oil margarine is also produced for the baking trade for use in puffed pastries and other specialties. It is composed of 25 to 65 per cent oleo stearin, with the remainder cottonseed oil.

Change in the oils used.

That the trend from animal-oil to vegetable-oil margarines was mainly a shift from oleo oil and neutral lard to coconut oil is indicated by the table below.

TABLE 25.—*Oils, except milk and butter, consumed in the production of margarine*

[Fiscal years ending June 30]

Oil or fat	In thousands of pounds			In percentages of total consumption of oils		
	1914	1929	1931	1914	1929	1931
Vegetable and animal oils, except milk and butter	115, 862	286, 105	233, 352	100. 0	100. 0	100. 0
Vegetable oils, total	29, 697	207, 577	188, 623	25. 6	72. 5	80. 8
Coconut oil	322	171, 411	155, 954	. 3	59. 9	66. 8
Cottonseed oil	23, 206	28, 173	22, 037	20. 0	9. 8	9. 4
Peanut oil	4, 214	6, 617	5, 291	3. 6	2. 3	2. 3
Palm-kernel oil, Palm oil, Corn oil, Sesame oil, All other	1, 955	1, 376	5, 340	1. 7	. 5	2. 3
Animal oils, except milk and butter, total	86, 165	78, 528	44, 729	74. 4	27. 5	19. 2
Oleo oil	57, 549	47, 185	28, 040	49. 7	16. 5	12. 0
Oleo stearin	1, 698	5, 834	5, 484	1. 5	2. 0	2. 4
Oleo stock		1, 294	1, 025		. 5	. 4
Neutral lard	23, 287	24, 189	10, 180	20. 1	8. 5	4. 4
Miscellaneous	3, 631	26		3. 1		

Technical position of specified oils in margarine manufacture.

Coconut oil (or palm-kernel oil) forms the hard-oil base of vegetable-oil margarines, being specially adapted to the purpose because of its high melting point, about 77° F. It is smooth and firm in texture, light in color, and easily rendered almost neutral in odor and taste; it has a sharp melting point and melts quickly in the mouth without leaving a greasy feeling.

Coconut oil, as a rule, requires some hydrogenation, but palm oil, which has a higher melting point, can be used in margarine without any hydrogenation. Palm oil is also more plastic and has a higher vitamin content, but it does not have as narrow a melting range and is refined with difficulty. As long as palm oil was imported entirely from Africa and was high in free fatty acids and objectionable in odor and taste, it was not used for food purposes. But with the advent in the last few years of higher quality palm oil from Sumatra and the development of improved methods of refining, palm oil became available for making a natural yellow margarine. When

such margarine was subjected to the excise tax of 10 cents per pound, this practice ceased, little, if any, palm oil being used in white margarine. Bleached palm oil is available but at prices substantially above those for the unbleached.

The hard-oil base for animal-oil margarines is usually oleo oil and neutral lard, although other edible animal oils are sometimes used. Neither oleo oil nor neutral lard requires hydrogenation, their melting points being so high as to require the admixture of a larger proportion of soft vegetable oils than are used with coconut oil.

In the United States hydrogenated whale oil and fish oils have not been used in place of oleo oil and neutral lard as the hard-oil base for animal-oil margarines, but they have been so used in Europe on a large scale. Margarine produced from them is said to be of excellent quality.

The soft-oil admixture in both animal and vegetable oil margarine is usually either cottonseed or peanut oil. Many producers prefer peanut oil; moreover, according to a ruling of the Department of Agriculture, those producing goods labeled "nut margarine" must use peanut or some other nut oil. For these reasons a price premium is paid for peanut oil, but because of this premium more cottonseed than peanut oil is used.

If conditions of price and supply were favorable, corn and sesame oils would be used to a larger extent than they have been in margarine manufacture, in place of cottonseed oil. Soybean oil is less suited to margarine than these oils because of its taste, odor, and color, which require much processing to remove completely and permanently. This oil, however, was successfully used in 1930 and 1931 in making a naturally yellow animal-oil margarine, but so far it seems not to have been used in vegetable-oil margarine, as it is said not to blend well with coconut oil. Moreover, except to a very minor extent, it has been used but slightly in making white margarine, to which producers are practically confined since the passage of the law taxing naturally yellow margarine 10 cents per pound.

Interchangeability of margarine and butter.

Margarine and butter differ little in fat content and digestibility, but butter usually has a higher vitamin content. Most consumers prefer good creamery butter and buy margarine, if at all, because of price. In this both taste and custom are factors.

THE LARD COMPOUND INDUSTRY

Lard compounds, sometimes called substitutes, are usually vegetable oils, or combinations of vegetable and animal oils, specially prepared for shortening and general cooking purposes. The production and consumption of lard compounds in the United States have been as follows.

TABLE 26.—*Production and consumption of lard compounds in the United States*

[In thousands of pounds]

Calendar year—	Production	Consumption	Calendar year—	Production	Consumption
1912	876,927		1925	1,152,620	1,135,215
1914	1,136,522		1927	1,178,995	1,166,413
1919	1,350,000		1929	1,220,102	1,214,986
1921	811,095		1930	1,211,268	
1923	750,522	747,899			

More than half of the lard compounds produced in the United States are made solely of vegetable oils, but there is a substantial production of mixed animal and vegetable compounds. As a rule, cottonseed oil is the predominant constituent of both types. The table below indicates that it has in recent years formed about seven-eighths of all the oils used in lard compounds of all types and that the next largest constituent is oleo stearin.

TABLE 27.—*Oils used in the manufacture of lard compounds*

	1912	1914	1918	1922	1923	1929
	In thousands of pounds					
Total oils used	944, 659	1, 143, 190	1, 222, 411	773, 843	757, 858	1, 220, 101
Vegetable oils, total	874, 981	1, 063, 029	1, 154, 602	704, 964	681, 454	1, 104, 810
Cottonseed oil	866, 696	1, 053, 142	1, 015, 051	655, 675	640, 630	1, 083, 202
Other	8, 285	9, 887	139, 551	49, 289	40, 824	21, 608
Animal oils, total	69, 678	80, 161	67, 809	68, 879	76, 404	115, 291
Oleo stearin	57, 644	64, 926	54, 598	43, 916	43, 075	44, 138
Other	12, 034	15, 235	13, 211	24, 963	33, 329	71, 153
	In percentages of total oils used					
Vegetable oils, total	92. 6	93. 0	94. 4	91. 0	89. 9	90. 5
Cottonseed oil	91. 7	92. 2	83. 0	86. 6	84. 7	88. 8
Other	.9	.8	11. 4	4. 4	5. 2	1. 7
Animal oils used, total	7. 4	7. 0	5. 6	9. 0	10. 1	9. 5
Oleo stearin	6. 1	5. 6	4. 5	5. 7	5. 7	3. 6
Other	1. 3	1. 4	1. 1	3. 3	4. 4	5. 9

Other than cottonseed oil, the vegetable oils separately reported are coconut, peanut, soybean, corn, and palm oils. In addition, some sesame and sunflower oils are known to have been used. Other than oleo stearin, the animal oils separately recorded are edible tallow, pork fat and lard, oleo oil, and fish oils.

Technical position of specific oils in lard compounds.

Cottonseed oil.—As noted, cottonseed oil forms about seven-eighths of the entire consumption of oils in lard compounds; many compounds are made solely of that oil. This predominance was gained because, in seeking to perfect a cooking fat of high grade, and lower in price than lard, manufacturers found at hand an ample and cheap supply of cottonseed oil, which was being consumed mainly in the soap kettle. For a time this supply was easily expanded by an increased utilization of cottonseed for oil production. Moreover, cottonseed oil proved technically well suited to their purpose, possessing high shortening value and being easily refined and hydrogenated.

Oleo stearin, edible tallow, and other animal oils.—Which is superior, straight vegetable oil or mixed animal and vegetable-oil compounds, is a matter of opinion. Originally lard compounds were of the mixed type. The subsequent predominance of the vegetable-oil variety has been partly a matter of price. Whether other factors operated is a disputed question.

Vegetable oils other than cottonseed.—Peanut oil, although considered equal or superior to cottonseed oil for lard compounds, has been used only to a minor extent because of its higher price. Sesame oil, which in 1930 and 1931 was used to a considerable extent by Pacific coast producers, seems to be the equal of cottonseed oil for lard compounds, although opinions differ. Corn oil is also probably about as well suited technically for use in lard compounds as is cottonseed oil. Sunflower oil was used in lard compounds in 1930 and 1931, apparently with some success.

When prices have been favorable, soybean oil has been used, but only to a limited extent because of the difficulty of refining it to the point where it will be permanently white and permanently neutral in taste and odor. If its price were sufficiently low to make its use economical, means might be devised of overcoming the refining difficulties and of overcoming the tendency of compounds made from it to spoil quickly.

In the last few years refined and bleached Sumatran palm oil has been used to some extent by a few producers in making low-price lard compounds. It is possible that future improvements in refining methods may result in its larger consumption in the higher-price grades.

Coconut oil (or palm-kernel oil) is often used in lard compounds. Ordinarily only 1 or 2 per cent is used, and 10 per cent is the maximum. It is not used to a greater extent partly because of its relatively low shortening value and partly because it is said to foam and smoke when used in frying. Manufacturers continue to use cottonseed oil when they could get coconut oil at a lower price.

Whale oil and fish oils, when properly refined and hydrogenated, make, it is said, a satisfactory lard compound. Both have been used in Europe, but in this country only fish oil, and that to a very small extent.

THE COOKING AND SALAD OIL INDUSTRY

The products of this industry include (1) oils refined and prepared for salad, cooking, and general culinary purposes; (2) mayonnaise and other dressings, including Thousand Island, French, and Russian, and sandwich spreads. Their output has increased rapidly in recent years. In their production is consumed probably as much as 700,000,000 to 800,000,000 pounds of vegetable oils annually. Production of salad and cooking oils alone was 509,000,000 pounds in 1929.

Technical position of the various oils.

The oils used in salad oils and dressings must be liquid in form, clear, and unclouded at ordinary winter as well as summer temperature. In addition they must keep well, be of medium consistency, and be readily emulsifiable with other materials. These requirements eliminate many oils, particularly solid oils, like coconut, palm, palm-kernel, and most animal oils, and drying and semidrying oils which oxidize easily, as do linseed, whale, and fish oils. The position of each of the commercially available oils suited to this use is discussed below.

Olive oil is widely preferred as a salad and cooking oil, and as such commands a large price premium over competing oils. But in the United States it is not used by manufacturers of mayonnaise and other

prepared salad dressings, as for this purpose it possesses no marked advantage over cheaper oils.

Quantitatively cottonseed oil is the principal salad and cooking oil consumed in the United States. It predominates in the manufacture of salad dressings, primarily for economic reasons, not because of superiority to several other oils for this purpose. For use in this industry cottonseed oil usually is not only refined but also winterized—that is, its stearin content is removed by pressing to prevent clouding at low temperatures.

After cottonseed oil, the most important material for the uses under discussion is corn oil, most of the domestic production of which goes into those uses. Because of its lower solidifying point, it is widely used in place of cottonseed oil in the winter months in the colder sections of the United States.

If peanut oil were on a price parity with cottonseed oil, it would be a strong competitor as a material for salad and cooking oils and salad dressing. Its flavor is perhaps superior to that of either cottonseed or corn oil.

Sesame oil has been used to a considerable extent as a salad oil and in making salad dressings, for which purpose it is considered by many as equal to cottonseed or corn oil. It has the advantage of not having to be winterized; some also claim that it keeps longer without turning rancid than any other commercially available oil.

Soybean and sunflower oils have never been used to any considerable extent in the United States in the production of salad oils and dressings. Soybean oil would be very difficult to refine to the desired blandness, and a strong tendency to rancidity would have to be overcome.

THE CONFECTIONERY AND BAKING INDUSTRIES

Besides their use as shortening, animal and vegetable oils are used in the confectionery and baking industries in preparing fillings, centers, and coatings of candies and cakes; in cooking and salting nuts; and in making hard chewy confections, such as caramels. According to reports to the commission, these industries consume annually about 50,000,000 pounds of coconut oil and about 10,000,000 pounds of palm-kernel oil. To some extent the whole oils are refined and used hydrogenated or unhydrogenated. More often, however, these oils are separated, by chilling and pressing, into stearin, or hard butter, and olein. Coconut stearin is the portion of coconut oil which does not melt until subjected to a temperature of about 84° F.; palm-kernel stearin, the portion of palm-kernel oil which does not melt until subjected to a temperature of about 90° F. The olein, which is liquid at ordinary room temperature, is used in that form or is hydrogenated and used under the designation "soft butter."

Coconut and palm-kernel oils, in the form of hard or soft butter, are preferred for fillings, coatings, and hard chewy candies, because of (1) their keeping qualities, (2) their high melting point, (3) their sharp solidifying and melting points, causing them to set quickly, to remain firm over a wide range of temperature, to melt rapidly without stickiness or greasiness, and to leave a sense of coolness in the mouth. With the exception of cocoa butter, all other commercially available oils do not possess, in as high a degree, these properties.

Confectioners and bakers state that, if necessary, they would be willing to pay a price premium for coconut and palm-kernel oils for many types of fillings and coatings. Next to cocoa butter, dairy butter is probably the nearest competitor. Both butter and coconut oil are used in making hard, chewy candies but yield products different in many respects. As a rule each is preferred for certain types of products.

Olein, or the unhydrogenated soft portion of coconut oil, is used mainly for nut salting, where it is preferred because of its keeping qualities and its stability at ordinary temperature.

OTHER INDUSTRIES

The paint and varnish industry.

In making paints, varnishes, and enamels it is necessary to use oils which will oxidize quickly and in doing so form a hard, durable film. In order of their drying qualities, the drying oils are tung, perilla, linseed, hempseed, poppyseed, walnut, soybean, and sunflower; the semidrying oils are sardine, menhaden, corn, whale, herring, cottonseed, and sesame. The semidrying oils, with few exceptions, can be used in this industry only to a minor extent, and the drying oils vary greatly in usability.

Perilla oil, used in 1929 to the extent of 2,573,000 pounds, represents an almost negligible percentage of the oils consumed in the factory production of paints and varnishes, less than 1 per cent as compared with 75 per cent represented by linseed oil and 20 per cent represented by tung oil.

Conditions of supply and price and custom all contribute to the predominance of linseed oil in paints and varnishes. But equally important is the fact that perilla oil seems less well adapted to general use in the industry than linseed oil. It dries less smoothly than linseed oil. This can be corrected by proper treatment, but usually linseed would still be preferred. Whether a larger supply and a lower price for perilla would in time overcome this preference is a matter of opinion. Under present conditions of supply, manufacturers, as a rule, continue to use linseed, even when perilla is lower in price, except in making certain special types of varnishes and enamels used for purposes where an exceptionally hard film is required. Manufacturers state that it would be difficult to make these without perilla oil.

The other oils most used in paints and varnishes—tung, fish, soybean—are so different in drying qualities as not to be, to any substantial degree, interchangeable with perilla oil.

The linoleum, oilcloth, printing ink, and other drying-oil industries.

In all these industries the standard practice seems to be to use linseed oil, although substantial quantities of fish, soybean, and tung oils are also used. In printing inks small quantities of soybean and perilla oils are used, the latter in making special printing-ink varnishes, which can not be made as well with other materials.

The fatty-acid industry.

In this industry oils or fats are first separated into fatty acids and glycerin, and the fatty acids are then separated by pressing into liquid fatty acids or "red oil" (chiefly oleic acid) and the solid acids or stearic acid. The lowest grade of inedible tallow, yellow, brown, and

garbage greases and yellow grease stearin are the raw materials most frequently used. Palm oil, which is preferred by some producers, is used to a small extent.

The tin-plate industry.

In making tin plate, oil is used to keep the air away from the plate before entering and after leaving the molten tin and to impart to it a smooth, bright finish. Producers of tin plate use palm oil exclusively, and state that no other oil will give permanently, even approximately, the same finish. Tallow will give a similar finish which will last only a few days and then turn yellow. Unhydrogenated cottonseed oil can not be used because it becomes gummy when subjected to high temperatures. Laboratory and mill tests indicate that hydrogenated cottonseed oil could be used in place of palm oil, but it has never been used commercially.

Sulphonated oils.

Sulphonated oils, which are oils treated with concentrated sulphuric acid, will dissolve and emulsify in water. They are used in the textile and leather industries and as an antifoam agent in making coated paper. Castor oil predominates in sulphonated oils for the textile industry, with red oil (oleic acid) and inedible olive oil next in importance. Cod and other fish oils are important for the leather industry. Other oils used to a minor degree are corn oil, sperm oil, tallow, and grease. Rapeseed oil makes an inferior sulphonated oil which is used in minor quantities only.

Lubricants for marine engines.

Blown rapeseed oil, in blend with petroleum lubricating oil, is used as a lubricant for marine-reciprocating engines. So far as the commission could learn, no other oil has been discovered which will give satisfactory results in this use, although attempts have been made to substitute such oils as cottonseed, corn, peanut, and fish. Rapeseed oil is specially fitted for this use because it can be blown—that is, easily oxidized—with little tendency to rancidity. When blown rapeseed oil blends with mineral oils in the proportions desirable for the different types of marine engines, and lubricants compounded of it form an emulsion (with water) which adheres to engine bearings and does not easily wash off.

Rubber substitutes.

Rubber substitutes are made by the action of sulphur or sulphur chloride on a vegetable oil. They are used alone in erasers, and compounded with rubber in the production of many types of rubber goods, some times as a cheapener but more often for certain qualities which they impart. The lower their price compared with rubber prices, the stronger is the tendency to use rubber substitutes. Even when rubber substitutes are higher in price than rubber, they continue to be used for many purposes.

Practically all rubber substitutes are made of either rapeseed or corn oil, and the two types are interchangeable only to a limited degree. The rapeseed-oil substitute, which is the lower in free oil and sulphur, is easy to incorporate with rubber and is usually preferred for that purpose. For erasers the corn-oil substitute is preferred as it binds better into cake form and is more abrasive. In a few uses in the rubber industry it is also preferred.

Thus far, no other oil has been discovered which makes as satisfactory a rubber substitute for compounding with rubber as

rapeseed oil. It is the opinion of one of the leading producers, however, that soybean oil could replace corn oil in making erasers.

Section 5.—Economic Factors Affecting Interchangeability of Oils—The Question of Replacement (Summary of Part V)

(A) GENERAL CONSIDERATIONS

Even if there were no technical differences between domestic and foreign oils affecting the character of the products made from them, it would not necessarily follow that the entire quantity of foreign oils used in the United States could be considered as in replacement of domestic oils. Consideration would first have to be given to the questions of how far and under what conditions the supply of domestic oils available for domestic consumption could be increased, either by a reduction in exports or by an expansion of production, or both. The extent to which an increase could be accomplished in either of these two ways would depend upon the unpredictable course of demand and supply under different conditions of price both for oils and for finished products made from them. For this reason the amount of replacement can in no case be definitely established. Moreover, it can not be established because of the question whether foreign oils may be considered as replacing as much domestic oils as might become available if imports were drastically reduced and as could be substituted for foreign oils only with material changes in the resulting products.

The general summary statement dealt with the question of replacement by considering what might happen if the importation of foreign oils and oil-bearing materials should be entirely eliminated, or greatly reduced; here it will, in the main, be dealt with historically. For this purpose the 20-year period, 1912 to 1931, inclusive, will be studied as regards changes in price relationships, in consumption of different oils in different uses, and in domestic production and exports. A summary will be given, moreover, of the information available as to the possibility of increasing the production of domestic oils by a drastic curtailment of imports and a substantial increase in prices. Before this is done, however, a brief introductory account must be given of some of the major economic factors to be considered in connection with the question of replacement.

Supply factors.

The possibility of expanding production of animal and vegetable oils depends on complex economic factors. These have to do largely with the extent to which the production of an oil is related to the production of other commodities. Most oils are produced with joint products, and some important ones are made from materials, such as cottonseed, which are by-products in connection with the production of other commodities. Another point of importance is the length of time required to effect an increase or decrease in supply. With respect to whether by-products or principal products, and with respect to the duration of the process of production, six groups of oils may be distinguished as follows:

1. *Animal oils which are themselves principal products.*—Such are whale oil and some fish oils.

2. *Animal oils which are by-products.*—Such are lard, oleo oil, tallow, and some fish oils.

3. *Oils which are principal products of annual plants.*—Such are soybean, linseed, sesame, perilla, and rapeseed oils.

4. *Oils which are made from by-products of annual plants.*—Such are cottonseed and corn oils and, in the United States, peanut oil.

5. *Oils which are the principal products of perennial plants.*—Such are coconut, palm, palm-kernel and tung oils.

6. *Oils which are by-products of perennial plants.*—Such are almond, apricot-kernel, grapeseed, and raisin oils.

Other supply factors of importance to the manufacture of products containing oil are size, regularity of supply, and dependability in quality.

Prices and demand factors.

Prices of domestic and foreign oils and their changing relationships form part of the available data bearing on the question of replacement of specific domestic oils by specific foreign oils. The comparison in the following table of 5-year average prices of different oils, domestic and foreign, indicates very roughly the price position of each oil, even though prices often are for different markets, different containers, and sometimes for different stages of refinement. As might be expected from the relatively large number of oils suitable in some degree for soap making, oils used mainly in soap command relatively lower prices than those used mainly for food, for paints and varnishes, and for special uses. Coconut oil commands a somewhat higher price than most soap oils, owing to its increasing use in the food industries and to its special adaptability to the production of types of soap which increasingly predominate in domestic consumption.

TABLE 28.—*Average monthly prices of different oils in the 5-year period, 1926–1930* [1]

Oil	Market	Container	Average price
			Cents per pound
1. Mainly for edible use:			
Lard	Chicago	Hardwood tubs	13.8
Neutral lard	do	Tierces	14.0
Oleo oil	do		12.2
Cottonseed oil—			
Refined	New York	Barrels	9.8
Crude	Southeast	Tanks	8.3
Tallow, edible	Chicago	Tank cars	8.7
Sesame oil, refined	New York	Drums	12.9
Peanut oil, refined	do	Barrels	13.8
Corn oil	do	do	12.0
2. For edible use and for making soap:			
Coconut oil	Pacific coast	Tanks	7.7
3. Mainly for making white soaps:			
White grease	Chicago	Tank cars or drums	7.3
Whale oil—			
Crude, No. 1	Coast	Tanks	7.2
Crude, No. 2	do	do	6.8
Tallow, inedible	Chicago	Tanks, cars	7.5
4. Mainly for making colored soaps:			
Palm oil—			
Lagos	New York	Casks	7.6
Niger	do	do	7.2
Yellow grease	Chicago	Tank cars or drums	6.9
House grease	New York	Tierces	6.9
Brown grease	Chicago	Tank cars or drums	6.4
Rosin, K grade	Savannah	Barrels of 280 pounds	3.0
5. Mainly for use in paints and varnishes:			
Linseed oil, raw	New York	Tanks	10.5
Perilla oil	do	Barrels	14.0
Soybean oil, crude	do	do	12.0
6. For miscellaneous uses:			
Rapeseed—			
Blown	do	do	13.1
Refined	do	do	10.9

[1] Trade journals and Bureau of Labor Statistics, the former once a month quotation, the latter usually once a week.

The amount which a manufacturer will pay for an oil for a specific use in competition with other oils depends to a large extent on the amount of refining necessary to fit the oil for the use, on the results obtainable from it as to character of finished products, and on the amount of recoverable by-product, such as glycerin in soap manufacture. Moreover, if the properties of the finished product are to be kept uniform, substituting one oil for another, or changing materially the proportion used, may necessitate changes in the kinds and proportions of other ingredients. Before making the substitution the manufacturer, therefore, must consider the total price of the ingredients in the old formula and of those in the proposed new formula.

The price which a given industry will pay for an oil, in the face of the competitive demand of other industries, depends also in part upon the demand for and the price of the products made from it. Thus it is affected by changes in the kinds of finished products demanded, which in turn may be influenced to a considerable extent by advertising undertaken to provide a market for products made from oils obtainable at low prices. The demand for particular oils also may be influenced by the reputation of established brands of products made from them. Unless forced to do so by great price changes in the oils, manufacturers will not risk the loss in sales which might result from noticeable changes in formulas.

(B) RELATIONSHIP OF THE SEVEN OILS NAMED IN SENATE RESOLUTION NO. 323

Three of the seven oils named in Senate Resolution No. 323—sesame, perilla, and rapeseed—have their own special uses and are not interchangeable with each other or with the other oils named. Whale and palm oil are to a considerable extent technically interchangeable in soap making, although not to any appreciable extent interchangeable with the other oils named. Coconut and palm-kernel oils are interchangeable with each other in a wide range of uses. Nevertheless, coconut oil is usually preferred to palm-kernel oil in most uses, except in making "stearin" for hard-grease coatings of cakes and candies, and usually sells for a slightly higher price. In the five years, 1926 to 1930, coconut oil averaged 9.1 cents per pound and palm-kernel oil 8.7 cents per pound. Both averages are for spot sales in barrels.

Hereafter when the term "coconut oil" is used, it is to be interpreted to include palm-kernel oil, except that statements of price refer to coconut oil alone.

(C) ECONOMIC FACTORS AFFECTING INTERCHANGEABILITY OF COCONUT OIL, OLEO OIL, AND OTHER EDIBLE OILS IN MARGARINE

Table 29 shows a comparison of prices of crude coconut oil with oleo oil and neutral lard, the principal animal oils used in margarine. Taking into consideration that coconut oil must be refined for use in margarine and that the refined oil sells usually from 2 to 3 cents a pound higher than the crude, the comparison indicates that during the period of the World War and immediately after coconut oil changed from its normal pre-war position of higher in price to lower in price than oleo oil and neutral lard. At the same time the pro-

portion in which coconut oil was used in margarine rose from less than 1 to 32 per cent. Three years—1917, 1918, and 1919—of relative scarcity of animal fats, resulting in a high price premium for oleo oil and neutral lard, were sufficient to establish practically a new industry—the manufacture of vegetable oil or nut margarine, on a large scale. But the greater price decline of the animal oils in 1921 and 1922 gave coconut oil, taking into consideration costs of refining, a price premium and resulted in a temporary setback to its use in margarine.

From 1923 to 1930 coconut oil was cheaper than either oleo oil or neutral lard, and its use steadily increased. In the fiscal year 1931, it formed 67 per cent of all oils used in margarine; in the same year oleo oil and neutral lard together formed only 15 per cent. There may have been a swing in the other direction since that year, for prices of oleo oil in 1931 were unusually low compared with those of coconut oil.

TABLE 29.—*Comparison of prices and consumption of coconut oil, oleo oil, and neutral lard in margarine*

Year [1]	Prices (cents per pound) [2]			Ratio to total consumption of oils in margarine (per cent) [3]		
	Coconut oil (plus freight rate from Pacific coast to Chicago) [4]	Oleo oil	Neutral lard	Coconut oil	Oleo oil	Neutral lard
1913	12.6	11.5	11.8			
1914	12.8	10.9	11.4	0.3	49.7	15.0
1915	12.8	12.2	11.0			
1916	15.6	14.0	14.0	.3	41.7	15.6
1917	17.6	21.7	23.5	7.9	38.7	14.0
1918	18.9	25.7	27.8	22.6	35.3	13.5
1919	18.5	30.6	31.8	23.3	32.7	12.3
1920	18.8	21.4	23.3	26.5	29.4	9.9
1921	11.3	11.3	13.3	43.8	21.1	9.2
1922	9.6	10.7	12.6	35.3	25.2	12.4
1923	9.0	12.8	13.3	37.0	26.3	12.4
1924	9.4	15.1	15.0	41.0	25.8	11.8
1925	10.6	13.8	18.6	43.2	24.0	10.4
1926	10.2	12.0	16.8	46.4	22.3	8.8
1927	9.0	13.4	14.3	49.2	22.4	8.4
1928	8.8	14.1	13.8	56.3	18.1	7.4
1929	7.8	10.9	13.0	59.9	16.5	6.3
1930	6.6	10.5	12.1	62.7	15.4	5.0
1931	[5] 5.2	[5] 6.8	[5] 9.5	66.8	12.0	3.3

[1] Calendar years for prices and fiscal years for ratios.
[2] Bureau of Labor Statistics, Wholesale Prices, Chicago.
[3] Computed from data given in section on soapmaking.
[4] Varied from 0.55 cent to 1.50 cents per pound during the period.
[5] Average for first 6 months.

Competition of animal-oil and vegetable-oil margarine.

That the price of oleo oil is higher than that of coconut oil is, in part, explained by the fact that some buyers are willing to pay a higher price for animal-oil than for vegetable-oil margarine. The higher price is passed on to oleo oil, the supply of which, as has been noted, is limited and not readily expansible. This price premium, as indicated by the following table, has been attended by a decreased use of animal-oil and an increased use of vegetable-oil margarine.

TABLE 30.—*Comparison of annual average prices of vegetable-oil and animal-oil margarines, Chicago* [1]

Calendar year	Nut (vegetable-oil) margarine (cents per pound)	Animal-oil margarine (cents per pound)		Proportion production composed of—	
		First grade [2]	Second grade [4]	Nut (vegetable-oil) margarine	Animal-oil margarine
				Per cent	*Per cent*
1920	28.7	33.8	32.4	52.8	47.2
1921	22.1	22.9	21.9	47.8	52.2
1922	19.4	19.7	18.7	40.8	59.2
1923	20.2	22.3	21.3	42.9	57.1
1924	21.2	23.4	22.4	44.2	55.8
1925	21.2	25.8	22.6	48.9	51.1
1926	21.5	24.4	21.2	50.8	49.2
1927	18.2	23.8	21.1	56.4	43.6
1928	17.2	24.0	21.1	63.8	36.2
1929	17.5	25.0	20.6	64.8	35.2
1930	17.0	23.5	19.1	69.2	30.8
1931 [5]	14.1	17.3	14.4	.....	.....

[1] The National Provisioner.
[2] Calculated from data in section on margarine.
[3] Quoted as butterine 1920-1924; highest grade animal-oil oleomargarine, 1925-1931.
[4] Quoted as natural color butterine 1920-1924; white animal-fat oleomargarine 1925-1931.
[5] Average for first 6 months.

Conditions of supply of coconut oil.

The relatively low price of coconut oil and the relatively high price of oleo oil and neutral lard in recent years were due, in part, to the rapidly increasing supply of coconut oil and to the relatively stationary supply of the two animal products. The estimated production of coconut oil in the principal producing countries increased from 1,436,000,000 pounds in 1923 to 1,896,000,000 pounds in 1930. Production of copra in the Philippines, the chief source of imports of both copra and coconut oil, rose from 261,000,000 pounds in 1910 to 1,059,000,000 pounds in 1929. The possibility of further expansion there is indicated by the fact that of 101,527,000 coconut trees reported as planted in 1929 only 65,083,000 were then in bearing. There are also good prospects of further expansion in the Dutch East Indies and Malaya. The conditions of supply of oleo oil and neutral lard are discussed below.

The question of replacement.

It is obvious that if no coconut oil were used in margarine and if the total quantity of margarine produced should remain unchanged, a much larger quantity of oleo oil and neutral lard would be used in margarine. But this does not answer the question of the extent of the replacement of domestic oils by coconut oil. Consideration must also be given to the factors which affect the production and consumption not only of oleo oil and neutral lard but also of margarine and to the fact of a substantial export surplus of the two animal oils.

In replacing a given quantity of vegetable-oil margarine by the same quantity of animal-oil margarine, the quantity of oleo oil and neutral lard used would not equal the quantity of coconut oil displaced, for the hard animal oils require a larger admixture of soft vegetable oil than does coconut oil. The following table shows for each year, 1917–1930, the production of nut or vegetable-oil margarine

and the estimated quantity of animal oil which would have been used in producing an equal amount of animal-oil margarine.

TABLE 31.—*Estimated quantity of animal oil required to produce animal-oil margarine equal to the production of vegetable-oil margarine*

Fiscal year	1 Production of vegetable-oil margarine	2 Amount of oleo oil required for producing animal-oil margarine equal to total production of vegetable-oil margarine	3 Neutral lard which would be used with this amount of oleo oil	4 Other animal oils which would be used with this amount of oleo oil	5 Total of columns 2, 3, and 4	6 Export of oleo oil
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1917	21,801,000	6,530,000	3,314,000	1,057,000	10,901,000	----------
1918	88,974,000	26,647,000	13,524,000	4,315,000	44,486,000	----------
1919	142,699,000	42,738,000	21,690,000	6,920,000	71,348,000	----------
1920	195,639,000	58,594,000	29,737,000	9,488,000	97,819,000	74,529,000
1921	101,291,000	30,336,000	15,396,000	4,913,000	50,645,000	106,415,000
1922	75,510,000	22,615,000	11,478,000	3,662,000	37,755,000	117,174,000
1923	96,779,000	28,985,000	14,710,000	4,694,000	48,389,000	104,956,000
1924	101,130,000	30,288,000	15,372,000	4,905,000	50,565,000	92,965,000
1925	112,705,000	33,755,000	17,131,000	5,466,000	56,352,000	105,145,000
1926	121,149,000	36,284,000	18,414,000	5,876,000	60,574,000	90,410,000
1927	153,623,000	46,010,000	23,350,000	7,451,000	76,811,000	92,720,000
1928	196,314,000	58,796,000	29,840,000	9,521,000	98,157,000	64,851,000
1929	221,622,000	66,378,000	33,688,000	10,750,000	110,816,000	63,187,000
1930	215,879,000	64,655,000	32,813,000	10,470,000	107,938,000	61,093,000

Without coconut oil and the resulting production of vegetable-oil margarine, the total consumption of margarine might have been reduced. Vegetable-oil margarines have been cheaper than animal-oil margarines, and without their competition animal-oil margarine, and its principal constituents oleo oil and neutral lard, might have been higher in price than they actually were. Moreover, there may be some who prefer the special properties of the vegetable-oil product and who would not use the animal-oil product in its place.

Another factor to be considered is how much the production of oleo oil could have been increased as a means of replacing coconut oil. Production of oleo oil in the United States, amounting to 143,000,000 pounds in 1914, since then has ranged only from a high of 165,000,000 pounds in 1922 to a low of 123,000,000 pounds in 1929. As oleo oil is a relatively minor by-product of the beef industry, the volume of its production is largely determined by the volume of beef production, which increases at a smaller rate than the growth in population. The only ways in which higher prices for oleo oil might cause an increase in the quantity of oleo oil produced would be by causing (*a*) beef producers to fatten cattle more, and (*b*) packers to use more of the fat in the carcass for oleo oil. The effect of either would probably be small; just how much it might be is necessarily a matter of speculation.

But the question whether the production of vegetable-oil margarine, based on coconut oil, represents a replacement of domestic oils may be considered in connection with exports of oleo oil. Except in 1929 and 1930, exports of oleo oil were in excess of the estimated quantity of that oil required to produce animal-oil margarine equal in quantity to the production of vegetable-oil margarine. It must be a matter of speculation whether a reduction of exports of oleo oil in

order to increase the domestic production of margarine would be advantageous to farmers and others concerned with oleo oil.

The situation with respect to the exports of neutral lard is very similar to that with respect to oleo oil. On the average during recent years the exports of neutral lard have been roughly equal to the estimated quantity which would have been required if the vegetable-oil margarine produced had been replaced by an equivalent quantity of animal-oil margarine.

Competition of margarine and butter.

Through its use in vegetable-oil margarine, coconut oil competes not only with oleo oil and neutral lard but also with butter, although on a lower price level. Domestic production of butter is about 2,000,000,000 pounds annually; the quantity of coconut oil used in margarine is somewhat less than 200,000,000 pounds. To the extent that coconut oil, in the form of vegetable-oil margarine, replaces oleo oil and neutral lard, in the form of animal-oil margarine, it of course, does not affect the production and consumption of butter. The question of how far any increase in the total production of margarine, due to the development of nut margarine at a lower price than animal-oil margarine, was at the expense of butter, fat meats, lard, and other fatty foods, or of nonfatty foods, can not be answered, as it involves matters on which only speculation is possible. The effect on the production and consumption of butter hinges largely upon the extent to which the lower price of margarine, due to the use of coconut oil, caused the substitution of margarine for butter.

The data in the table below suffice to indicate the character of the competition between margarine and butter. From them the following conclusions seem warranted:

1. From 1914 to 1930 the per capita consumption of both margarine and butter increased, although margarine consumption is smaller now than in 1918, 1919, and 1920, which were the years of smallest per capita consumption of butter.

2. In periods of industrial expansion the tendency is for the per capita consumption of butter to decline and of margarine to increase, as butter prices then rise to such a height as to cause a tendency to substitute margarine, which is relatively stable in price, for butter.

3. In periods of depression the tendency is for the per capita consumption of butter to rise and that of margarine to decline, as prices of butter decline much more than those of margarine.

The tendency, indicated by the preceding table, for some consumers to shift from butter to margarine as the price difference between the two widens and to shift from margarine to butter as this difference narrows is shown also from season to season within a year. Margarine prices being relatively stationary, the seasonal fluctuations in the price difference are due mainly to fluctuations in the price of butter, which in turn are due to seasonal variations in the quantity of butter produced. (See Pt. V, p. 192, particularly Table 145, p. 196, and Chart XI, p. 197.)

TABLE 32.—*Comparison of prices of butter and margarine and per capita consumption of butter and margarine* [1]

Calendar year	Price of butter	Price of margarine	Difference	Consumption (pounds per capita)		Ratio of margarine consumption to butter consumption
				Butter [2]	Margarine [3]	
	Cts. per lb.	*Cts. per lb.*	*Cts. per lb.*			*Per cent*
1914	27.3	17.9	9.4	16.5	1.4	8.5
1917	40.3	23.5	16.8	14.7	2.2	15.0
1918	48.9	27.6	21.3	14.4	3.1	21.5
1919	57.2	33.6	23.6	14.6	3.3	22.6
1920	56.8	32.5	24.3	14.6	3.5	24.0
1921	40.0	21.6	18.4	15.8	2.6	16.5
1922	37.7	18.8	18.9	16.2	1.7	10.5
1923	44.4	21.4	23.0	16.9	1.9	11.3
1924	39.9	22.4	17.5	17.3	2.1	12.2
1925	42.6	22.5	20.1	17.0	1.9	11.2
1926	41.4	21.3	20.1	17.8	2.1	11.8
1927	44.3	21.1	23.2	17.8	2.2	12.4
1928	44.9	21.0	23.9	17.4	2.5	14.4
1929	43.7	20.5	23.2	17.3	2.8	16.2
1930 [4]	35.3	21.8	13.5	17.6	2.5	14.2

[1] Bureau of Labor Statistics: Butter, extra at Chicago; margarine, standard uncolored, Chicago.
[2] Katherine Snodgrass, Margarine as a Butter Substitute (Stanford University, Food Research Institute, Fats and Oils Studies, No. 4), p. 311.
[3] Calculated from production figures.

(D) ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF COCONUT OIL AND COTTONSEED OIL IN THE MANUFACTURE OF MARGARINE

Coconut oil to a limited degree competes with soft vegetable oils in the margarine industry, for the reason that more of those oils are used in connection with hard animal oils than in connection with coconut oil. Being the principal oil to meet this competition, domestic cottonseed oil is taken as representative. Later the competition between the various soft vegetable oils will be separately considered.

As a result mainly of the increased use of coconut oil and the decreased use of oleo oil and neutral lard, the use of cottonseed oil in margarine declined between the fiscal years 1917 and 1931 from 63,000,000 to 22,000,000 pounds, and from 26 to 9 per cent of total consumption of oils in that use. A contributing factor to the decline in use of both cottonseed oil and oleo oil was the fact that in 1917 and preceding years coconut oil regularly sold for a much higher price than cottonseed oil, whereas after 1917 it usually sold for a lower.

The following table shows the estimated additional quantity of cottonseed oil which would be used in the production of margarine if an equivalent quantity of animal-oil margarine were substituted for vegetable-oil margarine, and if cottonseed oil were the only vegetable oil used in the margarine. The question to what extent without the importation of coconut oil the production of cottonseed oil might have increased is elsewhere discussed. The table shows that the estimated quantity of cottonseed oil required for the replacement of vegetable-oil margarine by animal-oil margarine could, except in the last three years, have been supplied by reducing exports.

TABLE 33.—*Estimated quantity of cottonseed oil required to make animal-oil margarine equal to quantity of vegetable-oil margarine produced*

Calendar year	Estimated quantity of cottonseed oil required for producing animal-oil margarine equal in quantity to the total production of vegetable-oil margarine	Net exports of cottonseed oil	Calendar year	Estimated quantity of cottonseed oil required for producing animal-oil margarine equal in quantity to the total production of vegetable-oil margarine	Net exports of cottonseed oil
	Pounds	*Pounds*		*Pounds*	*Pounds*
1917	5,990,000	[1] 145,951,000	1924	27,810,000	43,342,000
1918	24,467,000	[1] 86,402,000	1925	30,993,000	62,416,000
1919	39,241,000	165,327,000	1926	53,315,000	34,222,000
1920	53,800,000	175,290,000	1927	42,246,000	67,982,000
1921	27,854,000	251,881,000	1928	63,986,000	51,702,000
1922	20,765,000	75,283,000	1929	60,948,000	26,075,000
1923	26,613,000	48,583,000	1930	59,366,000	28,297,000

[1] Fiscal year.

(E) ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF COCONUT OIL, COTTONSEED OIL, AND INEDIBLE TALLOW IN SOAP MAKING

Comparison of price and consumption trends.

The table below shows that during the war period changes in the price relationships of coconut oil, cottonseed oil, and inedible tallow synchronized with changes in the proportions in which each of these oils were used in soap making. In particular, the increased use of coconut oil and the decreased use of cottonseed oil were concurrent with a change in the price position of coconut oil from higher to lower than cottonseed oil. But this change in the price positions of these two oils can not be assumed to be the principal cause of the change in their relative importance in soap. In both 1921 and 1922 cottonseed oil was lower in price than coconut oil and yet the use of coconut oil declined only slightly, and the use of cottonseed oil continued to decline, although at a lower rate. This may have been due in part to changes in the types of soap produced, but perhaps more important was the fact that inedible tallow, which in the war period had declined in relative price position, remained lower in price than cottonseed oil, with the result that it continued to be used in both yellow and white laundry soaps instead of cottonseed oil. As has already been indicated, the price of tallow in relation to cottonseed and coconut oils is a more significant price comparison than that of the prices of the two vegetable oils in relation to each other.

TABLE 34.—*Comparison of prices and consumption in soap making of coconut oil, cottonseed oil, and inedible tallow* [1]

Calendar year	Coconut oil (in tanks) crude, Pacific coast	Cottonseed oil; prime summer yellow (in tanks), New York	Tallow, inedible		Proportion of consumption of oil in soap making supplied by [2]		
			Packers prime, Chicago	No. 1 packers [3]	Coconut plus palm-kernel oil	Cottonseed oil	Inedible tallow, greases, red oil; fish oil and palm oil
	Cts. per lb. [4]	*Cts. per lb.* [4]	*Cts. per lb.* [4]	*Cts. per lb.* [4]	*Per cent*	*Per cent*	*Per cent*
1913	12.0	7.3	7.1				
1914	12.2	6.6	6.9		13.4	14.6	47.8
1915	12.3	6.8	6.9				
1916	15.1	10.6	9.9		11.0	18.4	45.2
1917	17.1	15.4	15.6		14.4	10.5	44.1
1918	18.1	20.1	17.9				
1919	17.4	24.1	15.4		20.6	6.2	50.3
1920	17.4	15.4	13.1	11.9			
1921	10.1	7.9	6.4	5.0	19.7	4.8	59.0
1922	8.4	10.1	7.1	6.2	21.3	1.8	64.6
1923	8.2	11.3	8.2	7.0	22.7	.9	63.6
1924	8.6	10.8	8.5	7.6	20.0	.8	66.9
1925	9.8	10.8	9.7	9.1	23.4	.6	61.2
1926	9.4	11.8	8.7	8.1	23.8	.3	60.6
1927	8.2	9.7	8.1	7.4	22.5	.5	60.9
1928	8.0	9.9	8.8	8.2	23.6	1.2	61.3
1929	7.1	9.7	8.5	7.9	24.6	.7	60.4
1930	5.9	8.1	6.8	5.7	21.3	.5	64.4
1931 (average for first six months)	4.5	7.2	4.3	3.8			

[1] Gamble's naval stores' Yearbook, 1913–1918; Naval Stores Review, 1921–1930.
[2] Computed from data given in section on soap making.
[3] The National Provisioner.
[4] Bureau of Labor Statistics, Wholesale Prices.

Conditions of supply of and demand for cottonseed oil.

Conditions of supply of coconut oil have already been discussed, and conditions of supply of inedible animal oils will be discussed in connection with their competition with palm, whale, and fish oils. This leaves only cottonseed oil to be discussed here.

Until some method is devised for a more complete extraction of oil from the seed, it is not likely that any increase in the price of cottonseed oil will materially affect the volume of supply beyond the limited quantity which might be obtained under the stimulus of higher oil prices by a more complete utilization of seed for crushing. Any further increase in cottonseed oil would necessitate an increase in the cotton crop, and incidentally an increase in cottonseed meal and other joint products made with cottonseed oil.

Price fluctuations of cottonseed oil show little or no correspondence with those of coconut oil, its price, as determined from the side of demand, being largely a result of competition, in the form of lard compound, with lard. The price of lard is influenced not only by this competition but by competition in Europe with lard from other sources and with margarine used there to a considerable extent as a cooking fat. The price of cottonseed oil is also affected by the dwindling competition of exported lard compound and exported cottonseed oil with goods in foreign countries, and by competition in the domestic market with domestic corn oil, and to a much smaller degree with foreign sesame oil, in making salad oils and dressings and, to some extent, in making lard compounds.

Question of replacement.

The practical disappearance of cottonseed oil from the soap kettle after 1917 involved mainly (1) a shift from cottonseed to inedible animal oils (tallow and greases) for yellow laundry soap, (2) a similar shift in making white laundry soap, and (3) a shift from yellow to white laundry soap. The change in composition of yellow laundry soap did not affect the use of coconut oil, but the change in composition of white laundry soaps involved a small increase, and the change from yellow to white soaps a considerable increase in the use of coconut oil. The substitution of inedible tallow for coconut oil in white laundry soap may not alter materially the characteristics of the resulting soaps, but a white laundry soap differs materially from a yellow laundry soap.

The changes discussed above are merely the technical means of reducing the use of cottonseed oil in soap. One of the principal causes of the reduction was the absorption of cottonseed oil into food uses at prices above the level of soap oils. This is accounted for by its special adaptability to the production of lard compounds and salad oils and salad dressings. It was rendered possible by the conditions of supply of cottonseed, which severely restricted any increase of output in response to increases in price and thus kept production within the limits of consumption in food industries. In fact, the practically complete absorption into food uses was hastened by a decrease in the production of cottonseed oil from 1917 to 1923, due largely to a succession of short cotton crops. The reduced supply came to be used almost entirely for food. Since 1924, although its production has been larger, there has been no restoration of its use in soap.

Another important cause of the decreased use of cottonseed oil in soap was changes in the types of soap produced. These changes may be due partly to advertising undertaken to provide a market for products made from oils obtainable at low prices.

The question of replacement, approached by considering what might be the effect on the future utilization of cottonseed oil of a drastic reduction or elimination of coconut oil, brings up the question of whether the possibility of an increased use of cottonseed oil involving material changes in the character of soap produced may be regarded as evidencing replacement. Leaving aside this question, the possibility of increasing the use of cottonseed oil in soap in the event of a reduction in the consumption of coconut oil depends on the extent to which cottonseed oil (through increase in price of soap oils), might be diverted from lard compounds any substantial increase in production being out of the question. The diversion of cottonseed oil from food uses into the soap kettle would reverse the tendency which has prevailed for three decades, even before it became higher in price than coconut oil. For a discussion of the conditions under which this might occur, see the general summary statement, p. 16, and Part V, p. 210.

The question whether the domestic production of soft vegetable oils, principally corn, peanut, and soybean, could not be increased in the United States and take the place once held in soap making by cottonseed oil will be considered later.

(F) ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF COCONUT OIL AND ROSIN IN SOAP MAKING

Price and consumption trends.

Although rosin always has been lower in price than coconut and other soap oils, its tendency toward a higher price level may have been a contributing factor in the trend from yellow to white laundry soaps. The price of K grade, used largely in soap, rose from 1.3 cents per pound in 1915 to 5.8 cents in 1919, declined to 1.5 cents in 1921, rose to 4.5 cents in 1926, and declined to 1.9 cents in 1930. Its consumption in soap has been as follows:

	Pounds		Pounds
1914	185, 310, 000	1926	118, 257, 000
1919	119, 529, 000	1927	100, 277, 000
1924	104, 956, 000	1928	92, 777, 000
1925	140, 615, 000	1929	114, 300, 000

The decline of the use of rosin in soap making presents a question of the meaning of the term "replacement." There is no direct competition between coconut oil and rosin—only that involved in the competition between yellow and white laundry soaps; that is, between rosin, low-grade inedible animal oils (or palm, whale, or cottonseed oil), and a small proportion of sodium silicate, on one side, and coconut oil, higher grade inedible animal oils, and a larger proportion of sodium silicate, on the other. As has been pointed out, rosin is the quick-lathering ingredient of the yellow, and coconut oil of the white. Although the two soaps differ materially in characteristics, so far as could be determined the price difference between them has usually been small, sometimes one and sometimes the other being lower in price.

The tabulation below shows the actual quantity of rosin used in soaps in specified years subsequent to 1914 and the quantity which would have been used if its consumption, instead of decreasing, had increased to the same extent as did the total consumption of oils.

Year	Amount of rosin used in soaps	Amount of rosin which would have been used if its use had increased compared with 1914 to the same extent as the use of oils	Difference	Year	Amount of rosin used in soaps	Amount of rosin which would have been used if its use had increased compared with 1914 to the same extent as the use of oils	Difference
	Pounds	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
1919	119, 529, 000	203, 841, 000	84, 312, 000	1927	100, 227, 000	336, 913, 000	266, 686, 000
1924	104, 956, 000	298, 349, 000	193, 393, 000	1928	92, 777, 000	368, 766, 000	275, 989, 000
1925	140, 615, 000	318, 733, 000	178, 118, 000	1929	114, 300, 000	387, 297, 000	272, 987, 000
1926	118, 257, 000	335, 411, 000	217, 154, 000				

The increased quantity of rosin required to maintain the same proportionate production of yellow laundry soaps as in 1914 was exceeded several times by the quantity of exports, which in recent years have ranged from about 600,000,000 to 700,000,000 pounds annually.

(G) ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF PALM AND WHALE OILS WITH DOMESTIC INEDIBLE ANIMAL OILS, INCLUDING GREASE AND FISH OILS, IN SOAP MAKING

Price and consumption trends.

From 1914 through 1922 the proportions of the total consumption of oils in soap making supplied by inedible animal oils increased. Between the same years the proportion supplied by palm oil remained small, rising, however, from between 1 and 2 per cent to between 2 and 3 per cent of the total. During most of this period palm oil was higher in price than tallow. Since then, however, the tendency has been for palm oil and tallow to sell at close to parity in price, taking into consideration refining costs, which are usually higher for palm oil, and glycerin yields, which usually are higher for tallow. Since then also the use of palm oil in soap making has increased, and in each year from 1923 to 1930 it has supplied from 6 to 12 per cent of the total consumption of oils in that industry. This increase has occurred mainly on the Atlantic seaboard, where imported oil has a more advantageous price position than in the soap centers of the Middle West, close to the largest domestic production of inedible animal oils.

Representative price data, such as can be published, were not obtainable on whale oil or fish oils. When they are used in soap making, they compete with inedible tallow and must be bought at a price sufficiently below that of tallow to offset the cost of hydrogenating them.

Conditions of demand.

Palm oil and hydrogenated whale oil and fish oils have a more restricted market than tallow. Tallow is generally preferred by soap makers to hydrogenated whale oil and fish oils, which are used mainly to blend with tallow in the production of general household and laundry soaps. The principal limitation on the use of palm oil arises from the fact that it is confined largely to yellow soaps, as it is expensive to bleach and usually is not obtainable at a price sufficiently below that of tallow to warrant the added cost. On the other hand, palm oil has a considerable market in which it is preferred. This market is created by demand for it (1) in certain textile soaps, (2) in certain trade-marked brands of soap, the brand name and advertising description of which require the use of palm oil, and (3) in certain brands of soap to which palm oil gives a distinctive red color. There are, however, certain important manufactures, such as that of yellow laundry soaps, in which it is freely interchangeable with tallow, the cheaper of the two being used.

Conditions of supply.

Palm oil.—Palm oil production had a marked expansion during the decade 1920–1930, and gives promise of further expansion. From 1923 to 1930 its export from the principal producing regions increased about 55 per cent; its import into the United States, about 120 per cent; its use in domestic soap making, about 90 per cent. Although there are possibilities of expansion in West Africa, the prospects for further increase there in the production of palm oil in the near future are not good. A large increase, however, may be expected from the Dutch East Indies, chiefly Sumatra, and from British Malaya. In the main palm-growing region of Sumatra the acreage planted to oil palms increased from 10,860 in 1918 to 61,123 in 1929. In the entire

island there were planted to palms in 1929, 93,409 acres, on only 41,174 acres had the trees reached bearing. The acreage in British Malaya increased from 2,240 in 1922 to 24,000 in 1928, with further acreage reserved for future plantings.

Whale oil.—The world production of whale oil expanded tenfold from the whaling season 1919–20 to the season 1930–31. This increase resulted from the wholesale exploitation, largely by Norwegian and British whalers, of the Antarctic waters which afford the principal remaining undepleted supply of whales. For a limited number of years longer, the catch of whales may continue to increase, although perhaps at a slackened rate. In a comparatively short time, however, a rapid decline may be expected to set in, unless an international agreement is made severely curtailing each year's catch. Large whalers, principally Norwegian, operating in the Antarctic region have voluntarily limited operation for the 1931–1932 season only.

Domestic fish oils.—It seems probable that under favorable conditions of price the production of fish oils in the United States could be somewhat increased, but the maximum increase which could be expected would still leave fish oils a minor source of supply of animal and vegetable oils consumed in the United States. In the 5-year period 1926–1930, average domestic production of fish oils amounted to 96,763,000 pounds and the total consumption of animal and vegetable oils, except butter, to 5,700,000,000 pounds.

Domestic inedible tallow and animal greases.—Production of inedible tallow and animal greases in the United States increased 82 per cent, or from 447,000,000 pounds in 1914 to 811,000,000 pounds in 1930. This increase was due largely to a greater utilization of waste fats, for between the same years the production of meat rose only 23 per cent. Further increase in the utilization of those wastes may occur, but it probably will be gradual. Ultimately, of course, the production of tallow and grease is limited by the production of meat, which seems to be growing less rapidly than the growth in population. Increase in the price of animal oils might, however, cause such change in the method of feeding animals as would result in a greater proportion of fat. To what extent this would prove profitable or would actually take place in case of a marked reduction in consumption of foreign oils it is impossible to judge; it should be noted that such a change would affect the character of the meat sold as such, not merely add to the quantity of tallow and greases available.

Replacement.

Table 35 shows for the years 1926 to 1930 general imports of palm oil, whale oil, fish oil, and inedible tallow and animal greases, separately and in total.

TABLE 35.—*General imports of palm oil, whale oil, fish oil, and inedible tallow and animal greases*

Year	Palm oil	Whale oil	Fish oil [1]	Inedible tallow and greases	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1926	130,746,000	63,434,000	31,090,000	15,617,000	240,887,000
1927	159,912,000	39,750,000	85,721,000	15,969,000	301,352,000
1928	169,228,000	68,386,000	72,497,000	16,493,000	326,604,000
1929	261,816,000	54,532,000	77,919,000	18,957,000	413,224,000
1930	287,492,000	74,663,000	84,277,000	5,175,000	451,607,000

[1] Includes herring, sardine, and "other" fish oils, including salmon.

With the exception of some 15,000,000 pounds of palm oil used annually in the tin-plate industry, practically all these imports may be taken as technically interchangeable with tallow and grease, although palm oil is not much used in white soaps because of the cost of bleaching. Since this is true, how far they may be considered as in replacement of domestic oil and how far as supplementary to them depends on the extent to which the domestic supply of inedible animal fats, whale oil, and fish oils would have been expanded had the imported materials not been available. Any increase which would have occurred in the domestic production of whale oil and fish oils would have been small compared with these imports, unless domestic whalers should begin operations in the Antarctic. At higher prices a larger expansion of the production of inedible tallow and greases might have occurred. How great this expansion would have been hinges upon unpredictable factors, such as the effects of higher prices on demand for and supply of tallow and grease and their joint products, tankage, and crackling.

(H) ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF DOMESTIC SOFT VEGETABLE OILS

In the foregoing discussion the question of the possibility of substituting imported coconut, palm, and whale oils for domestic soft vegetable oils, other than cottonseed oil, has been raised. The oils which must be considered in this connection are corn, peanut, and soybean oils. Sunflower seed has also been mentioned as a possible source of domestic oil. Sunflower seed has been produced in various parts of the country for poultry feed, but so far as known, has never been crushed for oil on a commercial scale.

Comparison of prices.

Table 36 affords a comparison of prices of cottonseed, corn, and peanut oils.

TABLE 36.—*Comparison of prices of cottonseed, corn, and peanut oils in barrels*

[Cents per pound]

Year	Cottonseed oil, refined, white, deodorized, Chicago	Corn oil, refined, New York	Peanut oil, refined, New York
1926	13.6	13.5	15.8
1927	11.2	11.6	14.4
1928	10.6	12.0	13.3
1929	10.6	11.3	13.3
1930	9.7	10.4	12.1
Average	11.1	12.0	13.8
1931 (first half)	9.2	9.9	11.7

Table 37 indicates that until 1931 soybean oil was higher in price than corn oil, and therefore higher in price than cottonseed oil.

TABLE 37.—*Comparison of annual average prices of crude corn and soybean oils in barrels*

[Cents per pound]

Year	Crude corn oil	Crude soybean oil
1926	12.0	12.6
1927	10.8	12.0
1928	10.5	12.2
1929	10.3	12.0
1930	9.4	10.1
Average	10.6	11.8
1931 (first half)	8.4	7.2

It is apparent that if cottonseed oil, because of price, is not available for the soap kettle, neither are domestic corn, peanut, or soybean oils. Practically their entire production, like that of cottonseed oil, has been absorbed in uses in which they command prices in excess of those paid for soap oils. Some off grades of these oils do go into the soap kettle, but ordinarily little, if any, of the standard grades.

Conditions of supply.

It has already been indicated that there is little prospect of much expansion of the supply of cottonseed oil. It remains to analyze the conditions of supply of corn, peanut, and soybean oils.

Corn oil.—Corn oil is produced, along with about an equal amount of corn-oil cake and meal, from the corn germ, which forms from 6 to 13 per cent of the total weight of the corn kernel. The oil production in the United States has been confined to that obtained from crushing the germs which are separated from the rest of the corn in the manufacture of cornstarch, glucose, and related products, and of degerminated corn-meal grits and hominy. The amount of corn oil produced in any year, therefore, depends almost entirely upon the magnitude of the production of the corn products named. Considerably higher prices than have hitherto been obtainable for corn oil might lead to some increase in its production, which since 1921 has fluctuated from 112,000,000 to 134,000,000 pounds annually. A larger utilization of the germ separated in producing corn meal and hominy might result in a small increase in production. It might also be technically possible to devise an economical method of separating the corn germ for oil purposes, leaving the remainder of the kernel for animal feed. To what extent such a process could be applied would depend on its cost and on the relative demand for degerminated corn as against whole corn for animal feed.

Peanut oil.—In the United States peanut oil, in most years, has been made entirely from cull peanuts, which is the grade of peanuts left after separating out the grades salable for direct human consumption and for use in making candy or peanut butter. Increased production could be accomplished only in one of the following ways:

(1) By increasing the peanut crop, which would give a larger volume of culls for crushing but would tend to lower the price for the major products, graded peanuts, in the shell and shelled.

(2) By crushing not only culls but some of the higher grade nuts. To make this possible either prices of oil must rise or prices of graded peanuts for direct consumption must decline.

(3) By crushing peanuts as they come from the farm ungraded. This would happen on a considerable scale only when peanuts are worth about as much for oil and cake as they are for direct consumption. This could occur in two ways—(1) by the value of peanuts for oil rising to their value in direct consumption or (2) by their value in direct consumption falling to their oil value. The former seems to have happened in some of the war years, with the result that in 1919 the peanut oil produced reached the record amount of 88,000,000 pounds.

Soybean oil.—Soybean oil is produced from soybeans, a principal and not a by-product. The bean when crushed yields, however, only about 15 per cent of oil, the remainder being oil cake and meal of high feeding value. Production in the United States, although still small, has been increasing in recent years, as shown by the following figures for production in years beginning October 1 and ending September 30 of the years named.

	Pounds		Pounds
1924–25	2, 269, 000	1928–29	7, 285, 000
1925–26	2, 638, 000	1929–30	12, 391, 000
1926–27	2, 659, 000	1930–31	39, 129, 000
1927–28	4, 374, 000		

Through 1929–30 the production of soybean oil seems to have kept largely within the limits of the ability of the paint and varnish industry to absorb it at prices above those prevailing among the oils, like cottonseed oil, most widely used in the food industries. If soybean-oil production, however, is extended much beyond the amount which will be absorbed in the paint and varnish industry, it will come into competition with cottonseed oil and other edible oils and may be expected to fall below cottonseed oil in price, as it is more difficult to refine than cottonseed oil, which is preferred to it in most edible uses. If it should come to be used on a large scale in soap making its price would drop still lower. But whether it would be profitable to raise soybeans for oil, even at cottonseed oil prices, is problematic. Much would depend on the market for oil cake, discussed below.

Oil cake and oil meal.

The possibility of expanding domestic production of soft vegetable oils, such as corn, peanut, and soybean, depends to some extent upon the market for oil cake and oil meal. Cottonseed and soybeans yield about five and one-half times as much meal as oil; sunflower seed, three and one-half times as much; peanuts, two and one-half times as much; and flaxseed, twice as much. The corn germ yields about equal amounts of the two, and copra yields about half as much meal as oil.

Exports of oil cake and oil meal have exceeded imports by the following amounts:

	Pounds		Pounds
1921	1, 105, 000, 000	1926	1, 329, 000, 000
1922	833, 000, 000	1927	1, 381, 000, 000
1923	793, 000, 000	1928	936, 000, 000
1924	1, 135, 000, 000	1929	943, 000, 000
1925	1, 397, 000, 000		

Imports have been considerable, however, and have come in mainly on the Pacific coast, where the local production has not been sufficient to supply the demand. Exports have been almost entirely from linseed-oil mills in the Northeastern States and from cottonseed-oil mills in the Southern States. The linseed cake exported is made from imported flaxseed and is exported with benefit of the drawback

Crushers in the East and in the South usually have found a more advantageous market in Europe than in the far Western States, while the far Western States have found it more advantageous to buy in various countries of the Far East and in near-by Mexico. This situation arose largely from the fact that costs of ocean transportation are lower than those of transcontinental rail transportation. It may have been altered by the imposition in the tariff act of 1930 of a duty of three-tenths of 1 cent per pound on imported oil cake and oil meal.

The effect of an increased production of oil cake and oil meal incident to an increased production of oil expressed from domestic materials would vary according to the following factors:

(1) According to whether produced in the scarcity regions of the far West or in the surplus regions of the South and East.

(2) According to whether or not accompanied by a decrease in the oil cake and oil meal made from imported materials, such as copra and flaxseed.

(3) Upon the grade of the oil meal in which the increase should come. Linseed, cottonseed, and soybean-oil meals are of high grade. Corn oil is not as high as the others in protein content for which the oil meals are usually fed.

(4) Upon the possibility of expanding domestic consumption of oil meals.

(5) Upon the effect of an increased export to Europe upon European prices, if a larger export surplus should develop.

(I) ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF SESAME OIL WITH DOMESTIC COTTONSEED AND CORN OILS

Sesame oil, as has been noted, has been used in this country principally as a salad oil and as a constituent of salad dressing and, on the Pacific coast, in lard compounds. Some grades have gone into the manufacture of soap.

Price position.

The table below indicates that sesame oil has usually sold on the Atlantic seaboard for higher prices than cottonseed or corn oil, this being possible because in eastern cities there is a special trade which prefers it. In 1930 and 1931 sesame oil, crushed to a large extent in Pacific coast mills from imported seed and used there largely in lard compounds, may have had some price advantage there over cottonseed and corn oils shipped across the country from mills in the South, East, and Middle West. No price data are available, however, to determine this point definitely.

TABLE 38.—*Comparison of prices of cottonseed, corn, and sesame oils in barrels*

[Cents per pound]

Year	Cottonseed oil, white deodorized, Chicago	Corn oil, refined, New York	Sesame oil, refined, New York
1926	13.6	13.5	13.8
1927	11.2	11.6	13.0
1928	10.6	12.0	12.8
1929	10.6	11.3	12.5
1930	9.7	10.4	11.5
Average	11.1	12.0	12.9
1931 (first half)	9.2	9.9	10.8

Conditions of supply.

It has been noted that the supply of cottonseed and corn oils is not readily expansible. The same seems true also of sesame oil. In fact, exports of sesame seed from China and India have tended to decline in recent years. Altogether in 1930 they were equivalent to only 150,000,000 pounds of oil, of which about 36,000,000 pounds were consumed in the United States.

Question of replacement.

In forming a judgment on the extent to which sesame oil has replaced domestic oils, the following facts are pertinent:

(1) The whole quantity of sesame oil consumed in the United States is technically interchangeable with domestic cottonseed and corn oils.

(2) Before 1929, when the use of sesame oil amounted to from 5,000,000 to 15,000,000 pounds annually, consumption, except for a small use in soap, was divided between a special trade in eastern cities, in which it commanded a price premium, and the manufacture of salad oils and dressings, lard compounds, and soap, principally on the Pacific coast. In the latter use it competed directly with domestic cottonseed and corn oils.

(3) The increased domestic consumption of sesame oil since 1928 has gone to some extent into soap, but mainly into salad oils and dressing, lard compounds, and to a small extent into margarine.

(4) In eastern markets sesame oil has usually sold higher in price than cottonseed and corn oils. It may be that on the Pacific coast it has at times, particularly since 1928, undersold those oils, but no data on the subject are available.

(5) In 1928 and preceding years exports of cottonseed oil regularly exceeded domestic consumption of sesame oil; since then the reverse has been true.

(6) Further increase in the use of sesame oil is limited by the relatively small available supply of sesame seed, exports of which from China and India have tended to decline in recent years.

(J) ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF PERILLA OIL AND LINSEED OIL

The comparison below indicates that perilla oil was higher in price than linseed oil except in 1930 and 1931, when linseed oil seems to have had a slight price advantage.

TABLE 39.—*Comparison of prices of crude perilla and linseed oils in barrels, New York*

[Cents per pound]

Year	Perilla oil	Linseed oil	Year	Perilla oil	Linseed oil
1926	13.7	11.2	1929	15.2	12.3
1927	14.8	10.5	1930	12.2	12.5
1928	14.3	10.0	1931 (first half)	8.9	9.0

The supply of perilla seed is limited and uncertain in quantity. It is not probable that it will be increased to any appreciable extent in the near future. Perilla-oil cake is unfit for cattle feed, but is used in Japan as a fertilizer for mulberry trees.

Imports into the United States in the last 11 years have varied from a low of 652,840 pounds in 1921 to a high of 8,838,000 pounds in 1930. Next to 1930 the largest imports were 7,582,000 pounds in 1920 and 7,401,000 pounds in 1926. The larger imports in 1930 may have been in part due to a substitution of perilla oil for linseed oil in some uses, particularly in border-line uses where there is not much preference between the two oils. Only to the extent of such substitution could perilla oil be said to have replaced linseed oil except in the sense that if perilla oil had not been available consumers might have been forced to use somewhat different enamels and varnishes made of linseed or tung instead of perilla oil. Perilla oil ordinarily goes into the production of certain high-gloss enamels and baking varnishes, which manufacturers state would be difficult to manufacture without it. About half of the domestic consumption of linseed oil is domestic, the other half being imported or made from imported flaxseed.

(K) ECONOMIC FACTORS AFFECTING THE REPLACEMENT OF RAPESEED OIL AND DOMESTIC CORN OIL

No marked change may be expected to occur in the supply of rapeseed oil, either in the way of an increase or a decrease. Imports into the United States rose from 12,000,000 pounds in 1920 to 19,000,000 pounds in 1926, but declined to 15,000,000 pounds in 1930. The following comparison shows that it has sold at a lower price than corn oil, with which it is to a limited extent competitive as a material for rubber substitutes.

TABLE 40.—*Comparison of prices of rapeseed and corn oils in barrels, New York*

[Cents per pound]

Year	Rapeseed oil	Corn oil	Year	Rapeseed oil	Corn oil
1926	11.5	15.4	1929	10.8	11.3
1927	10.7	11.6	1930	8.4	10.4
1928	11.4	12.0	1931 (first half)	6.9	9.9

As far as the commission could learn, no other animal or vegetable oil has been successfully used in place of rapeseed oil in its principal use as a lubricant for marine engines. Any replacement of domestic oils by rapeseed oil which has occurred has been in the rubber-substitute industry. Two types of rubber substitutes are made, one from rapeseed oil and one from corn oil. Each type has distinctive characteristics which cause it to be preferred in certain uses, but there are some border-line cases where either could be used. In such cases replacement may be said to have occurred because the price of rapeseed oil was lower than that of corn oil. How far corn-oil substitute, in other cases, would be used if the rapeseed-oil substitute were not available can not be determined.

PART II

GENERAL INFORMATION ON VEGETABLE AND ANIMAL OILS

World production.

The important oils produced in the world, besides butter, lard, other animal oils, and fish and whale oils, and excepting mineral oils, are the vegetable oils obtained from cottonseed, peanuts, olives, coconuts, palm fruit (palm oil and palm-kernel oil), flaxseed, soybeans, sunflower seed, and rapeseed. Other vegetable oils of less importance are sesame, hempseed, perilla, corn, castor, and tung oils.

Cottonseed oil is produced in larger quantities than any other oil, and the United States is the largest world producer. Olive oil is the chief oil produced in Europe from home-grown raw material. Other important oils are produced from raw materials grown in Soviet Russia, Argentina, Africa, and the Orient.

Although the world output of individual oils has varied from year to year, the total output in recent years has been fairly uniform. A decline, however, was shown in 1930. Coconut oil increased regularly over the period up to 1930 except for an insignificant decline in 1928. A considerable decrease was shown in 1930.

Table 41 gives the world production of the more important vegetable-oil materials in terms of oil.

The figures in the table are based upon the production of oil seeds (exports in absence of production) of all important producing and exporting countries for which statistics are available. These figures should not be confused with actual production. For some countries they will exceed actual production, because of the inclusion of oil seeds not used for oil; for other countries they will be less than actual production, because of the exclusion (records unavailable) of raw material used for oil consumed locally. They indicate, however, the potential world oil supply, especially the trends of this supply.

TABLE 41.—*Vegetable oils: Production of more important materials, expressed in terms of oil yield, in leading producing countries*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture.]

[In millions of pounds]

Oil	Oil equivalent of raw material	Production, in terms of oil							
		1923	1924	1925	1926	1927	1928	1929	1930
	Per cent								
Cottonseed	15	2,689	3,106	3,539	3,511	3,466	3,740	3,730	3,524
Peanut	28	1,759	2,197	2,596	2,506	3,067	3,262	2,782	2,200
Olive	.....	1,543	1,720	1,442	1,287	2,349	1,496	2,695	[1] 968
Coconut	65	1,387	1,488	1,513	1,686	1,724	1,721	1,793	1,552
Linseed [2]	33	2,109	2,271	2,653	2,648	2,799	2,596	2,002	2,596
Soybean	15	933	959	1,143	1,346	1,361	1,493	1,557	1,264
Sunflower [3]	22	869	709	1,295	830	1,111	1,129	1,143	1,062
Rapeseed	38	1,139	1,112	1,219	1,004	1,048	931	881	1,041
Sesame	45	[4] 445	654	522	538	665	620	547	470
Palm-kernel	45	483	535	584	575	593	550	538	([5])
Palm [6]	.....	330	418	447	412	435	477	532	([5])
Hempseed	30	266	245	408	390	408	414	415	395
Tung [7]	.....	112	119	119	100	120	101	119	156
Total	.....	14,064	15,533	17,480	16,833	19,146	18,530	18,734	[1] 15,228
Total, excluding palm-kernel and palm oils [8]	.....	13,251	14,580	16,449	15,720	18,118	17,503	17,664	[1] 15,228

[1] Total in 1930 affected largely by the abnormally low olive-oil production.
[2] Five chief producing countries.
[3] Russia only for 1924; Russia and Bulgaria, 1925 to 1930.
[4] India only.
[5] Data not available.
[6] Includes some palm-kernel oil.
[7] Exports from China.
[8] These oils are excluded in order to make other years comparable with 1930.

The following tabular statement shows the chief sources of the principal vegetable oils and of whale oil as well as the sources of the raw materials from which such oils are made. It also shows the chief countries importing and exporting these oils and oil-bearing materials.

Data are unavailable on the world production of animal oils. The United States, however, is undoubtedly the chief producer of butter, lard, tallow, and greases. The output in the United States of butter approximates 2 billion pounds annually; lard about two and one-half billions; tallow, about one-half billion; and greases, about one-third billion pounds. The world output of marine-animal oils has increased to more than 1,750,000,000 pounds, of which somewhat less than 1,500,000,000 pounds is whale oil produced principally by Norway and the United Kingdom.

Vegetable oils and whale oil: Leading sources of the oils and of their raw materials, and chief countries importing and exporting such oils and oil-bearing materials

Oil	Chief countries					
	Producing raw material	Exporting raw material	Importing raw material	Producing the oil	Exporting the oil	Importing the oil
Cottonseed	United States, India, Egypt.	India, Egypt	United Kingdom	United States, United Kingdom, Egypt.	United States, United Kingdom, Egypt.	Canada, Germany, Netherlands.
Peanut	India, Africa, China	India, Africa	France, Germany	France Germany, China	France, Germany, China	United Kingdom, Netherlands.
Olive	Spain, Italy, Greece, Portugal, North Africa			Spain, Italy, Greece, Portugal, North Africa.	Spain, Italy	United States, France, United Kingdom.
Coconut	Philippine Islands, Netherland East Indies, Ceylon, British Malaya, India, South Pacific Islands.	Philippine Islands, Netherland East Indies, Ceylon, British Malaya, South Pacific Islands.	United States, Netherlands, Germany, France.	Philippine Islands, Netherland East Indies, Ceylon, India, United States, Netherlands, Germany, France.	Philippine Islands, Ceylon, Netherlands.	United States, United Kingdom.
Linseed	Argentina, United States, India, U. S. S. R.,[1] Canada.	Argentina, India, Canada.	United States, United Kingdom, Netherlands, Germany.	United States, United Kingdom, Netherlands, Germany, U. S. S. R.[1]	Netherlands, United Kingdom.	United Kingdom.
Soybean	China	China	Japan, United Kingdom, Germany.	China, Japan, United Kingdom, Germany.	China, Japan, United Kingdom, Germany.	United Kingdom, Netherlands.
Sunflower	U. S. S. R.,[1] China	U. S. S. R.,[1] China	Germany, United Kingdom.	U. S. S. R.,[1] China, United Kingdom, Germany.		
Rapeseed	India-China	India-China	Japan, United Kingdom, Germany, Netherlands.	Germany, India-China, Japan, United Kingdom, Netherlands.	Japan, United Kingdom.	United States.
Sesame	do	China	Netherlands, Germany, United Kingdom, France, United States.	India-China, Netherlands, Germany, United Kingdom, France, United States.	Netherlands	Do.
Palm-kernel	Africa, Netherland East Indies.	Africa, Netherland East Indies.	Germany, United Kingdom.	Germany, United Kingdom.	Germany, United Kingdom.	Do.
Palm	do			Africa, Netherland East Indies.	Africa, Netherland East Indies.	United States, United Kingdom.
Hempseed	U. S. S. R.[1]			U. S. S. R.[1]		
Tung	China			China	China	United States.
Perilla	do	China	Japan	China, Japan	China, Japan	Do.
Whale	Antarctic waters			Norway,[2] United Kingdom.[2]	Norway, United Kingdom.	United States, Germany.
Corn	United States			United States		

[1] Union of Socialist Soviet Republics (Russia).

[2] That is, vessels registered under flags of these countries.

Position of the United States with respect to oils.

Foreign sources supply an increasing share of oils consumed in the United States. Imports of oil, as such, increased from 728,000,000 pounds in 1923 to 1,124,000,000 pounds in 1930, while exports decreased from 1,373,000,000 to 873,000,000 pounds. Whereas in 1923 there was an excess of exports over imports of 645,000,000 pounds, by 1930 the reverse was true and imports exceeded exports by 251,000,000 pounds. Including the oil produced from imported raw material the change is from an almost even balance of imports and exports in 1923 to an excess of imports over exports of 1,072,000,000 pounds in 1929 and of 933,000,000 pounds in 1930. In other words, the United States now consumes about a billion pounds annually of foreign oils in excess of exports. As will be shown in a later table, the soap industry is chiefly accountable for this increasing importation. Table 42 shows the import and export trade of the United States in oils, including butter and lard but excluding derivatives, such as oleic and stearic acid, and products into which they enter, such as soaps and paints.

TABLE 42.—*Oils: Relation of imports to exports in the United States*

[In thousands of pounds]

Year	Excluding oil from imported stock			Including oil from imported stock		
	Imports	Exports	Excess exports over imports	Imports	Exports	Excess imports over exports
1923	727,629	1,372,938	+645,309	1,447,663	1,372,938	+74,725
1924	680,451	1,296,256	+615,805	1,231,357	1,296,256	−64,899
1925	824,338	1,028,319	+203,981	1,419,833	1,028,319	+391,514
1926	870,553	999,107	+128,554	1,629,999	999,107	+630,892
1927	920,620	1,006,952	+85,332	1,672,120	1,005,952	+666,168
1928	948,954	1,031,419	+82,465	1,658,725	1,031,419	+627,306
1929	1,201,783	1,079,195	−182,588	2,150,979	1,079,195	+1,071,784
1930	1,124,390	872,961	−251,429	1,805,866	872,961	+932,905

Source: For basic statistics, Foreign Commerce and Navigation of the United States, Department of Commerce.

As shown in Table 42, imports into the United States of oils including the oil equivalent of imported stock have increased until they now far exceed exports. With adjustments for stocks at the beginning and at the end of each year the United States consumption of oils for all purposes exceeds the domestic production by about a billion pounds annually. In the consumption of oils by the different industries, however, the situation varies.

Cottonseed oil and lard are produced in large quantities in the United States, and a part of these two products, particularly lard, is exported. These two are the major oils used for human food (apart from butter). More than offsetting these exports is the importation of the oils used in soap, paint, and miscellaneous manufactures some of which also are used in the food products industries. The present domestic production of inedible oils is less than the consumption in these industries, and this excess consumption over production is made up principally of imported vegetable oils and raw materials. Coconut oil and copra, palm, palm-kernel, whale, and fish oils, and olive oil foots are imported chiefly for use in the soap industry; tung, soybean, and perilla oils, and flaxseed, for use in the paint industry; sperm, cod, cod-liver, and rapeseed oils, and castor beans, for use in the miscellaneous industries.

The following classification shows the principal oils arranged according to their more important uses in the United States.

Animal and vegetable oils: Classification as to chief use [1]

Edible uses	Soap	Paint, varnish, linoleum	Miscellaneous uses
Butter. Lard. Tallow, edible. Cottonseed oil. Olive oil, edible. Peanut oil. Corn oil. Sesame oil. [2] Sunflower oil. [2]	Tallow, inedible. Greases. Coconut oil. Palm oil. Palm-kernel oil. [2] Olive oil, inedible. Olive-oil foots. Whale oil. Seal oil. Fish oils. Vegetable tallow. Cottonseed and other vegetable oil foots.	Linseed oil. Tung oil. Soybean oil. Perilla oil.	Castor oil. Rapeseed oil. Sperm oil. Cod and cod-liver oil. Sod oil. Wool grease. Neat's-foot oil. Almond oil. Croton oil.

[1] Listed as animal and vegetable oils in approximate order of the quantities used.
[2] Used for edible purposes when not denatured.
[3] Used for inedible purposes when denatured.

Table 43 shows the conditions of supply of oils, including butter and lard, in different branches of consuming industries of the United States. Here A, indicative of an export basis, is obtained by deducting imports plus stocks on hand at the beginning of the period from exports plus stocks on hand at the end of the period. B, indicative of an import basis, is obtained by deducting exports plus stocks at the end of the period from imports plus stocks at the beginning. The figures are tabulated according to the principal use of the oil or fat concerned and are not intended to show the actual consumption in each group. Coconut oil, for example, the consumption of which is about 60 per cent in the soap industry and about 40 per cent for edible uses, is tabulated under soap. An adjustment for this distribution would decrease A for edible uses and B for soap manufacture by more than 200,000,000 pounds. Likewise, the fish oils are tabulated under soap, although a certain percentage of them is used in paints.

TABLE 43.—*Oils: Conditions in the domestic supply, including butter, lard, oleo oil, oleo stearin, and oil from imported stock, shown by consumption groups*

[In thousands of pounds]

Year	A [1]	B [1]			B−A
	Edible uses	Soap industry	Paint industry	Miscellaneous industries	
1923	1,147,218	519,499	527,569	68,189	−31,961
1924	1,110,408	496,938	411,713	73,214	−134,543
1925	708,266	644,962	383,396	83,088	403,180
1926	954,050	663,076	532,495	85,533	327,654
1927	968,215	771,979	499,933	108,570	412,267
1928	755,254	929,284	473,170	113,812	761,021
1929	835,269	973,224	591,707	122,000	851,662
1930	582,235	912,599	386,802	103,580	820,746

Source: For basic statistics, Foreign Commerce and Navigation of the United States, and Bureau of the Census, United States Department of Commerce.

[1] See preceding text for definition.

United States imports of oils, including raw materials in terms of oil, free of duty, now considerably exceed imports of the dutiable oils. Table 44 shows imports into the United States of dutiable and free oils and oil-bearing materials in terms of oil.

TABLE 44.—*Animal and vegetable oils, dutiable and free, including raw material in terms of oil: Imports for consumption in the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

[In thousands of pounds]

	1923	1924	1925	1926	1927	1928	1929	Jan. 1 to June 17, 1930	June 18 to Dec. 31, 1930	Total, January to December, 1930
Dutiable:										
Flaxseed (in terms of linseed oil)	456,474	311,210	309,722	418,655	412,877	329,775	447,383	203,717	33,830	237,547
Olive oil, edible	73,568	76,900	87,683	80,760	71,848	83,394	92,050	53,330	38,687	92,017
Whale oil, n. s. p. f.	28,853	37,528	53,558	39,247	53,130	48,427	56,550	29,516	23,186	52,702
Castor bean (in terms of castor oil)	37,186	35,691	45,037	42,334	51,501	58,988	73,665	16,505	26,735	43,241
Castor oil	1,019	293	330	450	19	1,033	135	15	30	45
Menhaden, herring, and sod oil	4,324	4,511	4,253	14,571	39,216	375	34,713	21,916	7,067	28,983
Rapeseed oil	15,932	17,363	12,675	20,767	19,222	876	18,801	7,190	2,475	9,665
Soybean oil	33,222	11,210	15,905	26,370	11,515	12,587	16,317	7,227	3,387	10,614
Palm-kernel oil									9,867	9,867
Wool grease	9,431	12,744	9,967	11,797	10,927	10,669	10,550	5,977	1,936	7,913
Seal oil	3,806	3,630	2,738	4,881	4,719	1,461	4,731	2,206	1,146	3,352
Sperm oil	960	529	1,937	1,030	1,995	3,315	2,600	1,352	1,657	3,009
Linseed oil, raw, boiled, or oxidized	42,729	13,577	13,906	9,610	6,360	173	9,135	2,500	72	2,572
Butter	20,810	19,279	6,861	6,727	8,456	4,335	2,586	1,906	544	2,450
Fish oil, n. s. p. f.	1,052	1,122	943	810	697	2,371	3,493	1,502	549	2,051
Peanut oil	4,876	5,076	2,540	5,930	2,809	2,219	1,906	850	978	1,828
Oleo stearin	216	1,009	891	1,960	2,064	1,622	1,737	83	1,283	1,366
Animal tallow	10,823	2,440	1,771	13,647	12,908	13,482	16,468	400	190	590
Expressed and extracted oils, n. s. p. f.	170	267	112	2,441	1,641	1,092	3,344	46	854	900
Sesame oil, edible									88	88
Oleo oil	6			(1)	817	624	188	33	41	74
Animal oils, fats, and greases, n. s. p. f., inedible	223	136	216	225	145	262	229	53		53
Coconut oil (not from Philippine Islands)	1,209	135	453	327	38	60	43	29	3	32
Poppyseed oil, raw, boiled, or oxidized	16	19	64	176	42	45	39	14	14	28
Cottonseed (in terms of cottonseed oil)	10,314	14,258	9,575	8,843	1,640	157	25	13	5	18
Cottonseed oil	25			6,679	(1)	1	2			
Total	757,244	568,927	581,137	718,237	714,586	631,343	796,690	356,380	154,624	511,005
Free:										
Copra (in terms of coconut oil)	209,780	183,371	229,368	288,287	284,127	316,254	359,687	155,865	219,198	375,063
Coconut oil (from Philippine Islands)	180,700	224,635	232,499	245,129	293,370	290,637	411,936	167,707	150,213	317,920
Palm oil	128,495	101,780	139,179	130,747	159,911	169,228	261,816	101,030	186,462	287,492
Chinawood (tung) oil, nut oil, or oil of nuts	87,293	81,582	101,555	83,004	89,650	109,322	119,678	62,741	63,777	126,518
Olive oil, inedible	42,565	33,024	52,431	50,703	50,131	49,358	57,386	40,923	30,952	71,875
Palm-kernel oil	2,566	4,739	52,624	74,980	43,128	53,812	69,909	17,052	12,052	29,104
Perilla and sesame (in terms of sesame oil)	6,279	6,378	1,794	1,326	1,356	4,598	8,436	6,463	19,143	25,607

TABLE 44.—*Animal and vegetable oils, dutiable and free, including raw material in terms of oil: Inports for consumption in the United States*—Continued

[In thousands of pounds]

	1923	1924	1925	1926	1927	1928	1929	Jan. 1 to June 17, 1930	June 18 to Dec. 31, 1930	Total, January to December, 1930
Free—Continued.										
Sesame oil	8,702	7,843	4,295	8,862	1,704	6,264	21,585	10,669	26	10,695
Perilla oil	6,441	3,016	6,017	7,401	5,358	2,011	5,574	7,460	1,378	8,838
Cod-liver oil	3,953	6,983	9,150	14,411	17,815	19,289	21,455	12,059	9,653	21,712
Cod oil	13,392	14,367	13,163	18,192	15,857	11,769	15,681	7,622	7,760	15,382
Vegetable tallow	8,548	5,197	6,424	3,779	5,688	5,326	11,530	5,516	1,606	7,122
Almond oil, sweet	59	70	74	81	66	86	77	43	34	77
Croton oil	2	17	1	----------	2	1	1	1	1	2
Rapeseed oil	----------	----------	----------	----------	----------	----------	----------	----------	5,295	5,295
Total	698,805	673,002	848,574	926,902	968,163	1,037,955	1,364,751	595,151	707,550	1,302,702

[1] Less than 1,000 pounds.

Rates of duty on vegetable and animal oils are shown in the following table for the acts of 1930 and 1922:

TABLE 45.—*Animal and vegetable oils: Rates of duty and classification under the acts of 1930 and 1922*

Oil or fat	Dutiable under one or both of the tariff acts			
	Act of 1930		Act of 1922	
	Paragraph	Rate of duty	Paragraph	Rate of duty
Oils, animal and fish:				
Tallow	701	One-half cent per pound.	701	One-half cent per pound.
Lard	703	3 cents per pound	703	1 cent per pound.
Sod	52	5 cents per gallon	53	5 cents per gallon.
Herring	52	do	53	Do.
Menhaden	52	do	53	Do.
Whale	52	6 cents per gallon	53	6 cents per gallon.
Seal	52	do	53	Do.
Sperm—				
Crude	52	10 cents per gallon	53	10 cents per gallon.
Refined	52	14 cents per gallon	53	Do.
Eulachon	1730 (b)	Free	53	20 per cent ad valorem.
Fish oils, n. s. p. f.	52	20 per cent ad valorem	53	Do.
Oils, vegetable:				
Castor	53	3 cents per pound	54	3 cents per pound.
Hempseed	53	1½ cents per pound	54	1½ cents per pound.
Linseed	53	4½ cents per pound	54	3⅜6 cents per pound.[1]
Combinations and mixtures in chief value of such oil.	53	do	58	25 per cent ad valorem.
Olive—				
Weighing with container less than 40 pounds.	53	9½ cents per pound on contents and container.[1]	54	7½ cents per pound on contents and container.
Not specially provided for.	53	6½ cents per pound	54	6½ cents per pound.
Denatured	1732	Free	1632	Free.
Poppyseed	53	2 cents per pound	54	2 cents per pound.
Rapeseed—				
Not denatured	53	6 cents per gallon	54	6 cents per gallon.
Denatured	1732	Free		
All other expressed or extracted oils, n. s. p. f.	53	20 per cent ad valorem	54	20 per cent ad valorem.
Sunflower—				
Not denatured	53	do	54	Do.
Denatured	1732	Free		
Coconut	54	2 cents per pound	55	2 cents per pound.
Product of Philippines	Sec. 301	Free	Sec. 301	Free.
Cottonseed	54	3 cents per pound	55	3 cents per pound.
Peanut	54	4 cents per pound	55	4 cents per pound.
Palm-kernel—				
Not denatured	54	1 cent per pound	1632	Free.
Denatured	1732	Free		
Sesame—				
Not denatured	54	3 cents per pound	1632	Do.
Denatured	1732	Free		
Soybean	54	3½ cents per pound, but not less than 45 per cent.	55	2½ cents per pound.
Cod and cod-liver	1730 (b)	Free	1630	Free.
Croton	1732	do	1632	Do.
Palm	1732	do	1632	Do.
Perilla	1732	do	1632	Do.
Sweet almond	1732	do	1632	Do.
Tung	1732	do	1632	Do.
Nut, n. s. p. f.	1732	do	1632	Do.

[1] Changed to 3⅜6 cents per pound by presidential proclamation, effective July 25, 1929.
[2] Changed to 8 cents per pound by presidential proclamation, effective July 24, 1931.

The following table shows the 1926–1930 average of production, imports, exports, stocks, and consumption of fats and oils in the United States, segregated as to domestic and foreign origin. Oleo oil, oleo stearin, fatty acids, other derivatives, and products of which oils and fats form an important raw material, are excluded.

TABLE 46.—*Oils: Consumption in the United States, average 1926–1930, inclusive*

[Source: (*a*) Animal and Vegetable Fats and Oils, published annually by the Bureau of the Census, U. S. Department of Commerce, for statistics on production, stocks, and factory consumption; (*b*) Foreign Commerce and Navigation of the United States, Tables 9 and 3, published annually by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, for statistics on imports and exports]

[In thousands of pounds]

Commodity	Domestic production	Imports for consumption	Exports of products of the United States	Stocks, Jan. 1	Stocks, Dec. 31	Apparent consumption	Factory consumption	Excess apparent consumption over reported factory consumption
Oils and fats	5,657,289	1,023,616	890,406	805,053	899,443	5,696,109	4,210,259	1,485,850
Vegetable oils	2,876,289	883,443	72,775	523,127	564,533	3,645,551	3,196,522	499,029
Supplied primarily from domestic materials	1,784,708	4,275	31,695	150,510	150,921	1,756,877	1,750,574	6,303
Cottonseed	1,646,401	1,330	31,115	137,102	136,258	1,617,466	1,613,676	3,790
Peanut	15,060	2,938	.....	1,753	3,022	16,729	14,217	2,512
Corn	123,247	.....	580	11,655	11,641	122,681	122,681	.....
Supplied from both foreign and domestic materials—linseed	705,634	5,570	2,171	164,568	156,083	717,518	462,363	265 155
Supplied primarily from imports or from imported materials	385,947	873,598	38,908	208,048	257,529	1,171,156	993,586	177,570
Coconut	311,786	311,899	23,127	101,074	123,576	578,056	568,140	9,916
Soybean	7,169	15,481	5,416	5,883	7,994	15,123	16,446	−1,323
Olive, edible	1,373	84,025	.....	5,101	5,375	85,124	2,255	82,869
Palm-kernel	[1] 142	56,160	.....	10,346	11,334	55,314	51,219	4,095
Tung	.....	105,595	.....	24,737	28,127	102,205	89,396	12,809
Palm	.....	201,839	.....	31,890	45,492	188,243	165,312	22,931
Olive, inedible	18	9,727	.....	1,641	1,620	9,766	6,716	3,050
Sulphur oil or olive-foots	.....	46,163	.....	6,721	10,801	42,083	37,283	4,800
Rapeseed	[1] 35	18,126	.....	4,710	5,170	17,701	14,323	3,378
Chinese vegetable tallow	.....	6,689	.....	1,251	1,859	6,081	5,449	632
Castor	56,698	336	.....	7,707	8,318	56,423	22,765	33,658
Other (unspecified)	8,726	17,558	10,365	6,981	7,862	15,038	14,281	757
Animal fats and greases	2,681,236	20,151	816,715	191,781	216,875	1,862,878	838,769	1,024 109
Supplied primarily from domestic materials:								
Edible fats	1,765,523	239	747,203	64,374	64,404	1,018,529	74,582	943,947
Lard, neutral	43,599	19	18,867	3,450	3,203	24,998	23,868	1,130
Lard, other	1,675,200	220	722,360	57,113	57,337	952,836	16,242	936,594
Tallow	46,726	.....	5,977	3,810	3,864	40,695	34,472	6,223
Inedible fats and greases	918,712	20,213	69,512	127,407	152,471	844,349	764,187	80,162
Tallow	534,016	11,638	(3)	75,817	93,627	(3)	527,844	(3)
Wool grease	7,391	8,575	(3)	3,122	3,360	(3)	5,973	(3)
All other greases	377,305	.....	(3)	48,468	55,484	(3)	230,371	(3)
Marine-animal oils	96,763	110,722	916	90,146	118,035	187,690	174,968	[2] 12,712
Supplied from both foreign and domestic materials—Menhaden (domestic only) and herring (including sardine)	81,636	31,171	(3)	44,671	60,999	(3)	85,616	(3)
Supplied primarily from imports or from imported materials	15,129	88,550	(3)	45,474	57,036	(3)	89,351	(3)
Cod and cod-liver	1,732	34,313	(3)	8,139	9,151	(3)	15,730	(3)
Whale	10,132	50,012	(3)	29,921	37,402	(3)	64,862	(3)
Sperm	435	2,340	(3)	2,449	2,951	(3)	932	(3)
Other	2,530	1,886	(3)	4,965	7,532	(3)	7,828	(3)

[1] Production reported in 1930 only, used as basis for 5-year average.
[2] Production reported in 1926 only, used as basis for 5-year average.
[3] Can not be segregated.

The production of animal and vegetable oils from domestic and imported raw materials is shown in the following table. Production from imported materials has usually been less than 15 per cent of the total. It is derived principally from copra and flaxseed and to a less extent from castor beans and other oil-bearing materials.

TABLE 47.—*Animal and vegetable oils: Production from domestic and imported materials*

[Source: Bureau of the Census, U. S. Department of Commerce, for production from domestic materials (flaxseed production from Yearbook U. S. Department of Agriculture) and Commerce and Navigation, Department of Commerce, for production from imported materials]

[In thousands of pounds]

Commodity	1923	1924	1925	1926	1927	1928	1929	1930
PRODUCTION FROM DOMESTIC MATERIALS								
Vegetable oils:								
Cottonseed, crude	963,439	1,140,176	1,501,227	1,755,475	1,805,117	1,460,312	1,584,336	1,616,084
Peanut, crude and virgin	5,359	6,691	15,156	10,644	10,590	12,439	16,131	25,495
Corn, crude	111,343	117,065	104,153	120,041	117,441	124,327	133,680	120,747
Soybean, crude	1,404	950	2,520	2,646	3,088	4,716	11,009	14,387
Olive, edible	574	1,509	532	1,383	858	1,438	1,003	2,184
Olive, inedible		24		19	27	13	29	
Linseed [1]	291,718	543,008	377,376	321,828	444,968	336,217	255,605	345,953
Total vegetable oils	1,373,837	1,809,423	2,000,964	2,212,036	2,382,089	1,939,462	2,001,793	2,124,850
Marine-animal oils:								
Cod and cod-liver	708	798	1,071	1,358	2,197	1,873	2,050	1,180
Menhaden	55,960	29,429	46,619	30,517	30,628	27,752	24,557	24,700
Whale	10,098	8,563	8,071	9,495	11,407	10,234	11,084	9,939
Herring (including sardine)	14,338	27,470	41,741	39,225	36,109	49,266	74,427	70,997
Sperm	1,579	759	1,090	75	79	703	358	960
All other (including marine and animal)	2,622	2,066	2,571	1,978	2,220	1,988	3,154	3,311
Total marine-animal oils	85,305	69,085	101,163	82,648	82,640	91,816	115,630	111,087
Animal fats:								
Lard, neutral	60,961	68,324	46,629	46,423	48,116	52,991	43,508	26,957
Lard, other edible	1,944,862	1,934,545	1,506,892	1,578,925	1,608,195	1,799,976	1,813,354	1,575,548
Tallow, edible	52,923	51,676	50,215	58,284	48,892	41,047	43,727	41,676
Tallow, inedible	384,045	388,295	378,472	425,210	404,164	391,662	425,638	448,458
Neat's-foot oil	8,398	8,506	9,247	9,650	8,656	6,528	5,707	5,357
Total animal fats	2,451,189	2,451,346	1,991,455	2,118,492	2,118,023	2,292,204	2,331,934	2,097,996

[1] Converted from domestic flaxseed used in producing oil at the rate of 33⅓ per cent oil yield after deducting three-fourths bushel to the acre for seed planted (acres harvested and used).

TABLE 47.—*Animal and vegetable oils: Production from domestic and imported materials*—Continued

[In thousands of pounds]

Commodity	1923	1924	1925	1926	1927	1928	1929	1930
PRODUCTION FROM IMPORTED MATERIALS—continued								
Greases:								
White	97,500	93,630	73,097	72,161	73,398	77,951	76,390	64,799
Yellow	67,357	71,200	64,457	66,672	66,948	71,570	81,554	82,710
Brown	56,253	43,777	40,590	42,049	46,879	47,512	48,636	45,427
Bone	27,992	26,762	24,476	22,749	23,633	22,384	24,636	26,365
Tankage	58,481	53,290	51,467	50,689	54,887	53,537	53,213	52,479
Garbage or house	67,425	77,878	78,358	79,868	93,337	89,372	91,416	78,653
Wool	7,314	4,334	4,475	5,877	7,735	6,444	9,527	7,374
Recovered	15,008	15,433	14,281	3,149	3,086	2,656	2,521	3,204
All other	11,810	9,960	8,192	12,496	10,001	11,253	11,427	8,958
Total greases	409,140	396,264	359,393	355,710	379,904	382,679	399,320	369,969
Total production from domestic materials	4,319,471	4,726,118	4,452,975	4,768,886	4,962,656	4,706,161	4,848,677	4,703,902
PRODUCTION FROM IMPORTED MATERIALS [1]								
Coconut	209,780	183,371	229,368	288,287	284,127	316,254	359,687	375,063
Linseed	456,474	311,210	309,722	418,655	412,877	329,775	447,383	237,547
Castor	37,186	35,691	45,037	42,334	51,501	58,988	73,665	43,241
Sesame	6,279	6,378	1,794	1,326	1,356	4,598	8,436	25,607
Cottonseed	10,314	14,258	9,575	8,843	1,640	157	25	18
Total production from imported materials	720,033	550,908	595,496	759,445	751,501	709,772	889,196	681,476
Total production	5,039,504	5,277,026	5,048,471	5,528,331	5,714,157	5,415,933	5,737,873	5,385,378

[1] Converted to oil from imported seed on basis of oil yield as follows: Flaxseed, 33⅓ per cent; castor, 42 per cent; copra, 63 per cent; sesame, 46 per cent; and cottonseed, 15 per cent.

PART III

STATISTICAL INFORMATION ON COMMODITIES SPECIFICALLY COVERED BY THE RESOLUTION

COPRA

Rates of duty.

Act of 1930: Free.
Act of 1922: Free.

Description and uses.

Copra is the dried meat of the coconut obtained from the coconut palm. After removal of the fibrous husk and cracking of the nut the meat is dried by artificial heat or by exposure to the sun. In smoke drying, the customary method, it is partially dried in the shell, then removed, and further dried for crushing.

Copra is the form in which the fruit of the coconut palm is most used. The fresh coconut is consumed for food and drink chiefly by natives of the countries where coconuts are grown. Desiccated coconut, fermented liquor made from the flower bud, and the fibrous husk surrounding the coconut are also articles of commerce.

Copra is consumed only for the production of coconut oil and oil cake or meal. It is marketed in different grades, the grades being determined chiefly by color and estimated moisture content, rather than by analysis.

World production and trade.

Copra is produced principally in the Philippine Islands, the Netherland East Indies, Ceylon, British Malaya, the South Sea Islands, and India. These countries, with the exception of India, constitute the chief sources of supply for world trade. Exports of copra and coconut oil in terms of copra from the first four countries increased from 2,045,565,000 pounds in 1923 to 3,037,846,000 pounds in 1929. The exports in 1930, however, decreased to 2,586,924,000 pounds.

The total world production may be considered to exceed these figures by the exports of copra and oil (chiefly copra) from the South Sea Islands, together with the amount of coconut oil, in terms of copra, consumed locally. Such statistics are not available, but an idea may be formed of the exports of copra from these islands by studying the import statistics of the chief consuming countries. Their imports from all countries exceeded the exports of copra from the four countries named, from 1923 to 1929, inclusive, by an annual average of 245,000,000 pounds. The excess amounted to 422,000,000 pounds in 1930.

The Philippines and the Netherland East Indies are the world's largest sources of copra (see Table 48), being almost equally important; British Malaya and Ceylon supply considerably less than either of the other two countries. The total exports of copra and coconut oil in terms of copra from these four countries increased 48 per cent from 1923 to 1929. Exports from the four countries declined 15 per cent in 1930.

Table 48 shows exports of copra and coconut oil in terms of copra from the Philippines, Netherland East Indies, British Malaya, and Ceylon.

TABLE 48.—*Copra and coconut oil: Exports, in terms of copra, from chief producing countries* [1]

[In thousands of pounds]

Country	1923	1924	1925	1926	1927	1928	1929	1930
Philippines	768,726	736,227	687,815	794,090	946,136	1,014,555	1,049,355	899,945
Netherland East Indies	711,922	785,546	810,232	890,378	797,342	1,100,306	1,127,741	884,656
British Malaya	365,756	377,933	370,574	445,832	357,036	444,767	475,808	463,095
Ceylon	199,161	296,394	364,332	372,389	341,673	359,892	384,942	339,229
Total	2,045,565	2,196,100	2,232,953	2,502,689	2,442,187	2,919,520	3,037,846	2,586,924

[1] Sum of copra exports (Table 49, below) and coconut-oil exports (Table 57, p. 85) converted to copra on the basis of a 63 per cent oil yield.

Approximately two-thirds of the total exports of copra and coconut oil, in terms of copra, from the four countries covered in the table are in the form of copra. Exports of coconut oil in terms of copra from the Philippines exceed those of copra; in the other three countries, exports in the form of copra exceed those in the form of oil.

Exports of copra itself from the four countries increased 27 per cent from 1923 to 1929. The Netherland East Indies is the chief factor in this trade and has shown the greatest increase. A decline of 11 per cent occurred in the total exports of copra from these four countries in 1930.

Table 49 shows exports of copra itself from the four countries mentioned.

TABLE 49.—*Copra: Exports from chief producing countries*

[Source: Annual report of the insular collector of customs for the Philippines, for the Philippine Islands; International Yearbook of Agricultural Statistics, 1923 to 1930, inclusive; for the Netherland East Indies, except 1927, from Statistical Abstract for the Netherland East Indies; Statistical Abstract for the several British Oversea Dominions and Protectorates for 1923 to 1929, inclusive, and Foreign Crops and Markets, U. S. Department of Agriculture for 1930, for British Malaya and Ceylon]

[In thousands of pounds]

Country	1923	1924	1925	1926	1927	1928	1929	1930
Philippines	456,642	345,597	323,434	383,647	438,419	516,795	382,658	384,263
Netherland East Indies	706,771	757,087	773,837	830,873	763,515	972,019	1,007,214	828,306
British Malaya	344,335	356,270	343,249	415,305	320,414	409,602	444,949	429,417
Ceylon	113,732	198,148	254,657	270,973	222,002	221,382	228,759	203,446
Total	1,621,480	1,657,702	1,695,177	1,900,798	1,744,350	2,119,798	2,063,580	1,845,432

Copra is exported chiefly to the United States, Germany, France, and the Netherlands. These countries take over two-thirds of the total copra exported. Denmark, the United Kingdom, and Spain take considerable quantities, and Italy, Czechoslovakia, Norway, Austria, Belgium, and Sweden take smaller amounts.

Table 50 shows imports of copra by chief consuming countries. The total imports increased from 1,855,753,000 pounds in 1923 to 2,532,964,000 pounds in 1929, or 36 per cent. A decrease of nearly 11 per cent occurred in 1930.

TABLE 50.—*Copra: Imports by chief consuming countries*

[Source: Review of the Oil and Fat Markets; Faure, Blattman & Co.]

[In thousands of pounds]

Country	1923	1924	1925	1926	1927	1928	1929	1930
United States	332,974	285,430	364,078	457,603	451,040	495,425	567,936	600,340
Germany	317,533	323,875	385,605	445,122	419,931	449,700	547,785	337,693
France	314,586	327,067	358,711	322,446	345,887	405,760	422,361	438,169
Netherlands	320,589	322,970	288,848	335,350	293,574	297,844	304,783	210,383
Denmark	148,543	119,000	108,494	107,110	111,635	136,226	154,500	154,249
United Kingdom [1]	193,872	158,576	174,830	130,859	79,596	89,485	147,403	150,830
Spain	78,400	87,360	99,541	92,124	96,331	113,566	133,233	[2] 145,600
Italy	29,091	34,492	56,802	51,713	61,844	58,748	78,093	[2] 71,680
Czechoslovakia	30,276	32,944	31,969	52,591	50,113	39,838	62,382	[2] 39,200
Norway	29,635	36,944	38,853	44,663	36,028	46,041	52,438	69,960
Austria	15,593	25,847	26,260	30,314	29,796	29,669	26,042	[2] 22,400
Belgium	17,674	22,835	20,543	21,437	12,403	13,642	24,035	18,028
Sweden	27,077	29,669	31,161	35,995	22,037	21,486	11,973	8,767
Total	1,855,753	1,807,009	1,985,695	2,127,327	2,010,215	2,197,430	2,532,964	2,267,299

[1] Net imports.
[2] Estimated.

Conditions of production in chief producing countries.

As the coconut palm requires a high temperature and a heavy and preferably an evenly distributed rainfall, commercial growing is confined to regions within about 20° north or south of the Equator. It is a lowland plant and thrives best when receiving ample sunshine and when grown on well-drained soil. In general the Philippine Islands, the Netherland East Indies, southwestern India, Ceylon, British Malaya, and islands in the South Pacific fulfill these conditions. Because of variations in climate, topography, and soil not all parts of these countries are suitable for growing the coconut palm. The labor supply and competition of other crops are also important factors in the planting of coconut palms.

A coconut tree begins to bear fruit approximately five years after planting, but about 10 years are required to reach full bearing. The bearing period is estimated at from 60 to 100 years.

Coconut palms are grown principally by natives on garden plots of ground, for the most part without cultivation. The trees grown scientifically on plantations probably represent less than 5 to 10 per cent of the total. There are also a number of "wild" trees the products of which do not ordinarily reach the domestic or export market.

The picking of coconuts and the preparation of copra are performed almost entirely by natives. The native producer sells his copra to a retail merchant for cash or its equivalent in commodities. The retail merchant sells it to a wholesaler or dealer who transfers it to the local mill or to a port of exportation. These middlemen are often Chinese merchants or agents of local or foreign oil mills.

Most copra is produced in areas which are colonies or dependencies of leading nations of Europe or of the United States. The desire of the mother countries to build up their shipping services, to supply the home country with raw materials, and to furnish employment to domestic labor affects materially the trade in copra as well as in certain other oil-bearing materials. Shipping arrangements, business organization, and sometimes tariff policies are factors in this trade. This statement applies to the Netherland East Indies, the British colonies,

the French colonies, and the Philippines. As far as European countries are concerned, the tendency is to encourage importation of oil-bearing materials, such as copra, rather than finished products, such as coconut oil. Fed by raw materials from the colonies, the home oil industries are thus built up, and the national aspect of colonial trade becomes an important factor in the competitive situation between the countries which produce oil-bearing materials. A brief summary of the copra industry in the chief producing countries follows:

India.—In India the coconut palm is grown principally in the Province of Madras, including the districts of Malabar and Cochin where the industry is handled efficiently by the natives.

Indian copra is usually sun dried and generally sells for a higher price than copra produced in any other country. Oil made from copra produced in Cochin likewise generally sells at a higher price than that made in any other district. Relatively little of either the copra or oil, however, reaches international markets, and such international trade as does exist has been diminishing.

Ceylon.—The coconut-oil industry of Ceylon is efficiently organized and operated. More than a million acres are reported to be planted in coconut palms. Foreign holdings represent a greater percentage than in any other country except possibly British Malaya, but the industry is largely in the hands of natives. Although most of the acreage is in small holdings, there are also plantations of considerable size operated by both natives and Europeans. In the south and west, on the low coastal regions, coconuts are grown; further inland, on the rolling country, rubber is grown; and on the high land in the center of the island, tea is grown. These three agricultural products compete with one another for the use of land in certain areas. As territory suitable for the cultivation of the coconut palm is limited, no appreciable expansion of the copra industry is anticipated in Ceylon. Copra, usually sun dried, and coconut oil, exported from Ceylon generally sell at a somewhat lower figure than such products from India.

British Malaya.—In British Malaya, the influence of European plantation methods is apparent. The coconut-plantation industry is chiefly of recent development. It was doubtless due to the rubber plantations that attention was directed to the possibilities of growing coconut trees for copra. Although many estates are controlled by British companies, it is estimated that about 80 per cent of the trees are cultivated in small tracts by natives. In recent expansion the oil palm rather than the coconut palm seems to have been preferred. Copra from British Malaya usually brings a lower price than that from India or Ceylon but a higher price than that from the South Sea Islands.

Netherland East Indies.—The production of copra is an important industry in the Netherland East Indies. There are European-owned estates in Java, Sumatra, and Borneo, but it is estimated that about 95 per cent of the copra industry is owned and conducted by natives. In the thickly populated island of Java there is little probability of expansion of the industry, but in the outer Provinces there is a considerable possibility of its extension. A handicap in the outer Provinces, however, is scarcity of labor and competition for the use of land for other crops, such as rubber and oil palms. Recent expansion in Sumatra apparently favors oil palms. The quality of the copra produced in the Netherland East Indies is not uniform. In general,

it brings a price lower than Indian and Ceylon copra but higher than Philippine and South Sea Island copra.

South Sea Islands.—The South Sea Islands are a source of a considerable quantity of copra. Many of the islands are of coral formation and are not adapted to other types of agriculture. Most of them export no other commodity of importance. Some copra is produced on large plantations on the islands in the British and former German territories, but for the most part production is on small lots of ground by natives. The abundance of food, the general scarcity of labor, and, where the population is comparatively dense, the semisavage condition of the natives militate against large-scale production of copra in the South Seas. The infrequent calls of ships at many of the outlying islands are another handicap. In general, the copra produced in the South Sea Islands brings a lower price than that produced in any other region.

Philippine Islands.—The Philippine Islands are one of the largest single producers of copra and are the chief source of supply for the United States.

The Philippine Archipelago comprises a few large islands and hundreds of small ones covering in all an area of 114,000 square miles. Within this large area a considerable variation in climate exists. The population is about 12,000,000, or approximately a hundred to the square mile, distributed unevenly over the archipelago. Agriculture is the principal industry of the islands, and its growth has been marked in the last 30 years. In terms of acreage, rice is the main crop, and corn, abacá (hemp), and coconuts, about equal in importance, are the next largest crops. A smaller acreage is devoted to sugarcane and a still smaller to tobacco. Of the three principal commodities exported from the Philippines, namely, coconut products, sugar, and manila hemp, the products of the coconut palm rank first in value. The coconut products are exported principally in the form of coconut oil and copra. Compared with the quantities exported, the quantities consumed within the Philippines are small.

Table 51 shows exports of copra and coconut oil in terms of copra to all countries and to the United States. About three-fourths of the exports of copra and practically all of the exports of coconut oil go to the United States.

Although the coconut is native to nearly every locality in the Philippines, its development has been carried furthest in the Provinces of Laguna and Tayabas in Luzon, in the islands of Marinduque, Samar, and Cebu, and in the Provinces of Zamboanga, Misamis, and Davao on Mindanao. The coconut palm is grown principally by natives on small garden plots. Within the last 10 or 15 years, however, plantations have been established, particularly on the island of Mindanao. Since 1910 the acreage planted has practically tripled, while the output of copra has practically quadrupled. Table 52 shows the acreage planted, the number of trees planted and bearing, and the copra produced in the Philippine Islands.

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TABLE 51.—*Copra and coconut oil: Exports from the Philippine Islands to all countries and to the United States*

[Source: For 1900 to 1929, Statistical Bulletin of the Philippine Islands; for 1930, Annual Report of the Insular Collector of Customs]

[In thousands of pounds]

Calendar year	Copra		Coconut oil in terms of copra [1]		Total copra and coconut oil in terms of copra	
	To all countries	To the United States	To all countries	To the United States	To all countries	To the United States
1900	143,059	228	.....	.....	143,059	228
1905	122,903	226	36	.....	122,939	226
1910	265,619	15,737	.....	.....	265,619	15,737
1915	306,644	46,777	47,116	46,779	353,760	93,556
1916	159,342	78,198	56,310	53,567	215,652	131,765
1917	203,221	150,473	158,165	157,632	361,386	308,105
1918	121,389	121,389	403,410	397,300	524,799	518,689
1919	55,322	5,101	489,710	298,765	545,032	303,866
1920	50,885	3,160	277,451	251,762	328,336	254,922
1921	331,429	116,686	315,965	281,714	647,394	398,400
1922	381,510	196,999	375,160	373,190	756,670	570,189
1923	456,642	284,963	312,084	296,565	768,726	581,528
1924	345,597	237,054	390,630	386,879	736,227	623,933
1925	323,434	256,082	364,381	337,248	687,815	593,330
1926	383,647	284,572	410,443	402,189	794,090	686,761
1927	439,419	347,946	506,717	495,470	946,136	843,416
1928	516,795	402,529	497,760	492,828	1,014,555	895,357
1929	382,658	265,756	666,697	660,287	1,049,355	946,043
1930	384,263	311,205	515,682	511,273	899,945	822,478

[1] Converted to copra on basis of 63 per cent oil yield.

TABLE 52.—*Coconut trees planted and bearing, and copra produced in the Philippine Islands*

[Source: The Philippine Journal of Agriculture, 1930]

Year ending June 30—	Number of acres planted	Number of trees		Pounds of copra produced
		Planted	Bearing	
1910	406,000	32,839,000	.....	260,453,000
1910-1914 (annual average)	530,000	42,901,000	.....	279,799,000
1915-1919 (annual average)	759,000	61,445,000	33,743,000	496,106,000
1920-1924 (annual average)	1,070,000	84,340,000	48,078,000	819,319,000
1925	1,167,000	89,638,000	53,166,000	798,550,000
1926	1,199,000	91,909,000	54,050,000	806,066,000
1927	1,236,000	94,878,000	58,414,000	904,240,000
1928	1,274,000	98,056,000	61,068,000	953,850,000
1929	1,268,000	101,527,000	65,083,000	1,058,630,000
1925-1929 (annual average)	1,238,000	95,202,000	58,476,000	904,268,000

Copra produced in the Philippines has no tariff preference in the American market since all copra imported into the United States is free of duty. Coconut oil from the Philippines, however, has a protected American market, and the coconut-oil mills in the Philippines gain a considerable advantage from the duty on oil imported into the United States from other countries.

An increase in the production of copra in the Philippines is dependent upon a number of factors, such as the number of coconut trees planted but not yet bearing; injury or destruction of trees caused by drought, typhoons, and plant diseases; the quantity of copra prepared by natives, which is determined to a large extent by its price; and the extent of new plantings, which in turn is dependent upon the avail-

ability of labor and land, the competition of other crops, and the price received for copra. Table 52 shows 101,527,000 trees planted and 65,083,000 bearing in the Philippines in 1929. Assuming that the 36,444,000 trees not yet in bearing will mature in 10 years at the outside, it is possible for the output of copra at the end of that period to increase more than 50 per cent over the 1929 output. Such an increase, however, is dependent upon demand and upon some of the factors enumerated, such as weather conditions and prices received for copra. Present demand and low prices are not conducive to increased production. More coconuts will undoubtedly be produced, but they may not be harvested and converted into copra unless profitable prices prevail.

Imports into the United States.

The United States has taken more than its share of the increased world output of copra, marketed as such, imports having almost trebled in the last 10 years, increasing from 215,000,000 pounds in 1920 to a maximum of 595,000,000 pounds in 1930.

Table 53 shows imports of copra into the United States.

TABLE 53.—*Copra: Imports into the United States* [1]

(Source: Foreign Commerce and Navigation of the United States, Department of Commerce)

Calendar year	Quantity	Value	Value per unit of quantity	Calendar year	Quantity	Value	Value per unit of quantity
	Pounds				*Pounds*		
1920	215, 188, 461	$14, 187, 178	$0.066	1926	457, 598, 620	$23, 513, 066	$0.051
1921	189, 320, 950	7, 381, 863	.039	1927	450, 994, 683	20, 641, 189	.046
1922	268, 955, 518	9, 854, 576	.037	1928	501, 990, 020	22, 778, 268	.045
1923	332, 984, 498	13, 477, 469	.040	1929	570, 931, 185	24, 194, 618	.042
1924	291, 064, 369	12, 857, 226	.044	1930	595, 338, 541	21, 786, 826	.037
1925	364, 075, 612	18, 081, 056	.050				

[1] Imports of copra during the period have been free of duty.

The Philippine Islands are the chief source of copra for the United States, imports from that country since 1921 ranging from over 50 to 80 per cent of our total imports. In 1930 the Netherland East Indies, British Malaya, and British Oceania were the next most important.

Imports of copra enter the United States principally through the ports of San Francisco, New Orleans, and Portland, Oreg. Ports of less importance are Baltimore, Norfolk, Los Angeles, Philadelphia, and New York.

Imports of copra into the United States by country of shipment, are shown in Table 54.

TABLE 54.—*Copra: Imports into the United States by country of shipment*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

[In thousands of pounds]

Country of shipment	1920	1921	1922	1923	1924	1925
Philippine Islands	22,718	82,796	193,092	259,896	238,579	284,059
British Malaya	10,049	1	137	.....	7,489	20,424
Australia	51,861	25,282	20,373	13,267	374	11,208
British Oceania	40,526	25,222	14,683	19,732	13,147	10,312
French Oceania	24,660	15,445	25,884	27,149	22,365	22,392
Other Oceania	30,618	12,120	2,091	1,360	3,821	9,945
Netherland East Indies	29,116	15,636	5,871	3,823	230	224
Other countries	5,040	12,819	6,825	7,747	5,059	5,512
Total	215,188	189,321	268,956	332,974	291,064	364,076

Country of shipment	1926	1927	1928	1929	1930
Philippine Islands	275,696	341,389	371,889	310,194	336,555
British Malaya	98,049	47,077	35,784	84,532	60,254
Australia	9,017	4,980	21,144	69,579	35,582
British Oceania	23,905	17,422	24,774	44,826	53,030
French Oceania	31,898	28,246	19,015	24,097	18,307
Other Oceania	18	.....	2,744	3,909	24,191
Netherland East Indies	9,236	5,060	11,411	29,162	61,569
Other countries	9,780	6,815	14,629	4,633	5,851
Total	457,599	450,995	504,990	570,931	595,339

Reexports from the United States.

Reexports of copra from the United States, amounting to 4,692,320 pounds in 1929 and 6,690,293 pounds in 1930, are negligible compared with imports.

Costs of production.

Because of the length of time required to develop a coconut plantation, necessarily involving much capital and labor, and particularly because most groves are developed by the labor of a family through one or more generations, it is difficult even to approximate costs of production. No estimates of costs of production of copra are available except for the Philippines. In a memorandum prepared by the United States trade commissioner at Manila, the opinion was expressed that the average cost of production of copra throughout the Philippines, under conditions obtaining in 1929–30, could not have been less than the average for the Province of Tayabas (which produces 30 per cent of the total in the islands). This was estimated at 3.68 cents per pound, or $73.60 per ton, allowing the producer a normal return of 10 per cent on his investment. Costs of production are shown in the following table.

TABLE 55.—*Copra: Estimated costs of production in the Philippine Islands*

[Cents per pound]

Item	Capital cost	Manufacturing cost	Marketing cost	Total cost
Optimum copra production costs in Tayabas Province	1.56	0.52	0.51	2.59
Average cost in Tayabas Province	2.65	.52	.51	3.68

Recent prices for copra have been well below these costs of production. The addition of 1½ per cent Philippine sales tax and $6 per long ton freight to San Francisco would bring the cost up to 4.01 cents per pound, or $80 per short ton, at San Francisco. Lighterage, wharfage, insurance, and miscellaneous charges would increase these figures somewhat.

Prices.

Copra is marketed in grades bearing various names in the different countries of origin. Although not sharply defined, the grades are dependent chiefly upon moisture content, and successful buying depends upon the ability of the buyer to judge the moisture content by sight. As a rule the consumer does not have the option of specifying the grade of copra he desires but must take the grades that are available. In the Philippines these grades are known as "Manila corriente," "Manila buen corriente," "semiresacada," and "resacada," the moisture content being approximately 18, 12, 8, and 6 per cent, respectively. All these grades except the last are subject to shrinkage from loss of moisture. Copra is also marketed under other grade names, such as "fair merchantable" quality. The quality varies according to country of origin. Broadly speaking, the order is as follows: India, Ceylon, Straits Settlements, Netherland East Indies, Philippines, and South Sea Islands (India ranking first). The price of copra varies according to the country of origin and the grade.

The average prices of several grades of copra are shown in Table 56 (average based on weekly quotations except for Pacific coast ports, which are from monthly quotations).

TABLE 56.—*Copra: Prices of various grades*

[Cents per pound]

Market	Grade	1929	1930, first 6 months
Manila [1]	Buen corriente (f. m. m.)	3.38	3.10
Do.[1]	Resacada	3.78	3.45
Pacific coast ports [2]	(3)	4.43	4.14
London [3]	Singapore (f. m. s.)	5.04	4.72
Do.[3]	Netherland East Indies (f. m. s.)	4.99	4.72
Do.[3]	Ceylon (f. m. s.)	5.26	4.99
Do.[3]	South Sea (f. m. s.) January–April	5.04	.....

[1] Commerce and Industry Journal, Philippines.
[2] Oil, Paint and Drug Reporter; grade not specified.
[3] The London Grain, Seed, and Oil Reporter.

The weighted average price paid for copra delivered to the coconut oil mills in the United States from which costs were obtained was 4.67 cents per pound, or $93.40 per ton, for 1929 and 4.44 cents per pound, or $88.80 per ton, for the first six months of 1930. These weighted prices exceed the average quoted price at Pacific coast ports. This difference may be explained by the fact that the quoted prices may vary from actual transactions, that they are not weighted according to the quantity sold at each price, that the costs at the mills include handling charges, and that two of the mills are at interior points where the delivered costs would be higher than at the west coast.

The weighted average price paid by two of the largest crushers of copra in the Philippines for copra delivered into their mills during 1929 and six months of 1930 was, as might be expected, less than the cost to the mills in the United States, but exceeded the average quoted prices at Manila for that period.

COCONUT OIL

Rates of duty.

Act of 1930, 2 cents per pound.[1]
Act of 1922, 2 cents per pound.[1]

Description and uses.

Coconut oil is expressed from copra. Its principal use in the United States is in the manufacture of soap, this industry ordinarily accounting for more than 60 per cent of the total domestic consumption. The margarine industry is the second largest consumer and the confectionery and baking industries are the next largest consumers. Smaller quantities are consumed in lard substitutes, emulsions, and cosmetics.

World production and trade.

The estimated world production of coconut oil, exclusive of that consumed within the countries producing copra, rose from 1,436,299,000 pounds in 1923 to 2,209,555,000 pounds in 1929, an increase of 54 per cent in the 7-year period. In 1930 there was a decrease of 17 per cent.

The available supply of coconut oil is being augmented and is capable of still further expansion. (See pp. 77 to 81.) The extent of future production is dependent upon the demand, the competition of other crops for land in countries where copra is produced, and the competition of other oils in certain uses.

The chief countries producing coconut oil for export from home grown coconuts are the Philippine Islands, Ceylon, the Netherland East Indies, and British Malaya. The chief countries producing coconut oil from imported copra are the United States, Germany, France, and the Netherlands; countries of less importance are Denmark, the United Kingdom, Spain, Italy, Czechoslovakia, Norway, Austria, Belgium, and Sweden. From 1923 to 1930, production increased in all the foregoing countries except in the Netherlands, the United Kingdom, and Sweden. The estimated output of coconut oil by the chief producing countries is shown in Table 57.

The chief countries producing a surplus of coconut oil expressed from home-grown copra are the Philippine Islands, Ceylon, the Netherland East Indies, and British Malaya; those producing a surplus from imported copra are the Netherlands, Germany, Denmark, and France. The Philippine Islands are the chief exporter in the first group, while the Netherlands is the largest exporter of coconut oil made from imported copra. Exports from countries of the first group are shown in Table 57 and from those of the second group in Table 58.

[1] Free if product of the Philippines.

TABLE 57.—*Coconut oil: Estimated output by chief producing countries*

[Source: Annual reports of the insular collector of customs for the Philippines; International Yearbook for Netherland East Indies; Statistical Abstract for the several British overseas Dominions and Protectorates, 1923 to 1927, inclusive; and Foreign Crops and Markets, 1928 to 1930, for British Malaya and Ceylon]

[In thousands of pounds]

Country	1923	1924	1925	1926	1927	1928	1929	1930
Exports:								
Philippines	196, 613	246, 097	229, 560	258, 579	319, 232	313, 590	420, 019	324, 880
Ceylon	53, 820	61, 895	69, 095	63, 892	75, 393	87, 261	98, 395	85, 543
Netherland East Indies	3, 245	17, 551	22, 929	37, 488	21, 311	80, 821	75, 932	35, 500
British Malaya	13, 495	13, 648	17, 215	19, 232	23, 072	22, 154	19, 441	21, 217
Estimated[1] production from imported copra:								
United States	209, 774	179, 821	229, 370	288, 290	284, 155	312, 118	357, 800	378, 214
Germany	200, 046	204, 041	242, 931	280, 427	264, 556	283, 311	345, 105	212, 747
France	198, 189	206, 052	225, 988	203, 141	217, 909	255, 629	266, 087	276, 046
Netherlands	201, 971	203, 471	181, 974	211, 270	184, 952	187, 642	192, 013	132, 541
Denmark	93, 582	74, 970	68, 351	67, 479	70, 330	85, 822	97, 335	97, 177
United Kingdom[2]	122, 139	99, 903	110, 143	82, 441	50, 145	56, 376	92, 864	95, 023
Spain	49, 392	55, 037	62, 711	58, 038	60, 688	71, 547	83, 937	91, 728
Italy	18, 271	21, 730	35, 785	32, 579	38, 962	37, 011	49, 199	45, 158
Czechoslovakia	19, 074	20, 755	20, 140	33, 132	31, 571	25, 098	39, 301	24, 696
Norway	18, 670	23, 275	24, 477	28, 138	22, 698	29, 006	33, 036	44, 075
Austria	9, 824	16, 284	16, 544	19, 098	18, 771	18, 691	16, 406	14, 112
Belgium	11, 135	14, 386	12, 942	13, 505	7, 814	8, 594	15, 142	11, 358
Sweden	17, 059	18, 691	10, 631	22, 077	13, 883	13, 536	7, 543	5, 523
Total	1, 436, 299	1, 477, 607	1, 589, 786	1, 719, 406	1, 705, 443	1, 888, 207	2, 209, 555	1, 895, 538

[1] Imports of copra converted to oil on basis of 63 per cent oil yield. (See Table 50, p. 77.)
[2] Net imports of copra converted to oil.

TABLE 58.—*Coconut oil: Exports from chief exporting countries producing oil from imported copra*

[Source: International Yearbook of Agricultural Statistics for Netherlands, Germany, and Denmark, for 1923 to 1929, inclusive; French Commerce and Navigation for France, for 1923 to 1929, inclusive; Foreign Crops and Markets for all countries, 1930]

[In thousands of pounds]

Exports from—	1923	1924	1925	1926	1927	1928	1929	1930
Netherlands	145, 100	110, 902	115, 690	117, 981	115, 792	124, 479	134, 128	99, 336
Germany	5, 348	5, 817	17, 512	15, 076	27, 305	41, 956	64, 056	25, 874
Denmark	16, 398	17, 176	10, 836	17, 859	22, 132	33, 420	42, 819	44, 873
France[1]	6, 359	23, 837	25, 542	32, 078	34, 795	32, 810	33, 015	24, 921

[1] 1923 to 1927 include illipe, palm, and touloucouna oils.

The chief countries on an import basis in coconut oil are the United States, the United Kingdom, Sweden, and Belgium. The United Stares ranks first as an importer of coconut oil. Imports into these countries are shown in Table 59.

TABLE 59.—*Coconut oil: Imports by chief importing countries*

[Source: Foreign Commerce and Navigation of the United States, for United States; Statistical Bulletin No. 24 for 1923 and 1924, and Foreign Crops and Markets for 1925 to 1930, inclusive, for the United Kingdom; International Yearbook of Agricultural Statistics, for 1923 to 1929, inclusive, and Foreign Crops and Markets, 1930, for Sweden and Belgium]

[In thousands of pounds]

Imports into—	1923	1924	1925	1926	1927	1928	1929	1930
United States	181, 882	224, 763	233, 174	245, 129	293, 408	290, 697	411, 980	317, 952
United Kingdom	56, 022	52, 887	68, 723	82, 510	91, 349	141, 142	144, 072	94, 568
Sweden	16, 294	19, 037	24, 363	27, 184	28, 162	37, 497	45, 607	56, 327
Belgium	27, 278	26, 634	26, 000	31, 216	38, 761	34, 128	39, 728	18, 469

Conditions of production in various countries.

In general, conditions are more favorable to the production of coconut oil in the countries of consumption than in the countries where the copra is produced. The home oil-milling industry in most consuming countries is fostered by differential freight rates and sometimes by tariffs designed to protect the capital invested and to furnish employment to domestic labor. Mills in the consuming countries, moreover, have certain natural advantages in being closer to consuming markets, in being more favorably situated in regard to access to machinery and repair establishments, and in the greater availability of technical operators. Another factor in their favor is the better home market for the by-product of the industry—oil cake or meal. To offset these advantages are those possessed by the mills in the copra-producing countries of proximity to raw material and the availability of a cheaper labor supply.

During the World War great impetus was given the copra-crushing industry in countries where the coconut palm is grown. The boom was attended by the wildest speculation, occasioned by a world-wide shortage of fats and oils with insufficient shipping facilities for transporting the bulky copra. No less than 40 mills were built in the Philippines, many in the Netherland East Indies, and a large modern mill in India. When the boom collapsed in 1920 and 1921, most of these mills became bankrupt. By reorganizations effected during the years following, some of them were salvaged and others entirely scrapped.

India.—India has only one modern coconut oil mill; it now produces oil principally, if not entirely, for manufacture into its own finished products. India has a comparatively large number of primitive native "Chekku" mills which express the oil on the mortar and pestle principle. A high quality of coconut oil is produced almost entirely for consumption within the country.

Ceylon.—Ceylon possesses several medium to large size coconut oil mills, at least one of which is owned by British capital. Several are owned and operated by native Singhalese who have installed modern machinery. In addition, there are a number of small "Chekku" mills operated by natives and producing oil principally for local consumption. The medium-large mills produce coconut oil principally for the export trade. Ceylon was apparently not affected by the inflation in coconut-oil production and its subsequent collapse as were the Philippines, the Netherland East Indies, and to a certain extent India; production has increased, and the export trade has expanded gradually over a period of years. Coconut oil produced in Ceylon is exported principally to the United Kingdom and other European countries.

British Malaya.—In British Malaya, the coconut-oil industry has not advanced to any appreciable extent. Exports are principally in the form of copra. There are several mills operated by the Chinese which produce oil for export principally to the United Kingdom and other European countries.

Netherland East Indies.—During the boom years in coconut oil several Dutch companies in the East Indies built large modern copra-crushing mills which subsequently had to be taken over by the banks. For a period they were either operated at part capacity or allowed to stand idle, and little or no oil was exported. Later they

were reorganized and exports of coconut oil were again resumed, but on a smaller scale. Besides these mills operating on Dutch capital, there are a number of native mills producing oil for local consumption. The coconut oil exported is destined principally for the Netherlands and other European countries.

Philippine Islands.—Although the first oil mill was built in the Philippine Islands in 1906, the production of coconut oil did not attain importance until the World War period, when no fewer than 40 mills were set up. After the collapse of the inflation and the reorganization of the industry there were only about seven mills operating in the islands. At the present time there are still seven mills, practically none of which operate continuously throughout the year. These mills are, however, for the most part, of large capacity. With the exception of one mill on the island of Cebu, they are located in Manila and draw their copra principally from the island of Luzon. In addition, there are a number of small one or two expeller mills producing oil for local consumption only. Production in the Philippines may be gauged by exports, which probably represents 85 to 90 per cent of the total output. Exports increased from 1,441,000 pounds in 1906 to 420,019,000 pounds in 1929, but declined in 1930.

The mills in the Philippine Islands are financed largely by British and American capital. Others are controlled by Spanish, Chinese, and Filipino capital. Mills in the Philippine Islands are equipped with the latest type of machinery, comparable to that in American mills, and have the advantage of cheaper copra (delivered at the mill) and cheaper labor than American mills, but the disadvantage of being at a greater distance from consuming markets and of a higher cost of superintendence, heat, light, and power, materials and supplies, and repairs.

Practically the entire exportation of coconut oil from the Philippines is to the United States. This trade is favored by the admission of coconut oil to the United States free of duty while it is assessed at a rate of 2 cents per pound when imported from other countries.

Approximately 99 per cent of the oil, 75 per cent of the copra, and 90 per cent of the combined oil and corpra in terms of oil exported from the Philippines are shipped to the United States. Exports of coconut oil to the United States exceed exports of copra, in terms of oil, to the United States, and in most years exports of coconut oil to all countries exceed exports of copra, in terms of oil, to all countries. The fact that very little coconut oil is exported from the Philippines to foreign countries but that considerable quantities of copra are so exported, and the fact that the United States market is supplied in approximately equal quantities by Philippine and American mills, indicate that the Philippine mills can compete more advantageously in the United States than elsewhere because of tariff preferences.

Table 60 shows the exports of coconut oil and copra, in terms of coconut oil, from the Philippine Islands to all countries and to the United States.

TABLE 60.—*Coconut oil and copra in terms of coconut oil: Exports from the Philippine Islands*

[Source: Annual report of the insular collector of customs of the Philippines]

[In thousands of pounds]

Calendar year—	Coconut oil		Copra, in terms of coconut oil [1]		Total coconut oil and copra, in terms of coconut oil	
	To all countries	To the United States	To all countries	To the United States	To all countries	To the United States
1900	(2)		90,127	143	90,127	143
1905	23		77,429	142	77,452	142
1910	(2)		167,340	9,914	167,340	9,914
1915	29,683	29,471	193,186	29,470	222,869	58,941
1916	35,475	33,747	100,385	49,265	135,860	83,012
1917	99,644	99,308	128,029	94,798	227,673	194,106
1918	254,148	250,299	76,475	76,475	330,623	326,774
1919	308,517	188,222	34,853	3,214	343,370	191,436
1920	171,014	158,610	35,838	1,991	206,852	160,601
1921	199,058	177,480	208,800	73,512	407,858	250,992
1922	236,351	235,110	240,351	124,109	476,702	359,219
1923	196,613	186,836	287,684	179,527	484,297	366,363
1924	246,097	243,734	217,726	149,344	463,823	393,078
1925	229,560	212,466	203,763	161,332	433,323	373,798
1926	258,579	253,370	241,698	179,280	500,277	432,659
1927	319,232	312,146	276,834	219,206	596,066	531,352
1928	313,589	310,482	325,581	253,593	639,170	564,075
1929	420,019	415,981	241,075	180,026	661,094	596,007
1930	324,880	322,102	242,085	196,059	566,965	518,161

[1] Converted on basis of 63 per cent oil yield.
[2] Less than 500 pounds.

Domestic production.

The output of coconut oil in the United States is entirely from imported copra. It averaged about 28,000,000 pounds from 1910 to 1914, inclusive, increased to over 200,000,000 pounds in 1918 and 1919, then declined, but later increased to a maximum of 353,000,000 pounds in each of the years 1929 and 1930.

Coconut oil is produced by about nine domestic companies with mills located in San Francisco, Portland, Oreg., Los Angeles, Cincinnati, Baltimore, and New York. San Francisco is the chief center of production. The output of coconut oil in the United States is shown in the following table.

TABLE 61—*Crude coconut oil: Production in the United States*

[Source: Bureau of the Census, U. S. Department of Commerce]

Year	Pounds	Year	Pounds
1920	131,218,408	1926	260,712,073
1921	113,194,282	1927	281,654,384
1922	185,520,073	1928	311,180,693
1923	235,918,724	1929	352,654,322
1924	191,357,413	1930	352,727,286
1925	207,604,172		

Imports into the United States.

Imports of coconut oil averaged 54,000,000 pounds in the 5-year period 1910 to 1914, inclusive. The greatest expansion occurred in 1918 when 359,000,000 pounds were imported, a figure which has since been exceeded only once (in 1929). Between 1923 and 1929

the increase in imports was almost continuous and averaged 54 per cent of apparent domestic consumption. In 1930, imports declined. Table 62 shows the imports of coconut oil into the United States.

TABLE 62.—*Coconut oil: Imports into the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Calendar year	Rate of duty	Quantity	Value	Value per unit of quantity
		Pounds		
Not refined or deodorized:				
1920	Free	214,014,521	$32,812,428	$0.153
1921 (Jan. 1-May 27)	do	77,612,431	7,581,628	.098
Under general tariff:				
1921 (May 28-Dec. 31)[1]	20 cents per gallon	479,902	36,340	.076
1922 (Jan. 1-Sept. 21)	do	1,472,790	130,525	.089
1922 (Sept. 22-Dec. 31)	2 cents per pound	578,666	45,751	.079
1923	do	1,209,275	107,403	.089
1924	do	134,734	14,006	.104
1925	do	452,975	52,172	.115
1926	do	326,771	35,994	.110
1927	do	38,014	2,990	.079
1928	do	60,269	6,403	.106
1929	do	43,453	4,420	.102
1930	do	32,559	4,169	.128
From Philippine Islands:				
1921 (May 28-Dec. 31)	Free	111,082,485	7,668,083	.069
1922	do	224,153,070	16,127,781	.072
1923	do	180,699,829	13,009,489	.072
1924	do	224,634,804	17,288,232	.077
1925	do	232,498,697	19,040,542	.085
1926	do	245,129,333	22,087,870	.090
1927	do	293,369,704	22,899,807	.078
1928	do	290,636,702	23,061,357	.079
1929	do	411,936,213	29,552,206	.072
1930	do	317,919,253	19,901,053	.063

[1] One gallon equals 7.5 pounds.

Up to May 28, 1921, imports of coconut oil not refined or deodorized entered the United States free of duty and originated principally in the Philippine Islands, the Netherland East Indies, Ceylon, India, the United Kingdom, and France (and also from Japan in 1918 and 1919). Since that date coconut oil from all countries except the Philippines has been dutiable, and imports have originated almost entirely in the islands. Such dutiable imports as have come in have consisted principally of high-grade oil from India.

TABLE 63.—*Coconut oil (dutiable): Imports into the United States by country of shipment* [1]

[Source: Foreign Commerce and Navigation of the United States and monthly statistics of imports for consumption, Department of Commerce]

Year	India	French Oceania	Netherlands	United Kingdom	Germany	Other countries	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1921	401,010	620,227				661	1,021,898
1922	1,991,486	1,119,833	55,249			456	3,167,024
1923	1,033,442			34,820		114,052	1,182,320
1924	91,870			33,887		2,299	128,055
1925	101,394		255,419	288,527	56,017	4,398	675,755
1926	190,893		38,536	95,374		1,968	326,771
1927	32,790		4,694			530	38,014
1928	55,849			700		3,720	60,269
1929	33,765			100		9,588	43,453
1930	22,849			15	1,100	8,595	32,559

[1] For 1921 to 1925, inclusive, general imports; for 1926 to 1930, inclusive, imports for consumption.

Imports of coconut oil enter the United States principally at the port of New York. Other ports of entry are New Orleans, San Francisco, Boston, Los Angeles, and Seattle.

Exports from the United States.

Exports of coconut oil from the United States are small compared with domestic production and imports. They go principally to Canada, Mexico, and Cuba. Exports are shown in Table 64. In addition there are some reexports which are relatively small.

TABLE 64.—*Coconut oil: Exports from the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Year	Quantity	Value	Year	Quantity	Value
	Pounds			*Pounds*	
1920	25,694,794	$4,908,443	1926	15,952,287	$1,545,490
1921	7,498,284	724,272	1927	20,418,143	1,783,409
1922	12,072,264	1,071,924	1928	24,652,602	2,088,065
1923	16,562,237	1,417,000	1929	29,532,396	2,329,340
1924	17,900,589	1,603,695	1930	25,106,817	1,791,307
1925	17,901,213	1,763,741			

Domestic consumption.

The total apparent consumption (excess of domestic production and imports over exports) of coconut oil in the United States increased from 384,000,000 pounds in 1922 to 661,000,000 pounds in 1930.

The soap industry is the largest consumer of coconut oil. In the order of their importance, the margarine industry, the confectionery and biscuit industries, and the lard-substitute industry are the next largest consumers. The increase in consumption has been greater in the soap and margarine industries, and probably in the confectionery and biscuit industries, than in any others.

Table 65 shows the consumption of coconut oil in the manufacture of soap, margarine, and lard substitutes and a comparison of the total consumed in these industries with the total apparent consumption. The difference between the total apparent consumption and the reported consumption in the soap, margarine, and lard-substitute industries is accounted for by losses in refining (foots consumed in soap), and consumption in the confectionery, biscuit, and other miscellaneous industries. The greater part of the difference, excepting 1930, is probably accounted for by the confectionery and biscuit industries. The estimated consumption in soap appears low for 1930, and, if such is the case, the figure in the last column for that year is too high.

TABLE 65.—*Coconut oil: Consumption by industries and total apparent consumption*

[In thousands of pounds]

Year	Consumption in.				Total apparent consumption [4]	Excess apparent consumption over that in the three specified industries
	Soap [1]	Margarine [2]	Lard substitute [3]	The three specified industries		
1922	237,702	57,394	16,099	311,195	383,625	72,429
1923	267,982	75,915	21,205	365,102	445,443	80,441
1924	260,000	83,278	20,000	363,278	396,039	32,761
1925	286,000	90,913	20,000	396,913	428,297	31,384
1926	270,206	97,640	20,000	287,846	452,197	64,351
1927	334,765	122,635	20,000	477,400	540,643	63,243
1928	335,417	159,853	20,000	515,270	573,972	58,702
1929	[5] 393,914	185,507	22,000	601,421	662,007	60,586
1930	303,271	177,989	20,000	501,260	661,433	160,173

[1] For 1922, 1923, and 1929 official figures; for 1924 to 1928, inclusive, and 1930 estimates from the trade based on official statistics.

[2] From Bureau of Internal Revenue; 1922, fiscal year; 1923 to 1930, inclusive, calendar years.

[3] For 1922 and 1923, official figures; for 1924 to 1928, inclusive, and 1930, estimated; 1929, an estimate by the trade, based on official statistics.

[4] Production plus imports less exports plus stocks at beginning less stocks at end of year.

[5] Trade estimate 344,205,000 pounds.

Costs of production.

United States.—Costs of production of coconut oil in the United States during the year 1929 and the first six months of 1930 were obtained by the Tariff Commission for eight companies, which accounted for 99 per cent of the total coconut oil produced during the 18-month period. These companies had mills located in San Francisco, Portland, Oreg., Los Angeles, Cincinnati, and Baltimore.

Costs of copra were obtained as delivered to the mill. The various items of cost per ton of copra crushed have been allocated to coconut oil and coconut oil cake or meal, respectively, on the basis of the relative sales value of production of these products. The expense of grinding the cake and treating or refining the crude oil has been excluded from mill costs. An interest charge has been imputed at the rate of 6 per cent on depreciated fixed plant assets and inventories. Selling expenses are not included; administration expense has been distributed between manufacturing and selling.

Table 66 shows the weighted average costs of production per ton of copra crushed and per pound of coconut oil produced in the United States.

TABLE 66—*Coconut oil: Costs per short ton of copra crushed and per pound of oil produced in the United States, 1929 and first six months of 1930*

Cost item	Dollars per ton of copra	Cents per pound of oil
Cost of copra	91.87	6.53
Factory expense:		
Labor	1.68	.12
Superintendence	.23	.02
Heat, light, power	.62	.04
Materials and supplies	.33	.02
Repairs	.55	.04
Depreciation	.42	.03
Insurance	.14	.01
Taxes, other than Federal	.11	.01
Rent	.01	.....
Laboratory	.04	.....
Miscellaneous	.02	.01
Total factory expense	4.15	.30
General and administrative expense	.63	.04
Imputed interest on plant assets and inventories	1.02	.07
Total conversion cost	5.80	.41
Total copra and conversion costs	97.67	6.94
Copra crushed	tons..	406,265
Coconut oil produced	pounds..	512,192,152

Philippine Islands.—Costs of production of coconut oil were obtained by the Tariff Commission for two of the largest crushers in the islands with offices in the United States for 1929 and six months of 1930, but they can not be published without revealing the data for the individual concerns. To have obtained costs of other companies in the islands would have necessitated sending agents there. The costs of the two companies were less than the weighted average costs of the coconut oil produced by all the companies in the islands furnishing costs for the year 1923 and the first six months of 1924, when conversion costs were $7.19 and $7.32 per short ton of copra, excluding imputed interest and selling expenses, and copra costs were $86.67 and $89.24, respectively. A memorandum from the United

States trade commissioner of the Department of Commerce at Manila, prepared for the Governor General of the Philippines and for the Bureau of Insular Affairs of the War Department, contains the statement that the total cost of conversion of one short ton of copra in Philippine mills may now be regarded as ranging from $5 to $6.75, exclusive of interest on fixed assets and of selling expenses. The conversion cost of coconut oil in the Philippines, based upon an output of over half of the total in the islands, is greater than the conversion cost in the United States.

Prices.

Sales prices.—The weighted average net sales price of coconut oil for the companies for which costs were obtained in the United States was 7.64 cents per pound for 1929 and 6.85 cents for the first six months of 1930.

Import prices.—The price of imported coconut oil during 1929 and the first six months of 1930 was obtained from importers' records for the greater part of the coconut oil brought in at New York, the chief port of importation, New Orleans, Boston, San Francisco, and Los Angeles. The weighted average price, net, ex-container, landed at ports of entry, was 7.69 cents per pound during 1929 and 6.86 cents during the first six months of 1930.

Quoted prices.—The west coast is the largest source of supply of coconut oil, considering both imported and domestic oil together, consumed in the United States. For that reason quoted prices are here given at the west coast rather than at New York. The average of monthly quoted prices for coconut oil in tank cars on the Pacific coast was 7.10 cents per pound for 1929 and 6.40 cents for the first six months of 1930.

Principal markets and transportation charges.

The mid-western area from Kansas City on the west to Cleveland and Pittsburgh on the east and centering in Cincinnati and Chicago is the principal consuming region for coconut oil, since soap, margarine, and other factories using the oil are largely concentrated there. Practically all the production and importation of coconut oil on the Pacific coast, except relatively small quantities consumed locally, is shipped to this area, and a large part of that imported at New York and New Orleans is also consumed in this market. New York is the leading port of entry for imported coconut oil and the principal consuming market for oil thus imported. In the consumption of coconut oil from both domestic and foreign sources (including the Philippines) the New York area is a close second to the mid-western area as the principal consuming market.

In 1929 and the first six months of 1930, the freight rate on coconut oil from the Pacific coast to the mid-western area was 75 cents per 100 pounds; from New York and Boston to Cincinnati, 33 cents per 100; and from New Orleans to Cincinnati, 27 cents when originating in Europe and Africa, 30 cents when originating in other countries.

Summary of costs and prices.

Table 67 shows (a) average costs of production of domestic coconut oil; (b) average sales price of domestic oil as reported by the producing companies; (c) average import price, and (d) average quoted market

price of coconut oil in the United States, together with transportation charges to the principal consuming market (Cincinnati selected as the chief center in this area). The sales, import, and quoted prices delivered are shown to be in fairly close agreement.

TABLE 67.—*Coconut oil: Summary of costs of production and prices with transportation charges to principal consuming markets in the United States*

[Cents per pound]

Item	Costs of production in United States [1]	Average sales price of domestic oil [1]	Import price [2]	Quoted price [3]
1929				
Costs or prices	7.01	7.64	7.69	7.10
Transportation charges to the principal market [4]	.56	.50	.37	.75
Costs or prices delivered	7.57	8.14	8.06	7.85
1930 (first 6 months)				
Costs or prices	6.78	6.85	6.86	6.40
Transportation charges to the principal market [4]	.57	.47	.34	.75
Costs or prices delivered	7.35	7.32	7.20	7.15

[1] At the mill.
[2] Landed, ports of entry.
[3] In tank cars at Pacific coast; from Oil, Paint and Drug Reporter.
[4] The charges shown in the first 3 columns are weighted averages.

PALM-KERNEL OIL

Rates of duty.

Act of 1930, 1 cent per pound [2]; act of 1922, free.

Description and uses.

Palm-kernel oil is obtained from the nut of the oil-palm tree. The kernel furnishes palm-kernel oil, and the pericarp, or outer covering, palm oil. Palm-kernel oil is very different in characteristics from palm oil but has most of the characteristics of coconut oil. It is consumed in the United States chiefly in the manufacture of soaps and to a limited extent is used in the confectionery and biscuit industries and in margarine.

World production and trade.

World production of palm-kernel oil has been fairly constant for some years. The total output is estimated to average 550,000,000 pounds annually. Germany and the United Kingdom are the principal producers. They import the kernels principally from West Africa and, to a lesser but increasing extent, from the Netherland East Indies and British Malaya. West Africa, the Netherland East Indies, and Brazil are the chief sources of all palm kernels. In Africa the nuts are, for the most part, cracked by hand, and the kernels then bagged and shipped to the United Kingdom and other European countries for the expression of the oil. In Sumatra, the nuts are cracked by machinery before bagging and shipment abroad.

Table 68 shows exports of palm kernels from chief producing countries; Table 69 shows quantities taken by the United Kingdom and by Germany. These two countries usually import over 80 per cent of the world output. Germany, for many years the principal producer of palm-kernel oil, lost her dominant position in the industry during the

[2] Free when denatured

World War and in the years immediately following but has now practically regained it. Imports into the United Kingdom have declined in recent years but still exceed the pre-war figure.

TABLE 68.—*Palm kernels: Exports from chief producing countries*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture, 1923 to 1928, inclusive; International Yearbook of Agricultural Statistics for 1929 and 1930]

[In thousands of pounds]

Exports from—	1923	1924	1925	1926
Nigeria	499,900	566,372	611,346	577,978
Sierra Leone	133,398	136,900	141,636	145,598
Belgian Congo	120,388	104,668	163,354	155,256
French West Africa	135,404	158,930	161,618	154,834
French Cameroons	59,046	63,470	80,298	78,216
Brazil	77,782	40,376	24,052	50,016
All other countries	100,556	117,408	123,834	136,836
Total	1,126,474	1,188,214	1,306,138	1,278,734

	1927	1928	1929	1930
Nigeria	576,136	549,130	560,096	582,443
Sierra Leone	146,576	150,314	134,858	126,876
Belgian Congo	163,158	159,932	166,202	146,290
French West Africa	164,264	131,208	137,652	172,594
French Cameroons	74,284	71,412	75,486	80,207
Brazil	57,270	42,474	19,182	27,108
All other countries	130,220	118,712	121,479	126,175
Total	1,311,908	1,223,182	1,214,955	1,261,693

TABLE 69.—*Palm kernels: Imports into the United Kingdom and Germany, the chief importing countries*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture, except United Kingdom, 1923, which is from Statistical Bulletin No. 24, U. S. Department of Agriculture]

[In thousands of pounds]

Imports into—	1923	1924	1925	1926
United Kingdom	585,852	665,282	545,202	496,224
Germany	249,730	227,530	496,900	526,008
Total	835,582	892,812	1,042,102	1,022,232

	1927	1928	1929	1930
United Kingdom	411,578	367,906	340,506	282,172
Germany	603,434	655,576	671,246	676,272
Total	1,015,012	1,023,484	1,011,752	958,444

The estimated production of palm-kernel oil in the United Kingdom declined from 264,000,000 pounds in 1923 to 127,000,000 pounds in 1930; during this same period production in Germany increased from 112,000,000 to 304,000,000 pounds. The combined output of the two countries showed an increase during the period mentioned. It is estimated that the production of palm-kernel oil in Germany and in the United Kingdom represents about 80 per cent of the world output of approximately 550,000,000 pounds annually.

Exports of palm-kernel oil from the United Kingdom declined from 47,000,000 pounds in 1923 to 19,000,000 in 1930, while exports from

Germany increased from 9,000,000 to 98,000,000 pounds. Total exports from the two countries during this period averaged about one-fourth of their combined output. The United States has been the largest single consumer of palm-kernel oil exported from the United Kingdom and Germany.

Table 70 shows the estimated production and exports of the United Kingdom and Germany.

TABLE 70.—*Palm-kernel oil: Estimated production and exports of chief producing and exporting countries*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture, except Germany, 1923, 1924, and 1925, which is from Statistical Bulletin No. 24, U. S. Department of Agriculture, and United Kingdom, 1923 and 1924, from Annual Statement of Trade of United Kingdom]

[In thousands of pounds]

Year	Estimated production[1]			Exports		
	United Kingdom	Germany	Total	United Kingdom[2]	Germany	Total
1923	263,633	112,378	376,011	46,879	9,327	56,206
1924	299,377	102,388	401,765	63,430	8,361	71,791
1925	245,341	223,605	468,946	80,640	30,976	111,616
1926	223,300	236,704	460,004	62,392	41,174	103,566
1927	185,210	271,545	456,755	39,086	56,072	95,158
1928	165,558	295,010	460,568	42,358	84,224	126,582
1929	153,228	302,060	455,288	37,488	94,234	131,722
1930	126,977	304,322	431,299	18,952	97,884	116,836

[1] Converted from imports of palm kernels on basis of 45 per cent oil yield.
[2] Exports and reexports.

Conditions of production in chief producing countries.

In pre-war years Germany had an important oil-milling industry and was the leading importer of palm kernels and producer of palm-kernel oil. During the war the crushing industry was transferred to the United Kingdom, where, in order to retain it, a system of preferential export duties on palm kernels from the colonies was instituted. These duties were repealed in 1922, and Germany soon reestablished her dominance in the industry.

The German oil mills and refineries are equipped with modern machinery, and many of them are so situated that steamers and railroad cars can discharge their cargoes direct into warehouses and silos. The desire of Germany to reestablish this industry and to give employment to her domestic labor has been an important factor in her return to dominance of the industry. A greater factor in this return, however, has been the need of raw material for her huge margarine industry (and secondarily her soap industry) and of a supply of oil cake for her dairy and other cattle. In a country where the feeding of cattle is important, the crushing of palm kernels rather than copra is favored because more oil cake is produced from the palm kernels, the oil from the two serving largely the same purpose.

Domestic production.

The production of palm-kernel oil in the United States has been negligible, no commercial production being reported from 1921 to 1929, inclusive. In 1930 the small output reported was produced from several lots of palm kernels crushed for experimental purposes.

The output increased in 1931 because of the duty on palm-kernel oil for edible purposes. Probably the chief reasons why the crushing of palm kernels has not gained a foothold heretofore in the United States are: (1) The availability of large supplies of copra, the oil from which serves practically the same purpose as palm-kernel oil and (2) the greater yield of oil cake from palm kernels than from copra. This oil cake would come into competition with oil cake from domestic oil seeds, and much of it would have to seek a market abroad.

The output of palm-kernel oil in the United States is shown in Table 71.

TABLE 71.—*Palm-kernel oil: Production in the United States*

[Source: Bureau of the Census, U. S. Department of Commerce]

Year	Pounds	Year	Pounds
1920	2,671,112	1922–1929	(1)
1921	1,327,382	1930	711,529

[1] No production reported.

Imports into the United States.

Imports of palm-kernel oil into the United States were not of much consequence until 1925. The maximum in 1926, about 75,000,000 pounds, was again almost attained in 1929, when nearly 70,000,000 pounds were imported. A decline in imports was shown in 1930. Under the tariff act of 1930, palm-kernel oil for edible use (not denatured) is dutiable at 1 cent a pound; that for technical uses (denatured) is duty free.

Imports of palm-kernel oil for consumption in the United States are shown in Table 72.

TABLE 72.—*Palm-kernel oil: Imports into the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Calendar year	Rate of duty	Quantity	Value	Value per unit of quantity
		Pounds		
1920	Free	1,693,740	$238,399	$0.141
1921	do	2,883,483	195,208	.082
1922	do	2,179,148	191,278	.088
1923	do	2,565,789	198,542	.077
1924	do	4,738,736	431,754	.091
1925	do	52,624,334	4,698,804	.089
1926	do	74,979,912	7,086,702	.095
1927	do	43,127,657	3,548,986	.082
1928	do	53,812,482	4,369,100	.081
1929	do	69,909,169	5,301,174	.076
1930 (Jan. 1–June 17)	do	17,051,560	1,105,976	.065
1930 (June 18–Dec. 31)	do	12,052,291	665,080	.055
1930 (June 18–Dec. 31)	1 cent per pound	9,866,934	542,712	.055

Imports of palm-kernel oil originate principally in the United Kingdom and in Germany. Since 1927, Germany has displaced the United Kingdom as the chief country of origin, reestablishing her former position in the industry.

Imports of palm-kernel oil into the United States by country of shipment are shown in Table 73.

TABLE 73.—*Palm-kernel oil: Imports into the United States, by country of shipment* [1]

[Source: Foreign Commerce and Navigation of the United States, except 1930, which is from monthly statistics of imports for consumption, Department of Commerce]

Country	1924	1925	1926	1927	1928	1929	1930 [2]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
United Kingdom	4,317,635	47,525,922	51,931,654	29,372,771	24,919,034	33,443,705	7,220,515
Germany	119,393	4,728,471	20,245,079	13,255,749	27,286,411	36,343,044	31,638,118
Other countries	310,569	369,941	2,803,179	486,817	1,607,037	122,420	112,152
Total	4,747,597	52,624,334	74,979,912	43,115,337	53,812,482	69,909,169	38,970,785

[1] Prior to 1924 figures not separately shown.
[2] Includes both free and dutiable imports.

Imports enter the United States principally at the ports of New York and New Orleans, and to a lesser extent at Philadelphia, Boston, and San Francisco.

Exports from the United States.

No official statistics of domestic exports of palm-kernel oil from the United States are available. There is a small quantity of reexports of palm-kernel and palm oils, but figures are not shown separately.

Domestic consumption.

The apparent consumption of palm-kernel oil in the United States (total of imports and domestic production adjusted for changes in stocks) increased from less than 2,000,000 pounds in 1922 to 84,000,000 pounds in 1926. Consumption then declined, but again increased to nearly 73,000,000 pounds in 1929; 1930 registered a decline. The soap industry is the principal consumer of palm-kernel oil, with the confectionery and biscuit industries ranking next. Only small quantities are consumed in the margarine and lard substitute industries. For 1929 the Bureau of the Census shows a consumption of 11,824,000 pounds in the lard substitute, confectionery, and biscuit industries, taken together (probably almost entirely in the latter two).

Table 74 shows the estimated consumption of palm-kernel oil in soap and margarine, the total apparent consumption, and the excess of total apparent consumption over the consumption in the soap and margarine industries. The last column of the table indicates that the estimates for consumption in the soap industry may be a little too high from 1923 to 1928, inclusive.

TABLE 74.—*Palm-kernel oil: Consumption in soap and margarine compared to total apparent consumption*

[In thousands of pounds]

Year	Reported or estimated consumption in—			Total apparent consumption [3]	Excess of total apparent consumption over consumption in soap and margarine
	Soap [1]	Margarine [2]	Soap and margarine		
1922	685	----------	685	1,465	780
1923	3,287	46	3,333	2,478	−855
1924	4,440	----------	4,440	4,457	17
1925	45,037	165	45,202	45,036	−166
1926	83,653	146	83,799	83,611	−188
1927	31,248	68	31,316	31,333	17
1928	50,578	87	50,665	49,406	−1,259
1929	[4] 44,532	1	44,533	72,920	[5] 28,387
1930	29,431	3	29,434	38,587	9,153

[1] Official figures, 1922, 1923, and 1929; estimates by the trade, based upon official figures, 1924 to 1928, inclusive, and 1930.
[2] Calendar years, Bureau of Internal Revenue, U. S. Department of the Treasury.
[3] Imports plus stock at the beginning of the year less stock at end.
[4] Trade estimate 72,920,000 pounds.
[5] The figure would be 16,322,000 pounds if consumption in lard substitutes (including confectionery and biscuit industries) and for other minor uses is added to consumption in soap and margarine.

Costs of production.

No information is available on the costs of production of palm-kernel oil in Germany and in the United Kingdom, the principal producing countries, but import values and price quotations may be considered as evidence of costs.

Prices.

Import prices.—Palm-kernel oil is imported principally at the ports of New York and New Orleans, the former predominating. That imported at New York is consumed principally in the New York area and that at New Orleans principally in the Mid-West.

The prices of imported palm-kernel oil landed at New York, Philadelphia, Boston, and New Orleans were obtained from importers' records for 1929 and for the first six months of 1930. Table 75 shows the weighted average landed price of palm-kernel oil entered at New York only, the weighted average landed price at the four chief ports of entry, and the average price at these ports plus the weighted average of transportation charges to Cincinnati, Ohio.

TABLE 75.—*Palm-kernel oil: Import prices (landed) and transportation charges to Cincinnati, Ohio*

[Cents per pound]

Item	1929	1930 (first 6 months)
Weighted average landed price at New York	7.83	6.95
Weighted average landed price at four chief ports of entry	7.87	6.82
Weighted transportation charges from chief ports to Cincinnati, Ohio	.30	.31
Landed cost of chief ports plus transportation charges to Cincinnati, Ohio	8.17	7.13

Quoted prices.—Table 76 shows the quoted price of palm-kernel oil in casks at New York and the price including transportation charges to Cincinnati.

TABLE 76.—*Palm-kernel oil (in casks): Quoted prices at New York and transportation charges to Cincinnati, Ohio*

[Cents per pound]

	1929	1930 (first 6 months)
Quoted price at New York	[1] 8.45	[1] 7.60
Transportation charges to Cincinnati, Ohio	.33	.33
Quoted price plus transportation charges to Cincinnati, Ohio	8.78	7.93

[1] Oil, Paint and Drug Reporter.

It will be noted that the weighted import prices at New York for 1929 and 1930 (6 months) are 0.62 and 0.65 cent per pound, respectively, lower than the quoted prices. Although this may be partly due to the fact that quotations do not represent actual transactions and are unweighted, and to the fact that some may have been contracted for in advance, the chief reason for the difference is, doubtless, that the quotations are for palm-kernel oil in casks while a large part of the importations now come in bulk in tank vessels.

The quoted price for palm-kernel oil, naked, ex-mill, at Hull and Liverpool, averages about 0.8 cent per pound less than the prices quoted at New York in casks, and about 0.2 cent per pound less than the weighted import price at New York.

PALM OIL

Rates of duty.

Act of 1930: Free.
Act of 1922: Free.

Description and uses.

Palm oil, a semisolid fat ranging in color from pale orange to a deep red, is obtained from the outside fleshy portion of the ripe fruit of the oil-palm tree. The product from Africa, the chief country of origin, appears in grades known as hard, medium, and soft, the grade varying with the locality where the oil is produced and determined, chiefly by its free-fatty-acid content. The product from Sumatra is of a good grade, possessing a low free-fatty-acid content and is suitable for edible purposes.

The chief use of palm oil in the United States is in the manufacture of laundry soaps. Its next most important use is in the tin-plate industry to protect steel sheets from oxidation during immersion in the molten tin and to give the product a smooth, bright finish. The use of palm oil for edible purposes has been limited in the United States.

World production and trade.

The world production of palm oil, assuming production to be measured by exports, increased from 335,000,000 pounds in 1923 to 595,000,000 pounds in 1930, or an average of 490,000,000 pounds. The output (exclusive of local consumption in palm-oil producing countries), is seen to be somewhat less, therefore, than that of palm-kernel oil, the production of which averages about 550,000,000 pounds annually.

Palm oil is produced entirely where the palm fruit is gathered. Nigeria (British), the Belgian Congo, French West Africa, Sumatra,

and British Malaya are the chief sources of supply. The greatest increase in output has occurred in Sumatra, where the greatest future increase is also expected.

Table 77 shows exports of palm oil from chief producing countries.

TABLE 77.—*Palm oil:* [1] *Exports from chief producing countries*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture, 1923 to 1929, inclusive. International Yearbook of Agricultural Statistics for 1930]

[In thousands of pounds]

Exports from—	1923	1924	1925	1926
Nigeria	222,740	284,663	286,968	253,714
French West Africa	49,726	57,054	57,374	56,014
Belgian Congo	27,376	31,100	41,216	40,664
Netherland East Indies [2]	8,540	10,856	19,254	20,958
All other	26,946	34,369	42,044	40,812
Total	335,328	418,042	446,856	412,162

Exports from—	1927	1928	1929	1930
Nigeria	253,654	282,488	293,036	304,189
French West Africa	57,006	38,436	50,520	49,673
Belgian Congo	40,506	58,436	66,792	81,546
Netherland East Indies [2]	47,654	63,436	79,028	108,781
All other	35,874	34,626	42,420	50,612
Total	434,694	477,422	531,796	594,801

[1] Mostly palm oil, but includes a small quantity of palm-kernel oil.
[2] Represents actual production.

The United States and the United Kingdom are the principal consumers of palm oil, and Germany, France, and the Netherlands are the next in order of importance.

Table 78 shows imports of palm oil into chief consuming countries.

TABLE 78.—*Palm oil: Imports into chief consuming countries*

[Source: United States—Foreign Commerce and Navigation of the United States, Department of Commerce. United Kingdom—Annual Statement of Trade of the United Kingdom. Germany, France, and Netherlands—Statistical Bulletin No. 24, 1923 and 1924, U. S. Department of Agriculture; and Foreign Crops and Markets, 1925 to 1930, inclusive]

[In thousands of pounds]

Imported into—	1923	1924	1925	1926
United States	128,495	101,780	139,178	130,746
United Kingdom	144,036	165,704	180,266	155,501
Germany	10,349	20,301	40,964	31,126
France	40,264	45,486	38,872	45,774
Netherlands	13,598	67,375	40,430	25,462

Imported into—	1927	1928	1929	1930
United States	159,912	169,228	261,816	287,492
United Kingdom	129,066	116,370	133,896	132,246
Germany	38,038	44,682	44,242	65,124
France	25,828	35,148	18,942	25,430
Netherlands	21,464	19,672	20,262	21,666

Conditions of production in chief producing countries.

In Africa, palm oil is produced in a very primitive fashion by the natives, and the oil is, for the most part, fit only for technical uses. As against the primitive fashion of producing palm oil in Africa, the industry in Sumatra and British Malaya is conducted by scientific methods on plantations, and the product is suitable for edible uses.

The supply of palm oil in Africa is not expected to increase materially in the near future. The industry in Sumatra, on the other hand, although of recent origin, is rapidly expanding and promises to equal or surpass the African output. British Malaya's entry in the field as a source of supply is still more recent, and its output, although less than that of Sumatra, is of increasing importance. The chief factors that have stimulated the planting of palm trees in Sumatra and British Malaya are the low prices received for rubber and the desire of producers to avoid too great dependence upon a single crop for their revenue.

In 1929, a total of 93,409 acres, 41,174 acres of which were in bearing, were planted to palms in Sumatra. The acreage under cultivation in British Malaya increased from about 2,500 in 1922 to approximately 30,000 in 1929, with further lands set aside for future development. It is thus apparent that an increase in production may be expected from these countries in the future.

Domestic production.

No palm oil is produced in the United States.

Imports into the United States.

Imports of palm oil into the United States passed the 100,000,000 pound mark in 1923 and since then have increased to a maximum of 287,000,000 pounds in 1930. Imports of palm oil for consumption are shown in Table 79.

TABLE 79.—*Palm oil: Imports into the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Calendar year	Rate of duty	Quantity	Value	Value per unit of quantity
		Pounds		
1920	Free	41,948,224	$5,430,310	$0.129
1921	do	23,155,230	1,421,503	.061
1922	do	57,516,889	3,771,896	.066
1923	do	128,494,679	9,339,481	.073
1924	do	101,779,802	7,002,462	.069
1925	do	139,178,587	11,040,372	.079
1926	do	130,746,694	10,111,588	.077
1927	do	159,911,079	11,039,549	.069
1928	do	169,227,505	11,066,721	.065
1929	do	261,816,442	17,499,776	.067
1930	do	287,492,580	16,326,853	.057

Formerly palm oil was imported in greater quantities from the United Kingdom, acting as an entrepôt for the African product, than from any other country, but it is now imported chiefly in bulk shipments direct from West Africa and the Netherland East Indies. The increasing importance of the Netherland East Indies as a source of supply for the United States is shown by the imports from that country, amounting to nearly 77,000,000 pounds in 1930.

Imports of palm oil into the United States, by country of shipment, are shown in Table 80.

TABLE 80.—*Palm oil: Imports into the United States, by country of shipment*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

[In thousands of pounds]

Year	British West Africa	Netherland East Indies	Belgian Congo	United Kingdom	Germany	Other countries	Total
1920	12,157	44	.....	29,729	.....	18	41,948
1921	4,589	.....	.....	14,712	1,340	2,514	23,155
1922	23,368	.....	503	29,295	1,221	3,141	57,517
1923	54,363	168	10,226	43,300	10,603	9,835	128,495
1924	42,194	179	13,935	19,769	20,452	5,251	101,780
1925	58,402	2,909	21,217	31,445	11,959	13,247	139,179
1926	60,375	10,414	20,560	10,154	16,250	12,994	130,747
1927	80,831	13,166	25,642	10,599	12,207	17,466	159,911
1928	83,282	20,423	26,415	8,915	10,169	11,024	169,228
1929	144,772	45,030	36,067	12,044	11,211	12,692	261,816
1930	138,587	76,834	46,099	9,343	8,757	7,873	287,493

Palm oil is imported principally at the port of New York. Ports of entry of less importance are Boston, Philadelphia, New Orleans, and San Francisco.

Exports from the United States.

Official statistics do not show separately domestic exports of palm oil from the United States. Reexports are shown combined with palm-kernel oil and are small.

Domestic consumption.

The total apparent consumption of palm oil (imports adjusted for changes in stocks) in the United States increased from 46,000,000 pounds in 1922 to 246,000,000 pounds in 1930. The soap and tin-plate industries account for the greater part of the consumption. The quantity of palm oil going into edible products in the United States is small.

Table 81 shows the consumption of palm oil in the soap, tin-plate, and margarine industries in the United States and the total apparent consumption. The difference between consumption in the three industries named and total apparent consumption is accounted for by the use of palm oil in lard substitutes, lubricating greases, and fatty acids, used largely in turn in rubber goods and candles. The apparent increase in this figure in 1928, 1929, and 1930 may be due to increased use in these industries or to an error in the other statistics, as, for example, an underestimate of palm oil consumed in soap.

TABLE 81.—*Palm oil: Consumption in soap, tin-plate, and margarine industries compared to total apparent consumption*

[In thousands of pounds]

Year	Consumption in—				Total apparent consumption [4]	Excess total apparent consumption over total in the 3 specified industries
	Soap [1]	Tinplate [2]	Margarine [3]	Soap, tinplate, and margarine		
1922	30,389	12,398	.....	42,787	46,349	3,562
1923	102,323	14,506	.....	116,829	125,508	8,679
1924	82,250	13,657	14	95,921	96,885	964
1925	119,400	15,960	794	136,154	136,988	834
1926	100,960	17,158	748	118,866	138,587	19,721
1927	112,460	16,112	601	129,173	136,584	7,411
1928	142,363	16,000	1,168	159,531	188,814	29,283
1929	[5] 178,851	15,512	1,523	195,886	230,980	35,094
1930	191,956	14,500	863	207,319	246,249	38,930

[1] Official figures, 1922, 1923, and 1929; estimates by the trade based upon official figures, 1924 to 1928, inclusive, and 1930.
[2] Hearings before Committee on Ways and Means, House of Representatives, pp. 9027 and 9028, 1922 to 1927, inclusive; 1928 and 1930, estimated; 1929, official figures.
[3] Calendar years, Bureau of Internal Revenue, U. S. Department of the Treasury.
[4] Imports plus stocks at beginning less stocks at end of period.
[5] Trade estimate 192,331,000 pounds.

Costs of production.

Costs of production of palm oil are not available. In fact, it would be an impossible task to ascertain costs in Africa where the oil is produced in most primitive fashion, and a difficult task at best in Sumatra and British Malaya, where production is conducted scientifically. The allocation of investment over a period of years and the allocation of joint costs to the several products—palm oil, palm-kernel oil, and oil cake—would here offer a difficult problem. Import and quoted prices are given as evidence of costs.

Prices.

Import prices.—Palm oil is imported principally at New York and in smaller quantities at Boston, Philadelphia, New Orleans, and San Francisco. It is consumed primarily in the New York area and secondarily in the mid-western region.

The prices of palm oil, landed at the chief ports of entry, were obtained from importers' records. Table 82 shows the weighted average landed price of palm oil, at New York only and at the five chief ports of entry, and the weighted average transportation charges from the chief ports to Chicago.

TABLE 82.—*Palm oil: Import prices (landed) and transportation charges to Chicago*

[In cents per pound]

Item	1929	1930 (first 6 months)
Weighted average landed price at New York only	7.75	6.75
Weighted average landed price at 5 chief ports of entry	7.69	6.81
Weighted average transportation charges from chief ports to Chicago	.39	.39
Weighted average landed price at chief ports plus transportation charges to Chicago	8.08	7.20

Quoted prices.—Palm oil is quoted in trade journals as Niger and Lagos, the names signifying the points of origin and the type of oil. Actual transactions are now, however, principally with oil designated

as hard, medium, and soft. Table 83 shows the average prices of spot transactions in these grades at New York, together with transportation charges to Chicago. These quoted prices are lower than the import prices at New York for both periods. The difference is probably due to the fact that they are spot prices whereas some of the import prices are for shipments contracted for at a higher market, and also to the fact that they are unweighted averages whereas the import prices are weighted.

TABLE 83.—*Palm oil: Average quoted prices for spot transactions at New York and transportation charges to Chicago*

[In cents per pound]

Item	1929			1930 (first six months)		
	Hard	Medium	Soft	Hard	Medium	Soft
Average price at New York	7.23	7.32	7.54	6.17	6.22	6.34
Transportation charges via New York to Chicago	.38	.38	.38	.38	.38	.38
Price plus transportation charges	7.61	7.70	7.92	6.55	6.60	6.72

Table 84 shows prices for palm oil, in casks at New York, as quoted in trade journals.

TABLE 84.—*Palm oil: Prices at New York (in casks)*

[Source: Oil, Paint and Drug Reporter]

[Cents per pound]

Year	Niger	Lagos	Year	Niger	Lagos
1926	8.06	8.50	1929	7.40	7.78
1927	7.06	7.60	1930 (first 6 months)	6.48	6.81
1928	7.26	7.88			

SESAME OIL

Rates of duty.

Act of 1930: 3 cents per pound.[3]

Act of 1922: Free.

Description and uses.

Sesame oil rather closely resembles cottonseed oil but is usually lighter in color and refines with a lower percentage of loss. The best grades are used edibly as table or salad oil, in mayonnaise, lard substitutes, and margarine. Consumption in the margarine industry is small, the maximum for 1923 to 1930, inclusive, shown by the Bureau of Internal Revenue being 374,000 pounds in 1924 (calendar year). Lower grades are used in the production of soap. The investigation by the Tariff Commission disclosed the fact that about three-fourths of the consumption of sesame oil in the United States was in the manufacture of edible products and that about one-fourth of the total was consumed in the manufacture of soap.

[3] Free when denatured.

World production and trade.

Sesame oil is obtained from the seed of an annual plant grown principally in India and in China. For the seed, India is the chief producing country, although China is the largest exporter.

Compared with production, the surplus seed for export is small. Probably the low rate of exchange for China has been a factor in the increase of exports of seed from that country.

Production of sesame seed in India and exports from India and China are shown in Table 85.

TABLE 85.—*Sesame seed: Production in India and exports from India and China*

[In thousands of pounds]

Year	Production, India [1]	Exports		Year	Production, India [1]	Exports	
		India [2]	China [3]			India [2]	China [3]
1923	988,000	81,617	256,851	1927	1,212,000	3,510	75,514
1924	1,150,000	21,363	124,559	1928	1,075,844	24,782	127,488
1925	944,000	68,342	70,476	1929	1,029,548	68,282	195,628
1926	928,000	89,368	120,346	1930	1,019,200	24,167	256,436

[1] Foreign Crops and Markets, U. S. Department of Agriculture.
[2] Sea-Borne Trade of British India (year ending Mar. 31).
[3] Foreign Trade of China.

The world supply of sesame seed is taken by a large number of countries, no one country predominating. Importing countries are the Netherlands, Germany, the United Kingdom, the United States, and France.

Although India and China are the chief growers of sesame seed, they produce very little sesame oil for export. The Netherlands is the chief exporter of sesame oil. Exports of sesame oil from the Netherlands are shown in the following table:

TABLE 86.—*Sesame oil: Exports from the Netherlands*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture]

Year	Pounds	Year	Pounds
1923	15,386,000	1927	6,816,000
1924	12,090,000	1928	14,276,000
1925	12,184,000	1929	21,202,000
1926	12,003,000	1930	11,994,000

The United States, formerly the chief importer of sesame oil, now imports it principally in the form of seed. No one country is outstanding as an importer of the oil.

Domestic production (from imported seed).

Until 1931 there were no official statistics on the production of sesame oil in the United States. A small part of the total importation of sesame seed is used as such in confectionery and bakery establishments but the major part is crushed for oil. As the seed yields on the average about 46 per cent oil, that imported would yield, if all were crushed, the quantity of oil shown in Table 87. The greatest increase in the production of oil occurred in 1930 after the passage of the tariff act, under which sesame oil when fit for edible purposes (not de-

natured) was made dutiable at 3 cents a pound. Sesame oil is produced by a few companies on the Pacific coast, principally at Los Angeles. The lack of sufficient oil and oil cake on the west coast and the low rate of exchange in China for silver are factors favoring the importation and crushing of duty-free sesame seed in that area.

TABLE 87.—*Sesame oil: Estimated production in the United States* [1]

Year	Pounds	Year	Pounds
1923	6,279,221	1927	1,356,374
1924	6,378,354	1928	4,597,934
1925	1,794,441	1929	8,436,342
1926	1,326,364	1930	25,606,502

[1] Estimated from reported quantity of sesame seed imported, on basis of 46 per cent yield of oil.

Imports into the United States.

The maximum importation of sesame oil into the United States was in 1929. Since the imposition of the rate of duty of 3 cents per pound on sesame oil in the tariff act of 1930 imports have been practically negligible, imports of seed having been substituted for the oil.

Table 88 shows imports of sesame oil for consumption in the United States.

TABLE 38.—*Sesame oil: Imports into the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Calendar year	Rate of duty	Quantity	Value	Value per unit of quantity
		Pounds		
1920	1 cent per pound	806,935	$162,538	$0.201
1921	do	89,061	14,137	.159
1922 (Jan. 1-Sept. 21)	do	48,240	9,374	.194
1922 (Sept. 22-Dec. 31)	Free	15,940	2,821	.177
1923	do	8,702,034	973,351	.112
1924	do	7,842,580	873,186	.111
1925	do	4,294,634	511,591	.119
1926	do	8,861,947	1,046,182	.118
1927	do	1,704,120	203,413	.119
1928	do	6,264,113	667,902	.107
1929	do	21,585,211	1,915,301	.089
1930 (Jan. 1-June 17)	do	10,669,397	863,176	.081
1930 (June 18-Dec. 31)	3 cents per pound	87,761	8,645	.098
1930 (June 18-Dec. 31)	Free (denatured)	26,457	1,730	.065

Imports of sesame oil into the United States originate principally in the Netherlands and in the United Kingdom. Table 89 shows imports by country of shipment. Imports enter principally at the port of New York.

TABLE 89.—*Sesame oil: Imports into the United States by country of shipment* [1]

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce.]

Country of shipment	1926	1927	1928	1929	1930
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Netherlands	6,129,225	631,607	4,455,007	9,704,650	5,843,627
United Kingdom	40,620		19,959	9,993,723	3,597,117
Denmark	311,124	442,268	1,091,263	1,534,845	756,714
France	990,136	71,600	314,753	68,825	23,858
Belgium	124,329	200,404	267,707	77,807	149,571
China	352,276	91,582	19,349	23,751	12,347
Other countries	914,237	266,668	70,840	184,014	493,226
Total	8,861,947	1,704,129	6,238,878	21,587,615	10,876,460

[1] Not shown separately in general imports prior to 1926.

From 1923 to 1930 inclusive, imports of oil and oil equivalent of seed ranged from a minimum of 3,060,000 pounds in 1927 to a maximum of 36,364,000 pounds in 1930.

Exports from the United States.

There are no official statistics of exports or of reexports of sesame oil from the United States.

Costs of production.

Costs of production of sesame oil in the United States were obtained by the representatives of the Tariff Commission for 1929 and the first six months of 1930. The four companies from which costs were obtained were located on the Pacific coast and produced 8,072,092 pounds of oil, or 52 per cent of the total estimated output of the country. As the crushing of sesame seed was new to most of the companies, and as operations were, as a rule, not continuous throughout the period, conversion costs were high.

Table 90 shows the weighted average domestic costs of production, excluding the cost of oil refining and cake grinding per ton of sesame seed crushed and per pound of oil produced. The costs shown in the second column are the share of joint costs allocated to oil on the basis of the relative net sales value, at the mill, of the output of oil and oil cake, respectively.

TABLE 90.—*Sesame seed and oil: Costs per short ton of sesame seed crushed and per pound of oil produced in the United States, 1929 and first six months of 1930*

Cost item	Dollars per ton of seed	Cents per pound of oil
Cost of sesame seed	83.23	7.20
Factory expense:		
Labor	2.91	.25
Superintendence	.10	.01
Heat, light, and power	.86	.07
Materials and supplies	.43	.04
Repairs	1.33	.12
Depreciation	2.13	.18
Insurance	.37	.03
Taxes, other than Federal	.42	.04
Rent	.07	.01
Miscellaneous	.05	
Total factory expense	8.67	.75
General and administrative expense	.76	.07
Imputed interest on depreciated plant assets and inventories	2.61	.23
Total conversion costs	12.04	1.05
Total seed and conversion costs	95.27	8.25
Sesame seed crushed, tons	8,723	
Sesame oil produced, pounds	8,072,092	

The weighted average net sales value of sesame oil at the plant for three of the companies (one did not sell its oil on the market) was 7.88 cents per pound.

Los Angeles is the principal producing center and the principal market for domestic sesame oil. This is due to the location of edible oil and soap plants there. The freight rate to secondary markets in the Mid-West is 75 cents per hundred pounds, making the delivered costs to this market (weighted cost at plant of 8.25 cents and freight of 0.75 cent) 9 cents per pound.

Prices.

Import prices.—Sesame oil is imported into the United States principally at the port of New York and is consumed chiefly in the New York area. The prices of imported sesame oil landed at chief ports of entry were obtained from importers' records. The weighted average price of crude sesame oil landed at New York during 1929 and the first six months of 1930 was 7.95 cents per pound, and for refined oil, 10.28 cents per pound.

Quoted prices.—The average of monthly quoted prices of refined sesame oil in drums at New York follows.

TABLE 91.—*Sesame oil, refined: Price at New York*

[Source: Oil, Paint and Drug Reporter]

[In drums]

Year	Cents per pound	Year	Cents per pound
1926	13.79	1929	12.60
1927	13.04	1930 [1]	11.64
1928	13.79		

[1] 12.10 cents per pound for first 6 months of 1930.

PERILLA OIL

Rates of duty.

Act of 1930: Free.
Act of 1922: Free.

Description and uses.

Perilla oil is obtained from the seed of an annual plant grown principally in China. Because of its pronounced drying properties, it is consumed in the United States in the manufacture of paints, varnishes, linoleum, printing inks, and foundry core oils. Its principal use is in enamel paints and varnishes which come in frequent contact with water. It is reported to be used in the Orient for edible purposes as well as in lacquers, paper umbrellas, lanterns, and artificial leather.

World production and trade.

Neither perilla seed nor perilla oil is important in international trade. The seed is grown in China, Japan, and northern India; China being the principal source of supply. Exports of perilla seed from China follow.

TABLE 92.—*Perilla seed: Exports from China* [1]

[Source: Foreign Trade of China]

Year	Quantity	Year	Quantity
	1,000 pounds		*1,000 pounds*
1924	27,030	1928	14,415
1925	25,819	1929	19,328
1926	21,204	1930	34,745
1927	9,050		

[1] 1923 not available.

Perilla seed is crushed principally in Japan and in the city of Dairen, China (in the Province of Kwantung, leased to Japan). Japan is the chief importer of perilla seed. Imports of perilla seed into Japan follow.

TABLE 93.—*Perilla seed: Imports into Japan*

[Source: Foreign Trade of Japan]

Year	Quantity	Year	Quantity
	1,000 pounds		*1,000 pounds*
1923 [1]	23,796	1927	10,065
1924	30,399	1928	14,858
1925	24,316	1929	18,814
1926	23,194	1930	37,188

[1] Statistics not complete on account of earthquake.

Factors militating against the exportation of the seed to the United States or to Europe are the limited supply of the seed and the unfitness of the joint product, cake, for cattle feed. The chief market for the cake is Japan where it is used as a fertilizer for mulberry trees.

The demand for perilla oil in the Orient has been largely displaced by linseed oil produced from Indian flaxseed. The European demand for perilla oil has decreased, leaving the United States the principal market. International trade in perilla oil is chiefly from the city of Dairen (China) and Japan to the United States. The supply is limited, and it is not probable that it will be increased to any appreciable extent in the future.

Domestic production.

Perilla oil is not produced in the United States.

Imports into the United States.

Imports of perilla oil into the United States in the 1920–1930 period varied from less than 1,000,000 pounds to nearly 9,000,000 pounds. Table 94 shows imports of perilla oil for consumption in the United States.

TABLE 94.—*Perilla oil: Imports into the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Calendar year	Rate of duty	Quantity	Value	Value per unit of quantity
		Pounds		
1920	Free	7,581,555	$1,216,291	$0.160
1921	do	651,840	47,737	.073
1922	do	2,208,139	189,997	.086
1923	do	6,440,749	710,801	.110
1924	do	3,015,758	337,570	.112
1925	do	6,016,585	767,005	.127
1926	do	7,400,569	873,902	.118
1927	do	5,358,160	547,479	.102
1928	do	2,010,957	214,262	.107
1929	do	5,574,319	637,962	.114
1930	do	8,837,921	884,303	.100

Imports of perilla oil into the United States enter principally at San Francisco and originate in Japan and in the city of Dairen, China (in Province of Kwantung). Imports by country of shipment are shown in Table 95 for the only recent years shown in official statistics.

TABLE 95.—*Perilla oil: Imports into the United States by country of shipment* [1]

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Country	1928	1929	1930
	Pounds	*Pounds*	*Pounds*
Japan	1,092,117	2,193,385	7,010,071
Kwantung (China)	918,840	3,380,934	1,827,850
Total	2,010,957	5,574,319	8,837,921

[1] Not given in general imports prior to 1928.

Exports from the United States.

There are no official statistics of exports or reexports of perilla oil from the United States.

Costs of production.

No data are available on the costs of production of perilla oil. Price data, however, may be considered as evidence of costs of production.

Prices.

Import prices.—Perilla oil, imported principally at the port of San Francisco, is consumed chiefly in the Middle West where the chief paint factories consuming this oil are located. Table 96 shows the weighted average landed price of perilla oil imported into the United States, as obtained from importers' records, and transportation charges to the principal consuming market.

TABLE 96.—*Perilla oil: Landed price and transportation charges to principal consuming market*

[In cents per pound]

Item	1929	1930 (first 6 months)
Weighted average landed price	12.22	10.25
Transportation charges, San Francisco to Middle West	.75	.75
Landed price plus transportation charges, San Francisco to Middle West	12.97	11.00

Quoted prices.—Actual transactions in perilla oil are usually contracted for in advance of the season's output and may have little relation to quoted spot prices. Table 97 shows the average spot prices of perilla oil in barrels at New York and the average of spot prices in tank cars at San Francisco. It will be noticed that the quoted prices in tank cars at San Francisco are 0.62 and 0.25 cent higher than the import prices for 1929 and 1930 (6 months) at San Francisco.

TABLE 97.—*Perilla oil: Prices per barrel at New York and per tank car at San Francisco*

[Source: Oil, Paint and Drug Reporter]

[Cents per pound]

Year	New York	San Francisco	Year	New York	San Francisco
1926	13.72	12.25	1929	15.17	12.84
1927	14.81	12.25	1930	[1] 12.21	[2] 10.34
1928	14.31	12.47			

[1] For first 6 months of 1930, 12.87 cents. [2] For first 6 months of 1930, 10.50 cents.

RAPESEED OIL

Rates of duty.

Act of 1930: 6 cents per gallon.[4]
Act of 1922: 6 cents per gallon.

Description and uses.

Rapeseed oil is obtained from the seed of an annual plant grown principally in India, China, Japan, and to a less extent in European countries. In the United States it is used in lubricants (principally for marine engines), rubber substitutes, and textile soaps. A small quantity is also used in the treatment of leather. It is estimated by the trade that lubricants and rubber substitutes account for about 80 per cent and 15 per cent, respectively, of the total consumption.

World production and trade.

Although it is grown both in the Orient and in Europe, rapeseed is produced in greatest quantity in India. Production in that country averages about 1,000,000 short tons annually. Some of it is exported, but the greater part is consumed within the country itself for the production of oil for both edible and technical uses. China generally ranks next to India as a source of supply of rapeseed. Although the greater part of the production in India and China is consumed locally, the exportable surplus is normally sufficient to satisfy the demand, and no marked change is expected in regard to future supplies. Exports from these two countries are shown in Table 98.

TABLE 98.—*Rapeseed: Exports by chief exporting countries*

[Source: Sea-Borne Trade of British India and Foreign Trade of China]

[In thousands of pounds]

Exported from—	1923	1924	1925	1926	1927	1928	1929	1930
British India [3]	564,325	754,701	583,826	250,416	210,976	148,420	173,592	99,254
China	65,616	66,496	104,645	233,913	65,241	58,314	185,702	108,920

[3] Fiscal years, ending Mar. 31.
[4] Free when denatured.

The United Kingdom, Germany, France, the Netherlands, and Japan are the principal importers of rapeseed. Table 99 shows imports by these countries.

TABLE 99.—*Rapeseed: Imports by chief importing countries*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture, for 1924 to 1930, inclusive, except Japan; Statistical Bulletin No. 24, U. S. Department of Agriculture, for 1923, except France and Japan; French Commerce and Navigation for 1923 for France; Foreign Trade of Japan, for Japan, 1923 to 1930, inclusive]

[In thousands of pounds]

Imported into	1923	1924	1925	1926	1927	1928	1929	1930
United Kingdom	136,409	153,570	82,432	36,306	18,800	82,744	70,208	22,254
Germany	147,566	111,246	108,738	34,110	52,390	80,664	38,652	42,368
France [1]	70,238	51,412	32,452	30,704	31,532	33,180	32,464	36,984
Netherlands	75,560	44,078	52,404	37,054	14,116	40,836	39,202	21,234
Japan [1]	104,562	88,593	99,524	225,918	90,296	58,458	165,131	111,518

[1] Includes mustard seed.

Japan and the United Kingdom are the chief exporters of rapeseed oil. Exports by these two countries are shown in Table 100.

TABLE 100.—*Rapeseed oil: Exports by chief exporting countries*

Source: United Kingdom from Foreign Crops and Markets, U. S. Department of Agriculture; except for 1923 which is from Annual Statement of Trade of United Kingdom; Japan from Foreign Trade of Japan]

[In thousands of pounds]

Exported from—	1923	1924	1925	1926	1927	1928	1929	1930
Japan	[1] 2,028	3,153	6,422	30,208	31,410	10,142	22,604	31,739
United Kingdom	20,055	27,096	12,440	11,866	4,202	14,656	12,438	[2] 7,702

[1] Not complete on account of earthquake.
[2] Estimated on basis of average reexports.

The United States and the United Kingdom are the chief importers of rapeseed oil. Imports by these two countries follow.

TABLE 101.—*Rapeseed oil: Imports by chief importing countries*

[Source: Foreign Crops and Markets, U. S. Department of Agriculture; except United Kingdom for 1923, which is from Annual Statement of Trade of United Kingdom]

[In thousand of pounds]

Imported into—	1923	1924	1925	1926	1927	1928	1929	1930
United States	15,932	17,358	12,838	20,926	19,256	17,010	18,952	15,988
United Kingdom	958	1,274	5,462	15,832	18,604	4,260	10,546	16,872

Domestic production.

No production of rapeseed oil has been reported in the United States since 1926. Previous to that year the output was of minor importance. Production statistics follow.

TABLE 102.—*Rapeseed oil: Production in the United States*

[Source: Bureau of the Census, U. S. Department of Commerce]

Year	Pounds	Year	Pounds
1920	408,840	1924	30,000
1921	127,905	1926	173,300
1922	58,125		

Imports into the United States.

During the 1920–1930 period imports of rapeseed oil into the United States varied from 7,000,000 pounds to nearly 21,000,000 pounds. Under the tariff act of 1930 rapeseed oil is allowed free entry when denatured so as to be unfit for edible use. From June 18 to December 31, 1930, about one-third of the imports came in at the 6 cents per gallon rate and about two-thirds were imported free of duty. Table 103 shows imports of rapeseed oil for consumption in the United States.

TABLE 103.—*Rapeseed oil: Imports into the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Calendar year	Rate of duty	Quantity	Value	Value per unit of quantity
		Pounds [1]		
1920	6 cents per gallon	12,907,545	$1,921,579	$0.149
1921	do	7,151,918	788,705	.110
1922	do	10,860,765	957,473	.088
1923	do	15,932,468	1,423,203	.089
1924	do	17,362,088	1,580,007	.091
1925	do	12,675,930	1,458,816	.115
1926	do	20,767,778	2,025,234	.098
1927	do	19,223,932	1,581,910	.082
1928	do	16,875,675	1,504,321	.089
1929	do	18,801,405	1,587,725	.084
1930 (Jan. 1–June 17)	do	7,190,160	547,724	.076
1930 (June 18–Dec. 31)	do	2,474,670	166,725	.067
Do	Free	5,294,513	334,272	.063

[1] Converted on basis of 7½ pounds per gallon.

Imports of rapeseed oil enter the United States chiefly at the port of New York and orginate principally in the United Kingdom and Japan. Table 104 shows imports by country of shipment.

TABLE 104.—*Rapeseed oil: Imports into the United States by country of shipment*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Year	United Kingdom	Japan	Other countries	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*
1920	2,352,765	9,317,805	1,236,900	12,907,470
1921	4,698,885	1,898,063	554,970	7,151,918
1922	9,293,430	580,568	986,767	10,860,765
1923	14,697,975	954,480	280,020	15,932,475
1924	16,082,955	820,155	458,970	17,362,080
1925	8,895,292	2,825,558	1,014,345	12,735,195
1926	8,726,130	11,200,050	832,403	20,758,583
1927	877,253	17,763,450	463,410	19,104,113
1928	9,789,982	6,659,108	427,275	16,876,365
1929	6,219,375	12,267,495	314,385	18,801,255
1930	3,830,018	11,940,052	90,270	15,860,340

Exports from the United States.

Official statistics show a small quantity of rapeseed oil exported as such from the United States. In the 1923–1930 period, imports upon which drawback was paid, when the product into which it entered was exported, ranged from a minimum of 2,442,135 pounds in 1925 to a maximum of 4,083,180 pounds in 1929. This declined to 3,499,170 in 1930. Exports were principally in the form of lubricating oil.

Domestic consumption.

Apparent domestic consumption averaged 16,000,000 pounds from 1922 to 1930, inclusive, with an annual range from 11,000,000 to 19,000,000 pounds. The principal use of rapeseed oil is in the manufacture of marine engine lubricants.

Costs of production.

Costs of production of rapeseed oil are not available, but import prices may be considered as evidence of costs.

Prices.

Import prices.—Rapeseed oil, imported principally at New York, is consumed chiefly in that area. Table 105 shows the weighted average landed price of rapeseed oil imported at New York, as obtained from importers' records.

TABLE 105.—*Rapeseed oil: Price of imports landed at New York*

[Cents per pound]

	1929	1930 (first 6 months)
Weighted average landed price	9.64	8.74

Quoted prices.—The average monthly quoted spot prices of refined and blown rapeseed oil at New York are shown in Table 106.

TABLE 106.—*Rapeseed oil: Prices (in barrels) quoted at New York*

[Source: Oil, Paint and Drug Reporter]

[Cents per pound]

Year	Refined	Blown	Year	Refined	Blown
1926	11.47	13.83	1929	10.84	13.67
1927	10.74	13.06	1930	[1] 8.44	[2] 11.20
1928	11.41	13.68			

[1] For the first 6 months of 1930, 9.20 cents. [2] For the first 6 months of 1930, 12.40 cents.

The average of monthly prices of rapeseed oil, crude, extracted, ex-mill, at Hull, England, was 9.02 cents per pound for 1929 and 8.11 cents for the first six months of 1930.

WHALE OIL

Rates of duty.[6]

Act of 1930: 6 cents per gallon.
Act of 1922: 6 cents per gallon.

Description and uses.

Whale oil is obtained by rendering the blubber, flesh, and bones of all species of whale except the sperm whale. When hardened by hydrogenation it is somewhat similar to tallow. In the United States whale oil is practically all consumed as a raw material in the

[6] *Tariff status of whale oil imported from the high seas.*—The United States Court of Customs and Patent Appeals has ruled that whale oil rendered on a foreign vessel on the high seas and thereafter brought into the United States is "imported" from a foreign country and is subject to duty under the tariff act of 1930. An appeal from this decision has been filed in the Court of Customs and Patent Appeals, and the case is now pending in that court.

manufacture of soap. Small quantities of low-grade oil, however, are consumed in the production of fruit-tree and fly sprays, in treating leather and as an illuminant. Although consumed in the United States almost entirely for technical uses, in Europe it is used to a large extent for edible purposes.

World production and trade.

The world production of whale oil, now exceeding a billion pounds annually, has increased rapidly in the last few years. The increase is due primarily to the exploitation of the Antarctic waters and to modern methods of catching the whales and rendering them aboard ship. Because of the danger of glutting the market as well as exterminating the whales, it is problematical whether the present output can be increased or even maintained for any length of time. Most of the fleets have, in fact, ceased operations during the 1931–32 season. The Antarctic region, which includes the Falkland Islands and the Ross Sea, supplies over three-fourths of the output, and the African coast waters furnish most of the remainder.

Norway produces about half of the world supply of whale oil. Great Britain and British possessions produce the next largest quantity.

World production of whale oil is shown in Table 107.

TABLE 107.—*Whale oil: World production*

[Source: Review of the Oilseed, Oil, and Oil Cake Markets, Frank Fehr & Co.]

Year	Quantity	Year	Quantity
	Pounds [1]		*Pounds* [1]
1920	159,375,000	1926	437,571,375
1921	156,375,000	1927	457,055,625
1922	244,875,000	1928	508,615,500
1923	293,574,750	1929	698,203,875
1924	271,303,125	1930	1,043,273,250
1925	391,602,000		

[1] Converted on the basis of 375 pounds per barrel.

Trade statistics of most foreign countries do not show whale oil separately from fish oils. Exports, however, are accounted for chiefly by Norway and the United Kingdom (whaling being done principally by the fleets of these two countries). Germany is probably the largest single importer of whale oil. The Netherlands and the United Kingdom are also large importers.

Domestic production.

Production of whale oil in the United States averages about 10,000,000 pounds annually. The output is by companies (two recently) on the west coast, operating in Alaskan, Pacific coast, and Mexican waters. The whales are towed by small whaling boats to the mother ship or to the shore station where they are cut up and rendered. Fertilizer, bone meal, whale meat, gill bone, and tails are obtained as by-products. Production statistics follow.

TABLE 108.—*Whale oil: Production in the United States*

[Source: Bureau of the Census, U. S. Department of Commerce]

Year	Quantity	Year	Quantity
	Pounds		*Pounds*
1920	23,051,811	1926	9,494,692
1921	2,867,790	1927	11,406,750
1922	13,072,612	1928	10,233,735
1923	10,097,670	1929	11,084,302
1924	8,562,712	1930	9,939,218
1925	8,071,110		

Imports into the United States.

Imports of whale oil into the United States increased from less than 1,000,000 pounds in 1920 to over 56,000,000 pounds in 1929. Table 109 shows imports for consumption in the United States.

TABLE 109.—*Whale oil: Imports into the United States*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

Calendar year	Date of duty	Quantity	Value	Value per unit of quantity
		Pounds		
1920	5 cents per gallon	650,910	$75,176	$0.115
1921	do	2,747,858	135,247	.049
1922 (Jan. 1-Sept. 21)	do	32,033,040	2,508,457	.078
1922 (Sept. 22-Dec. 31)	6 cents per gallon	78,705	4,634	.059
1923	do	28,852,860	2,021,860	.070
1924	do	37,528,342	2,477,787	.066
1925	do	53,558,332	4,224,551	.079
1926	do	39,249,150	2,664,147	.068
1927	do	53,130,952	3,178,725	.060
1928	do	48,426,495	3,021,378	.062
1929	do	56,552,468	3,529,021	.062
1930	do	52,702,455	3,067,966	.058

Imports of whale oil enter the United States principally at the port of New York and originate chiefly in Norway (also New Zealand in 1929 and 1930). They are shown by country of shipment in Table 110.

TABLE 110.—*Whale oil: Imports into the United States by country of shipment*

[Source: Foreign Commerce and Navigation of the United States, Department of Commerce]

[In thousands of pounds]

Year	Norway	United Kingdom	Canada	Falkland Islands	Other	Total
1923	46	293	2,626	17,670	[1] 9,178	29,813
1924	19,352	5,816	4,482	5,546	2,861	38,057
1925	35,518	424	4,188	7,625	[2] 7,740	55,495
1926	39,235	14,203	1,330	.....	[3] 8,576	63,434
1927	32,804	903	2,597	.....	[4] 3,446	39,750
1928	63,969	1,177	3,038	.....	202	68,386
1929	4,642	1,507	2,548	.....	[5] 45,835	54,532
1930	48,867	19,347	2,305	.....	[6] 4,144	74,663

[1] 8,805 pounds from Chile.
[2] 7,549 pounds from Mexico.
[3] Largely from Germany and Mexico.
[4] Principally from Mexico.
[5] 44,164 pounds from New Zealand.
[6] 4,131 pounds from New Zealand.

Exports from the United States.

Exports or reexports of whale oil from the United States are not shown separately in official statistics.

Domestic consumption.

During the 1922–1930 period the apparent consumption of whale oil in the United States ranged from a minimum of 43,000,000 pounds in 1924 to a maximum of 71,000,000 pounds in 1929. Apparent consumption declined to 61,000,000 pounds in 1930. Consumption is almost entirely by the soap industry. Table 111 shows consumption of whale oil in soap in the United States compared with total apparent consumption. Negative or zero excesses in the last column indicate that some of the figures shown for consumption of whale oil in the soap industry are too high.

TABLE 111.—*Whale oil: Estimated consumption in soap and total apparent consumption*

[In thousands of pounds]

Year	Soap [1]	Apparent consumption [2]	Excess apparent consumption over that in soap	Year	Soap [1]	Apparent consumption [2]	Excess apparent consumption over that in soap
1922	60,816	45,596	−15,220	1927	59,894	59,957	63
1923	41,328	44,421	3,093	1928	65,001	65,506	505
1924	36,842	42,661	5,819	1929	70,664	70,664	0
1925	54,745	53,742	−1,003	1930	60,608	60,608	0
1926	62,155	58,784	−3,371				

[1] For 1922 and 1923 the figures are official; for 1924 to 1930, inclusive, estimates from the trade, based upon official figures.

[2] Production plus imports plus stocks at beginning of period less stocks at end. (Imports for consumption used for 1922—general imports not available—and general imports used for 1923 to 1930, inclusive.)

Costs of production.

Costs of production were obtained by the commission from the two domestic producers of whale oil for 1927, 1928, and 1929. The figures can not be published without revealing the costs of the individual companies. The costs of production, including imputed interest, exceeded the net sales value at the plant.

Costs of production of whale oil for the British and Norwegian whaling fleets are not available. Most of these fleets have the advantage of modern equipment and of fishing by modern methods in waters where whales are most abundant.

Prices.

Import prices.—Whale oil is imported principally at the port of New York and is consumed principally in the New York and the Mid-West areas. The landed price of whale oil imported into the United States was obtained from the principal importer, but can not be published without revealing the figure of an individual company. The foreign invoice prices of imports of whale oil into the United States, as shown in official statistics, were 6.24 cents per pound in 1929 and 5.77 for the first six months of 1930. Probably from three-quarters to 1 cent a pound should be added for delivering the oil from foreign ports to the Middle West.

Quoted prices.—Whale oil is usally contracted for at a definite price in advance of the season's catch.

The average of monthly quoted spot prices of crude No. 1 and No. 2 whale oil in tanks at the Pacific coast and the annual price of 0/1 whale oil c. i. f. London, are shown in Table 112.

TABLE 112.—*Whale oil: Prices (in tanks) at Pacific coast and c. i. f. London*

[Sources: Oil, Paint, and Drug Reporter for New York prices; Review of the Oilseed, Oil and Oil Cake Markets, Frank Fehr & Co., for London]

[Cents per pound]

Year	New York		London, 0/1
	No. 1	No. 2	
1926	7.69	7.44	7.10
1927	7.56	7.15	6.18
1928	7.25	6.75	6.41
1929	7.06	6.56	5.75
1930	[1] 6.71	[2] 6.21	4.1–5.4

[1] For first 6 months, 7 cents.

[2] For first 6 months, 6.50 cents.

PART IV

STATISTICAL AND TECHNICAL INFORMATION ON INTERCHANGEABILITY OF VEGETABLE AND ANIMAL OILS

The Senate resolution [1] in compliance with which this report is submitted, calls for a statement of "the kinds and amounts" of domestic oils (made from domestic raw materials) replaced in domestic industry by the oils named (whether imported or made from imported materials). It is, of course, easy to show for a series of years the increased use in certain industries of one or more of the oils specificially covered by this investigation and the decreased use in the same industries of certain oils made from domestic materials. For instance, in the soap industry the consumption of coconut oil increased from 79,000,000 pounds in 1912 to 344,000,000 pounds in 1929, while the consumption of cottonseed oil fell from 132,000,000 pounds to 12,000,000 pounds. But the full significance of these figures is not apparent without an understanding of all factors affecting the interchangeability of vegetable and animal oils. The statistical and technical information given in this part is the basis for the analysis in Part V of the economic factors affecting interchangeability.

1. GENERAL ASPECTS

This introductory section is concerned with a description (1) of the chemical composition of animal and vegetable oils, (2) of the principal physical and chemical properties affecting their fitness for particular uses and therefore their interchangeability with each other, and (3) of the nature of the refining processes by which the properties may be modified. It is followed by sections devoted to each of the particular oil-consuming industries, covering (1) the oils used, (2) the changes which have occurred in this respect in recent years, (3) the degree of interchangeability, technically, between the various oils used, and (4) the technical possibilities of using oils heretofore not used or of expanding the consumption of oils now used to a minor degree.

Chemical composition.

Animal and vegetable oils are mixtures in varying proportions of the glycerides of certain fatty acids.[2] Some of the more important among the glycerides found in commercial oils are olein, stearin, palmitin, laurin, linolein, linolenin, erucin, and ricinolein.[3] Each glyceride has it own individual properties. What properties belong to a particular oil or fat depends, therefore, upon the glycerides composing it and the proportions in which they are blended. Thus each oil has distinctive qualities especially fitting it for certain uses. Some oils, however, are sufficiently similar to be freely interchangeable in a wide range of uses, and small differences in price or changes in market conditions often cause one oil to be substituted for another. But, at the other extreme are oils so dissimilar that by no known

[1] S. Res. 323, 71st Cong., special sess.
[2] They also contain free fatty acids and unsaponifiable matter.
[3] Others of less frequent occurrence are myristin, butyrin, caproin, caprylin, caprin, and arachidin.

process of treatment can they be made interchangeable. Between the two extremes are oils which by treatment may be made interchangeable with certain other oils, but at added cost.

Technical factors affecting interchangeability.

Some of the technical factors determining the uses to which oils may be put are discussed below.

(1) *The melting point.*—The melting point of an oil, or the titre of its fatty acids, which approximates the solidifying point of an oil, is important in determining the uses to which it can be put. For most uses, both edible and technical, oils of fairly high titre are preferred. For example, in making hard soaps, margarines, and lard substitutes, oils of low titre—that is, those which are liquid at ordinary temperatures—can be used, unmixed with high-titre oils, only to a limited extent unless their melting point is raised by hydrogenation, or their liquid glycerides are separated out. However, there are important uses for which low-titre oils are required. An example is in paint and varnish manufacture. Another is in the preparation of salad oils, which must not only be liquid but must be unclouded.

(2) *Chemical "saturation."*—This is ordinarily expressed in terms of iodine value, or number, representing the amount of iodine which a given quantity of an oil will absorb. This affords a measure of the chemical saturation of the oil; that is, the amount of hydrogen which will chemically combine with it. When an oil is subjected to hydrogenation, its unsaturated glycerides are changed into saturated glycerides, its iodine value is lowered, and its melting point raised. These terms may be readily understood when applied to the fatty acids, which behave in the same way as do their glycerides. The acetic, or "saturated," series of acids may be represented by the formula $C_nH_{2n}O_2$, where C, H, and O are symbols for carbon, hydrogen, and oxygen atoms, respectively, and where $_n$ and the subnumerals represent the number of each atom in the molecule. Typical of this series are stearic, palmitic, and lauric acids, which can absorb no more hydrogen, and which thus have a zero iodine value. The unsaturated oleic series represented by the formula $C_nH_{2n-2}O_2$ differs from the saturated series only in having two less atoms of hydrogen in each molecule. The two atoms may be added by hydrogenation to obtain a saturated acid with a zero iodine value. Oleic acid, which is typical of this series, when hydrogenated becomes stearic acid. There are still more highly unsaturated series of acids, such as the series $C_nH_{2n-4}O_2$ represented by linolic acid, and the series $C_nH_{2n-6}O_2$, represented by linolenic acid.

In general, oils of the highest iodine value and the greatest unsaturation are liquids, and those of the lowest iodine value and the greatest saturation are solids. In general also, the power of combining with iodine and hydrogen is associated with the power of absorbing oxygen. Thus the relatively unsaturated oils, as indicated by high iodine values, dry most quickly and in drying form a hard durable film. The iodine value of an oil is, therefore, an index of suitability for use in paints and varnishes. Moreover, it is to some extent an index of unsuitability for food, and to a less degree, for soap, as rapid oxidation is undesirable in either of these uses.

(3) *Saponification value.*—This is measured ordinarily by the amount of caustic potash required to saponify a given quantity of an oil or fat. In soap making it is indicative of the quantity of alkali

required and of the yield of glycerine as a by-product. Differences in saponification value imply differences in chemical structure or the presence of worthless or harmful nonsaponifiable impurities in an oil.

(4) *Color, odor, and taste.*—Frequently color, odor, or taste determines the availability of an oil for specific uses. An oil objectionable in either of these three particulars may be unfit for food. If not too pronounced or persistent, however, the objectionable quality may be removed by refining at a cost varying according to the ease with which the refining is accomplished. Oils which can be modified most cheaply and permanently have the widest range of possible uses, technical as well as edible, for color and odor are frequently important considerations in technical uses, particularly in soaps.

(5) *Free fatty acid content.*—Free fatty acids are formed in an oil by the partial breaking down of its glycerides. Because of the odor and taste and the tendency to rancidity associated with them, their presence in excess makes an oil less valuable for either edible or technical uses. In oil intended for edible uses, the free fatty acids must be converted by chemical treatment into "foots," which settle out of the purified oil. As the foots are much less valuable than the oil from which they are removed, too high a fatty acid content makes it uneconomical to refine an oil. Although oils with an excess of free fatty acids are not excluded from soap making, they command a lower price for such purposes because of their higher refining cost, their lower yield of glycerin, and their tendency when unrefined to impart to soap an objectionable odor and color and to become rancid.

(6) *Content of moisture and unsaponifiable matter.*—The moisture and unsaponifiable matter in an oil are, for most purposes, useless and sometimes harmful. The extent to which they are present, therefore, often affects the price at which an oil is used. Moisture can be removed, but it is impracticable to remove unsaponifiable matter to any appreciable extent.

The six factors mentioned above as affecting the purposes for which an oil may be used are by no means a complete list. Among others are lathering qualities when made into soaps, oxidizing properties, drying properties, viscosity, specific gravity, the sharpness of the melting point, the ease with which it goes into solution with mineral oils, and special medicinal qualities, if any.

Oils may be roughly grouped according to their principal uses as edible, soap, paint, and miscellaneous. The following table shows the melting point, the iodine value, and the saponification value of various oils, grouped in this way.

TABLE 113.—*Physical and chemical characteristics of specified oils*

[Source: J. Lewkowitsch, Chemical Technology and Analysis of Oils, Fats, and Waxes]

Oil	Melting point, degrees centigrade	Iodine value: Grams of iodine which will be absorbed by 100 grams of oil	Saponification value: Milligrams of potassium hydrate required to saponify 1 gram of oil
Oils used principally for food:			
Butterfat	28–34.7	25.7– 50.3	209.3–237.1
Lard	32–48	49.9– 85	195.1–196.6
Peanut	[1] 0– 3	83.3–105	189.3–202
Cottonseed	[1] 3– 4	100.9–120.5	191 –194.5
Sesame	[1] –6––4	103 –115	188 –193
Corn	[1] –15––10	121 –130.8	189.7–192.6
Olive	[1] 3–10	77.3– 94.7	185 –203
Oils used to a large extent in both food and soap:			
Coconut	23–27	8 – 10	225 –268.4
Palm-kernel	23–30	10.3– 17.5	242.4–254.8
Oils used principally in soap:			
Tallow (beef)	40–48.5	35.4– 47.5	193.2–200
Palm	27–42.5	53 –57	196.3–205.5
Whale		110.1–136	188.5–194.2
Menhaden	[1] –4	139.2–192.9	188.7–193
Herring		103.1–142	179 –193.7
Oils used principally in paints and varnishes:			
Linseed	–20––16	170 –205.4	190.2–195.2
Tung	[1] 2– 3	149 –176.2	185.1–197
Soybean	[1] –15––8	124 –143	190.6–192.5
Perilla		193.3–203.1	189.6–193.4
Hempseed	[1] –27	140.5–166	190 –193.1
Poppyseed	[1] –18	132.6–157.5	189 –196.8
Oils used principally in miscellaneous uses:			
Castor	[1] –12––10	81.4– 90.6	176.7–186.6
Sperm		70.4– 96.4	120 –150.3
Rapeseed	[1] –10–10	93.5–105.6	167.7–178.7
Almond	[1] –10–21	93 –101.3	189.5–195.4
Croton	[1] –7	101.7–109.1	192.9–215.6
Cod liver	[1] –10– 0	135 –198.1	168.3–193.4

[1] Solidifying point.

Refining processes.

In determining whether an oil may be technically available for a specific use, account must be taken not only of its characteristics in the crude state but also of the changes which may be made in it when subjected to processes of refining. Particularly is this true now that improved methods of treatment have caused increased interchangeability. Some of the refining processes in general use are briefly described below. What processes will be applied in any particular case depends upon the oil and the use to which it is to be put.

(1) *Coagulation and settling.*—Oil may be put through this process at once or after being heated over water or brine. The clear oil is separated from the relatively coarse matter and from some of the coagulated mucilaginous substances by decanting or filtering, or both.

(2) *Neutralization.*—By the addition of an alkali—usually caustic soda or soda ash, or both—to the heated oil or fat, the free fatty acids are neutralized and settle as "foots," together with mucilaginous matter and a certain amount of coloring matter. The clear oil is separated by decanting or filtering, or both.

(3) *Treatment with siliceous earth or char.*—This treatment bleaches the oil, removing much, or all, of the color. At the same time it reduces the odoriferous constituents. It is often used after treatments (1) and (2).

(4) *Bleaching by the application of oxidizing or reducing agents.*—This is used when treatment with siliceous earth or char fails to remove the color as completely as is desired.

(5) *Hydrogenation.*—Hydrogen bubbled through a heated oil, containing a catalytic agent, combines chemically with the oil, raising its melting point and sometimes removing odor. This process, which came into commercial use about 1910, greatly increased the actual and potential interchangeablity of oils.

(6) *Deodorization.*—Oil is deodorized by passing superheated steam through the heated fatty material under vacuum. The process carries off odoriferous compounds having high boiling points. It is used chiefly for edible oils.

(7) *Stearin separation.*—Some oils contain hard glycerides, such as stearin, which are solid or cloudy at ordinary temperatures. For certain uses, as in table and salad oils, the stearin must be removed. This is done by cooling to the proper temperature and separating the solid stearin by decanting or pressing. Oleo oil is separated from oleo stearin and red oil (oleic acid) from stearic acid by the same method.

2. OILS IN THE SOAP INDUSTRY

Soap making is the largest oil-consuming industry and will be treated first, followed in order by industries making margarine, lard compounds, salad oils and salad dressings, cake and candy, and miscellaneous products.

Chemical composition of soaps.

Soaps are metallic salts of the fatty acids. The soaps in ordinary use are the sodium and potassium salts of these acids, all of which are soluble in water and possess lathering and detergent (cleansing) qualities. Most other soaps are but slightly soluble in water, do not form suds, and are nondetergents; of them all, only ammonium salts are used for cleansing. Some, however, have special industrial uses, For example, use is made of aluminum soaps in waterproofing, of calcium soaps in lubricants, of lead soaps in medicinal plasters, and of zinc soaps in ointments. This report is concerned only with the common sodium and potassium soaps.

As it appears on the market, soap rarely consists entirely of fatty acid salts. Even the soap content does not always consist entirely of such salts; yellow laundry soaps, for example, contain substantial amounts of salts of rosin which have the characteristics of true soaps. Caustic soda combines with the acids present in rosin to form these salts, which are soluble in water, yield a sticky soap, and have good detergent qualities. Rosin alone does not make a satisfactory soap; in combination with certain oils and fats, however, it improves the lathering power of the resulting soap and gives it a faint, pleasant odor.

Moreover, nonsoap detergents, such as sodium phosphate, sodium silicate, and sodium carbonate may be contained in laundry soaps and in some toilet soaps. These ingredients sometimes form a substantial part of the weight of laundry soaps, and they form a major proportion of the weight of scouring power.

Nondetergent materials sometimes found as admixtures of soaps are (1) free alkali; (2) inert fillers, such as talc, china clay, chalk, and starch; (3) perfumes of various sorts; (4) emollients, such as glycerin

and unsaponified fats; and (5) antiseptics and medicinals, such as carbolic acid, zinc oxide, and sulphur. Water in fairly large quantities is found in all soaps, and air is inclosed in floating soaps.

Classification of soaps.

Soaps may be classified as hard, soft, or liquid. In general, hard soaps are sodium soaps, and soft soaps are potassium soaps or emulsified combinations of sodium and potassium soaps. Liquid soaps are usually soft soaps in aqueous or alcoholic solutions or emulsions. Attention will be confined largely to hard soaps, which constitute the great bulk of domestic production.

Soaps may also be classified as to use, as follows:

(1) Laundry soaps are marketed in bars, chips, flakes, granules, beads, or powders. Public laundries generally use chips, flakes, or bars; for ordinary household washing bar soaps are used, but for washing silks, woolens, and fine fabrics in general, flakes, granules, beads, and powders are widely used.

(2) Dual purpose, or general household soaps are made to serve for both laundry and toilet. These are usually made up in cakes.

(3) Toilet soaps are largely made up in cakes, although powdered and liquid soaps are frequently used in public lavatories.

(4) Shaving soaps are in the form of sticks, powders, or creams. In the United States creams now predominate; they are usually emulsified mixtures of sodium and potash soaps, in the manufacture of which enter not only various oils and fats but also stearic acid. Shaving soaps also usually contain considerable admixtures of glycerin, free fats, and other emollients.

(5) Scrubbing soaps include those used primarily for household cleaning other than toilet and laundry. For this purpose washing powders of various sorts are most used. As a rule, these are basically mixtures of sodium carbonate with soap made from oil "foots"; for rough scrubbing, finely ground rock quartz or silica may be added. The abrasive action of the silica serves to loosen dirt and grease which may then be more easily removed by the soap content of the powder. (6) Special industrial soaps have many uses in the textile, tanning, lubricating, and other industries.

Methods of soap making.

In the method ordinarily used, soaps are made by treating selected animal and vegetable oils, composed of glycerides of the various fatty acids, directly with an aqueous solution of caustic soda (sometimes sodium carbonate) to make hard soap or caustic potash to make soft soap. As a result, glycerin is set free and soap is formed.[4] For most soaps the oils and caustic solution are boiled to make saponification more nearly complete, but for some soaps the so-called cold process is used. In the cold process the glycerin is retained in the soap; in the boiling process most, or all, of the glycerin is recovered and forms a valuable by-product.

When low-grade oils, particularly "foots," are used in soap manufacture, the oils may be first split, by distillation or otherwise, into glycerin and fatty acid. The liberated fatty acids are then treated with the proper amount of caustic soda or sodium carbonate in order to convert them into soap.

[4] According to the following equation, in which *R* represents the radicle of the fatty acid:

$$\underset{\text{(Oil or fat)}}{C_3H_5(O\,CO.R)_3} + 3\,Na\,O\,H = \underset{\text{(Glycerin)}}{C_3H_5(O.H)_3} + 3\,\underset{\text{(Soap)}}{R.CO\,O.Na}$$

(Caustic soda)

In completing the soap-making process, the soap is subjected to treatment with salt or brine to remove the glycerin and the excess alkali and other impurities. It is then crutched and run into cooling frames. The crutching process improves the consistency of the soap and thoroughly incorporates with it any emollients, nonsoap detergents, and filling materials which may be inserted. High-grade toilet soaps are also often "milled" to remove water and render them more homogeneous. Milling is effected by crushing a thin film of soap between rollers revolving at different speeds. Soaps are finally made into the form desired—bar, cake, chip, flake, bead, or powder.

TREND OF AGGREGATE SOAP CONSUMPTION

In recent years there has been an increase in the per capita consumption of soap in the United States. This is indicated by Table 114, which shows the total production and per capita consumption in each census year from 1909 to 1929. The per capita increase during this 20-year period was about 20 per cent.

TABLE 114.—*Production, imports, exports, and approximate consumption of soap in the United States* [1]

Calendar year	Production	Imports	Exports	Approximate consumption	Per capita consumption [2]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1909	1,854,286,000	(3)	(3)	1,854,286,000	20.4
1914	2,121,230,000	[4] 4,622,000	[5] 58,546,000	2,067,306,000	21.1
1919	2,383,108,000	2,157,000	[5] 157,750,000	2,227,515,000	21.2
1921	2,425,942,000	2,902,000	[5] 73,952,000	2,354,892,000	21.8
1923	2,781,617,000	5,337,000	92,324,000	2,694,630,000	24.2
1925	2,912,763,000	5,492,000	75,665,000	2,842,590,000	24.8
1927	3,034,018,000	6,025,000	77,408,000	2,962,635,000	25.1
1929	3,055,510,000	7,029,000	74,541,000	2,987,998,000	24.6

[1] Data from official sources. Production plus imports less exports equals approximate consumption.
[2] Approximate consumption divided by estimated population for respective years.
[3] Not given in quantities; would not make any material difference in per capita consumption.
[4] Castile soap only; fiscal year.
[5] All other soap only; toilet and fancy not given in quantities.

Changes in the character of soap consumed.

Increasing consumption of soap in the United States has been accompanied by changing standards of quality, associated with changing standards of living and national advertising in behalf of trade-marked brands of soaps. The trend has been toward soaps, whether for toilet or laundry, that are not harsh or irritating to the skin, that yield a quick firm lather, even in unheated hard water, and that are attractive in color. White soaps have increased for toilet and for laundry uses. The growing use of silk hosiery and silk-rayon underwear, which are usually laundered by hand in lukewarm water, has increased the demand for washing soaps that are quickly soluble. The widespread use of certain brands of soap flakes, granules, beads, and powders which meet that demand has been stimulated by national advertising. A similar trend is observable in shaving soaps, where the more easily soluble and more easily applied creams have largely superseded sticks and powders.

The trend has also been toward more lasting soaps containing less water, which is a considerable ingredient in all types of soap. There has been an opposite tendency, however, associated with the inclusion of air in floating soaps.

Trend in oil consumption in the soap industry, 1912–1930.

Table 115 shows, from 1912 to 1930, in absolute and percentage figures, the consumption in soap making of oils made in the United States from domestic materials and of oils imported or made in the United States from imported materials. Chart I shows graphically the increasing consumption of oils in soap making and the increasing proportion of domestic consumption supplied by oils imported or made from imported materials.

TABLE 115.—*Consumption in soap making of domestic and foreign oils* [1]

Calendar year	In thousands of pounds			In percentages of total consumption in soap making	
	Total	Domestic from domestic materials	Imported and made in the United States from imported materials	Domestic from domestic materials	Imported and made in the United States from imported materials
1912	741,351	601,613	139,738	81	19
1914	818,673	658,339	160,334	80	20
1916	1,058,795	827,727	231,068	78	22
1917	1,201,680	766,654	435,026	64	36
1919	907,523	586,926	320,597	65	35
1921	990,561	717,325	273,236	72	28
1922	1,119,381	756,089	363,292	68	32
1923	1,195,572	713,560	482,012	60	40
1924	[2] 1,321,411	880,542	440,869	67	33
1925	[2] 1,415,213	837,325	577,888	59	41
1926	[2] 1,485,712	869,276	616,436	58	42
1927	[2] 1,626,152	981,259	644,893	60	40
1928	[2] 1,634,663	926,577	708,086	57	43
1929	[3] 1,691,790	902,514	789,276	53	47
1930	[2] 1,559,700	881,489	678,211	57	43

[1] Government figures 1912–1919; 1921–1923 estimated, from data furnished by the trade to the Tariff Commission; 1924–1930 estimates from trade sources based on Government data.

[2] The figures are trade estimates based on Government data.

[3] The special census report Factory Consumption of Animal and Vegetable Oils and Fats in 1929 gives total consumption in the soap industry as 1,618,953,000 pounds, which can not be divided into foreign and domestic and evidently does not include red oil and certain other miscellaneous oils.

In the period from 1912 to 1930 total consumption of oils in soap making doubled, whereas the population of the country increased only about 28 per cent. A much greater increase occurred in the consumption of oils made from foreign materials than in those made from domestic materials—460 per cent as compared with 50 per cent. If the more normal year of 1928 had been taken for comparison with 1912 the disproportion would have been somewhat less—400 per cent as against 54 per cent. Oils made from foreign materials rose from 19 per cent of the total consumption of oils in soap manufacture in 1912 to 43 per cent in 1928 and 47 per cent in 1929.

Table 116 carries the analysis further by distinguishing (1) vegetable, (2) animal except marine, and (3) whale and fish oils. Certain oils made from domestic materials have also been classed as miscellaneous.

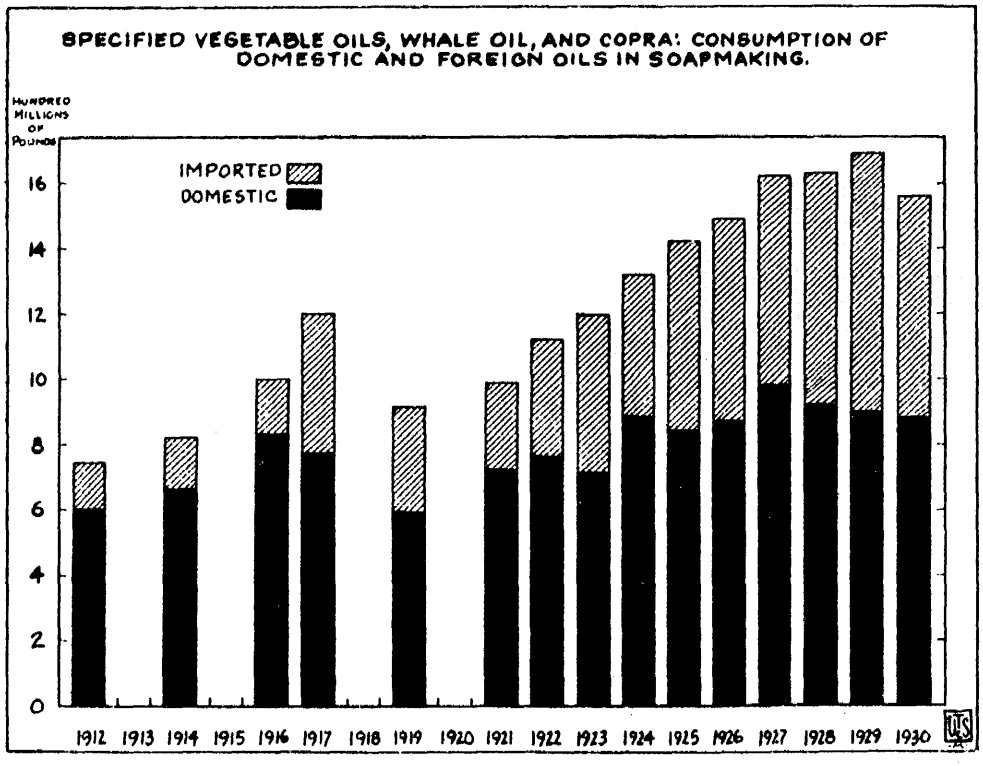
TABLE 116.—*Consumption in soap making of major classes of domestic and foreign oils* [1]

Calendar year	Made from domestic materials				Made from foreign materials		
	Vegetable oils	Animal oils and fats except marine	Whale and fish oils	Miscellaneous	Vegetable oils	Animal oils and fats except marine	Whale and fish oils
	In thousands of pounds						
1912	256,261	316,835	1,103	27,414	114,301	15,510	9,927
1914	263,763	351,690	11,853	31,033	131,956	24,355	4,023
1916	345,615	436,922	4,726	40,464	200,275	22,667	8,126
1917	292,429	410,036	7,576	56,613	342,124	87,170	5,732
1919	198,407	338,696	8,712	41,111	269,787	45,967	4,843
1921	159,445	498,653	35,179	24,048	246,761	24,041	2,434
1922	114,507	580,550	41,863	19,169	292,818	21,832	48,642
1923	100,775	554,326	36,127	22,334	414,047	30,823	37,142
1924	112,214	714,564	33,764	20,000	386,412	20,440	34,017
1925	140,824	630,427	46,074	20,000	508,194	16,828	52,866
1926	153,727	652,663	42,886	20,000	512,002	35,647	68,787
1927	194,011	726,741	40,507	20,000	534,851	15,000	95,042
1928	168,866	684,897	52,814	20,000	586,180	32,500	89,406
1929	162,716	670,271	49,527	20,000	679,696	25,000	84,580
1930	146,775	678,554	41,160	15,000	585,542	20,000	72,669
	In percentages of total consumption of oil in soap making						
1912	34.6	42.7	0.2	3.7	15.4	2.1	1.3
1914	32.2	43.0	1.4	3.8	16.1	3.0	.5
1916	32.6	41.3	.5	3.8	18.9	2.1	.8
1917	24.3	34.1	.6	4.7	28.5	7.3	.5
1919	21.9	37.3	1.0	4.5	29.7	5.1	.5
1921	16.1	50.3	3.6	2.4	24.9	2.4	.3
1922	10.2	51.9	3.7	1.7	26.2	2.0	4.3
1923	8.4	46.4	3.0	1.9	34.6	2.6	3.1
1924	8.5	54.1	2.6	1.5	29.2	1.5	2.6
1925	10.0	44.6	3.2	1.4	35.9	1.2	3.7
1926	10.4	43.9	2.9	1.3	34.5	2.4	4.6
1927	11.9	44.7	2.5	1.2	32.9	.9	5.9
1928	10.3	41.9	3.2	1.2	35.9	2.0	5.5
1929	9.6	39.6	2.9	1.2	40.2	1.5	5.0
1930	9.4	43.5	2.6	1.0	37.5	1.3	4.7

[1] Government figures 1912–1919; 1921–1923 estimated from data furnished by the trade to the Tariff Commission; 1924–1930 estimates from trade sources based on Government data.

Chart II shows graphically the data on animal (except marine) and vegetable oils presented in Table 116. These statistics disclose the fact that the largest increase, both absolute and relative, was in vegetable oils imported or made from imported materials. The increase extended throughout the period under consideration, the proportion represented by these oils rising from 15.4 per cent in 1912 to 35.9 per cent in 1928 and to 40.2 per cent in the somewhat abnormal year 1929. From 1912 to 1923 this increase was concurrent with a striking decrease, both absolute and relative, in the consumption of vegetable oils made from domestic materials. From 1912 to 1924 it was also concurrent with a decided increase in the consumption of

CHART I

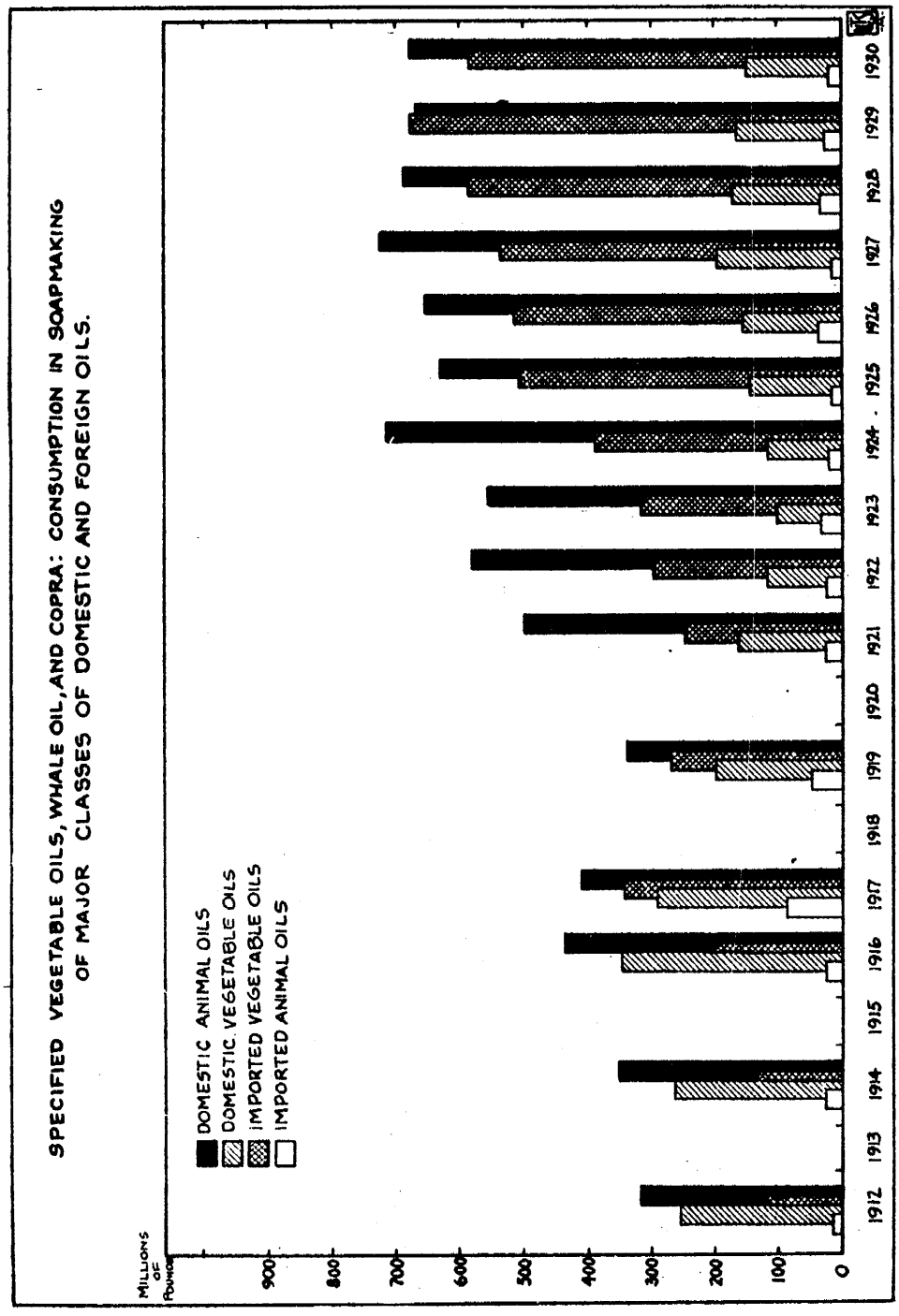


domestic animal oils which in the latter year supplied 54 per cent of the oils used in soap manufacture. After 1924, however, the proportion for this class fell in nearly every year, and in 1929 it amounted to only 39.6 per cent of the total. In recent years the absolute quantity of these domestic animal products used has shown no upward trend.

Table 117 presents data on the consumption in soap of the principal individual vegetable oils of foreign origin. It shows that throughout the period more than half of the consumption in soap making of vegetable oils imported or made from imported materials consisted of coconut oil. In absolute quantity coconut oil showed the largest increase. Proportionally, however, its increase was much less than that of palm oil, which showed the second largest absolute

increase. The relative increase in coconut oil came mainly in the war period, but that of palm oil, palm-kernel oil, and olive-oil foots came in the postwar period. Soybean oil was an important factor

CHART II



only during the World War. Since 1919 coconut oil has ranged from about 18 to 22 per cent of the total quantity of oils used in soap manufacture.

TABLE 117.—*Consumption in soap making of vegetable oils, imported or from imported materials* [1]

Calendar year	Coconut oil	Palm oil	Palm-kernel oil	Olive-oil foots	Olive oil, inedible	Soybean oil	Miscellaneous oils
	In thousands of pounds						
							Peanut oil
1912	78,816	7,546	20,579	5,457	600	1,182	31
1914	77,959	10,000	31,376	7,208	748	4,499	76
1916	111,084	14,938	5,804	9,411	1,184	57,373	481
1917	168,602	27,345	4,762	10,500	1,731	124,058	5,126
1919	182,613	17,268	4,551	3,964	935	58,401	2,055
1921	194,417	24,386	593	15,842	767	10,756	.....
1922	237,702	30,389	685	20,688	1,047	2,307	.....
							Vegetable tallow
1923	267,982	102,323	3,287	27,324	1,317	3,266	8,548
1924	260,000	82,250	4,440	24,785	7,239	2,500	5,198
1925	286,000	119,100	45,037	38,197	10,886	2,250	6,424
1926	270,206	100,960	83,653	42,981	9,225	2,500	2,477
1927	334,765	112,460	31,248	41,372	6,818	2,500	5,688
1928	335,417	142,363	50,578	39,621	8,439	2,500	7,262
1929	[2] 344,205	192,331	72,920	43,417	10,212	6,400	10,211
1930	303,271	191,956	29,431	43,013	6,829	5,000	6,042
	In percentages of total consumption of oils and fats in soap manufacture						
							Peanut oil
1912	10.6	1.0	2.8	0.7	0.1	0.2	.....
1914	9.5	1.2	3.8	.9	.1	.6	.....
1916	10.5	1.4	.6	.9	.1	5.4	.....
1917	14.0	2.3	.4	.9	.1	10.3	0.4
1919	20.1	1.9	.5	.4	.1	6.4	.2
1921	19.6	2.5	.1	1.6	.1	1.1	.....
1922	21.2	2.7	.1	1.9	.1	.2	.....
							Vegetable tallow
1923	22.1	8.6	.3	2.3	.1	.3	0.7
1924	19.7	6.2	.3	1.9	.6	.2	.4
1925	20.2	8.4	3.2	2.7	.8	.2	.4
1926	18.2	6.8	5.6	2.9	.6	.2	.2
1927	20.6	6.9	1.9	2.5	.4	.2	.4
1928	20.5	8.7	3.1	2.4	.5	.2	.5
1929 [3]	20.3	11.4	4.3	2.6	.6	.4	.6
1930	19.4	12.3	1.9	2.8	.4	.3	.4

[1] Government figures 1912-1919; 1921-1923 estimated from data furnished by the trade to the Tariff Commission; 1924-1930 estimates based on Government data.

[2] Census of factory consumption of animal and vegetable oils in 1929 shows 393,914,000 pounds of coconut oil used in the soap industry; 178,851,000 pounds of palm oil; 44,532,000 pounds of palm-kernel oil; 38,448,000 of olive-oil foots; 2,375,000 pounds of inedible olive oil.

[3] Based on census of factory consumption referred to in the preceding note, the percentages for this year would be as follows: Coconut oil 24.3, palm oil 11.0, palm-kernel oil 2.8, olive-oil foots 2.3, inedible olive oil 0.1. This report did not distinguish foreign and domestic soybean oil and miscellaneous oils.

Table 118 gives similarly the data for individual oils of domestic origin. It shows that the decrease in the use, in soap manufacture, of vegetable oils made from domestic materials was due mainly to the great decrease in cottonseed oil, which in 1912 formed nearly 18 per cent of the total consumption of oils in soap but in all except one year since 1922 less than 1 per cent. In actual quantity cottonseed-oil foots showed little change in consumption but fell from 12 to 6 per cent of the total. The other domestic vegetable oils have always been of minor importance in soap making.

TABLE 118.—*Consumption in soap making of specified domestic vegetable oils* [1]

[Quantities in thousands of pounds]

Calendar year	Cottonseed oil		Cottonseed-oil foots		Corn oil	Peanut oil	Miscellaneous soap stock
	Quantity	Per cent total oil consumption in soaps	Quantity	Per cent total oil consumption in soaps			
1912	132,312	17.8	89,127	12.0	9,822	.....	25,000
1914	119,254	14.6	108,141	13.2	11,368	.....	25,000
1916	194,916	18.4	112,178	10.6	12,821	700	25,000
1917	126,390	10.5	115,042	9.6	15,997	10,000	25,000
1919	56,130	6.2	108,389	11.9	2,235	1,000	60,653
1921	47,935	4.8	76,018	7.7	2,405	10,983	22,104
1922	19,759	1.8	61,966	5.5	4,941	6,711	21,130
1923	10,824	.9	52,676	4.4	5,617	6,900	24,753
1924	10,000	.8	77,214	5.8	5,000	5,000	15,000
1925	8,000	.6	109,824	7.8	5,000	.....	18,000
1926	5,000	.3	118,727	8.0	5,000	3,000	22,000
1927	7,500	.5	147,511	9.0	5,000	2,000	32,000
1928	20,000	1.2	105,206	6.4	5,000	3,000	35,660
1929	12,000	.7	108,904	6.4	5,000	1,700	35,112
1930	7,500	.5	103,360	6.6	4,000	1,500	30,415

[1] Government figures 1912–1919; 1921–1923 estimated from data furnished by the trade to the Tariff Commission; 1924–1930 estimates based on Government data.

Table 119, giving data for animal oils (except marine oils), shows that the use of domestic tallow and greases in soap manufacture increased from 1912 to 1922, both in quantity and in proportion to total consumption of oils in that industry. From 1922 to 1929 tallow, which showed no marked change in absolute amount, fell from 38 to 25 per cent of the total consumption. The quantity of domestic greases used has been, according to the available estimates, much larger since 1924 than before that time; in some years there was also a substantial proportionate increase, but the percentage of greases in the total consumption was not much greater in 1929 than in 1922. Imported tallow and greases have never been an important item, and during the period under consideration their importance diminished.

Table 120 shows the consumption in soap manufacture of marine animal oils. A significant increase occurred in the use of imported whale oil, although in no year has that oil formed more than 4 per cent of total consumption. Almost as significant is the increase in imported herring and sardine oil. Domestic whale oil and fish oils also have shown a considerable increase but amount to only 2 or 3 per cent of consumption.

TABLE 119.—*Consumption in soap making of animal tallow and grease* [1]

Calendar year	Domestic			Imported	
	Tallow (inedible)	Grease	Red oil	Tallow (inedible)	Grease
	In thousands of pounds				
1912	238,074	61,569	8,723	609	14,901
1914	258,023	72,908	10,275	12,690	11,665
1916	325,844	92,554	10,230	13,087	9,580
1917	288,678	101,065	12,812	73,619	13,551
1919	314,491	(2)	24,205	12,099	33,871
1921	371,355	114,149	13,149	1,868	22,173
1922	428,134	141,985	10,431	1,832	20,000
1923	401,926	140,167	12,233	10,823	20,000
1924	426,441	274,123	14,000	2,440	18,000
1925	388,961	227,466	14,000	1,828	15,000
1926	417,239	220,424	15,000	13,647	22,000
1927	484,029	227,712	15,000	.....	15,000
1928	428,413	241,454	15,000	12,500	20,600
1929	424,755	230,516	15,000	10,000	15,000
1930	434,610	231,944	12,000	8,000	12,000
	In percentages of total consumption of oils in soap making				
1912	32.1	8.3	1.2	0.1	2.0
1914	31.5	8.9	1.3	1.6	1.4
1916	30.8	8.7	1.0	1.2	.9
1917	24.0	8.4	1.1	6.1	1.2
1919	34.6	(2)	2.7	1.3	3.7
1921	37.5	11.5	1.3	.2	2.2
1922	38.3	12.7	.9	.2	1.8
1923	33.6	11.7	1.0	.9	1.7
1924	32.3	20.7	1.1	.2	1.3
1925	27.5	16.1	1.0	.1	1.1
1926	28.1	14.8	1.0	.9	1.5
1927	29.8	14.0	.9	.....	.9
1928	26.2	14.8	.9	.8	1.2
1929	25.1	13.6	.9	.6	.9
1930	27.8	14.9	.8	.5	.8

[1] Government figures 1912-1919; 1921-1923 estimated from data furnished by the trade to the Tariff Commission; 1924-1930 estimates based on Government data.
[2] Included in miscellaneous.

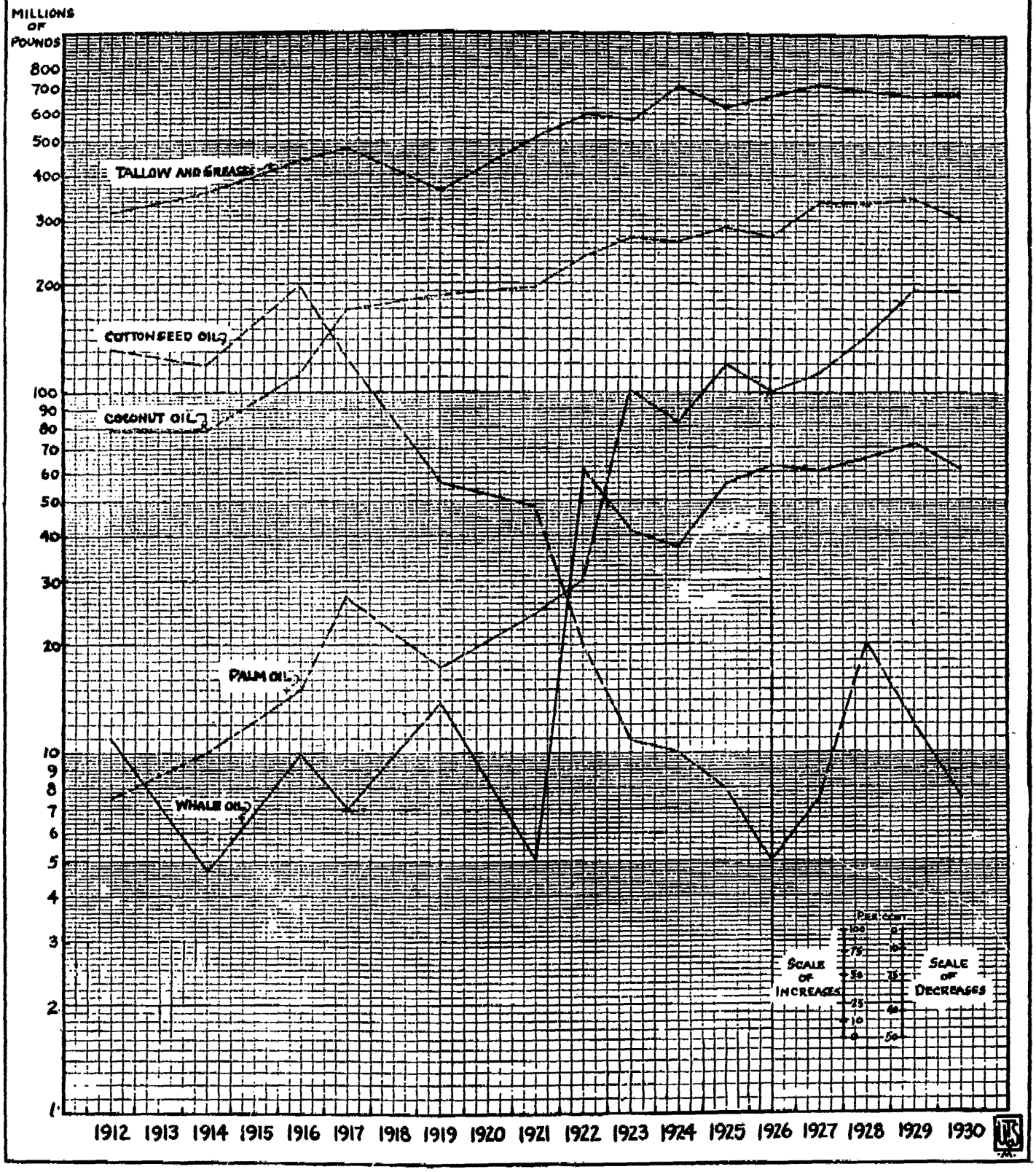
TABLE 120.—*Consumption in soap making of whale oil and fish oils* [1]

Calendar year	In thousands of pounds				In percentages of total consumption in soap manufacture			
	Imported oil		Domestic oil		Imported oil		Domestic oil	
	Whale	Herring and sardine	Whale	Herring, sardine, and menhaden	Whale	Herring and sardine	Whale	Herring, sardine, and menhaden
1912	9,927	.....	931	172	1.3	.....	0.1	.....
1914	4,023	.....	632	11,221	.5	.....	.1	1.4
1916	8,126	.....	1,691	3,035	.8	.....	.2	.3
1917	5,732	.....	1,193	6,383	.5	.....	.1	.5
1919	4,843	.....	8,712	.....	.5	.....	1.0	.....
1921	2,155	279	2,866	32,313	.2	0.1	.3	3.3
1922	47,044	1,598	13,772	28,091	4.2	.1	1.2	2.5
1923	31,766	5,376	9,562	25,565	2.7	.4	.8	2.2
1924	28,378	5,639	8,464	25,300	2.2	.4	.6	1.9
1925	40,671	6,195	8,074	38,000	3.3	.4	.6	2.7
1926	52,269	16,818	9,886	33,000	3.5	1.1	.7	2.2
1927	48,537	46,505	11,357	29,150	3.0	2.9	.7	1.8
1928	55,285	34,121	9,716	43,098	3.4	2.1	.6	2.6
1929	59,580	25,000	11,084	38,413	3.5	1.5	.6	2.3
1930	50,669	22,000	9,939	31,221	3.3	1.4	.6	2.0

[1] Government figures 1912-1919; 1921-1923 estimated from data furnished by the trade to the Tariff Commission; 1924-1930 trade estimates based on Government data.

CHART III

SPECIFIED VEGETABLE OILS, WHALE OIL, AND COPRA: CONSUMPTION IN SOAPMAKING OF SPECIFIED DOMESTIC VEGETABLE OILS.



110349—32. (Face p. 133.)

Charts III and IV summarize graphically the data in Tables 115 to 120, with respect to the consumption of specific oils in soap making. These two charts show the predominance of tallow and grease and coconut oil; also the increasing importance of palm and whale oils and the declining importance of cottonseed oil.

The data in the foregoing tables and charts show that oils imported or made from imported materials have formed a larger and larger proportion of the growing consumption of oils in the soap industry. In particular, coconut and palm oils have grown in importance, as have to a lesser degree imported palm-kernel oil, olive-oil foots, whale oil, and fish oils. This change has meant a decline in the relative importance, not a decline in the total actual quantity of the oils made from domestic materials going into the soap kettle. In fact, the soap kettle has taken not only more of these oils as a group but also more of each individual oil, with the exception of cottonseed oil and corn oil. The problem of replacement, therefore, resolves itself into the question: What proportion of the increase supplied by foreign materials could have been supplied from domestic materials? This involves, first, technical considerations as to interchangeability of oils, and, second, economic considerations. The technical aspects will now be reviewed.

General technical factors affecting use of oils in soap making.

In the actual selection of oils for use in soap making many technical factors must be considered, and the importance of the different factors will vary according to (1) the type of soap to be made—whether hard or soft, cake or powder—(2) the uses to which it is to be put—whether laundry, toilet, or other—and (3) the region in which it is to be used—whether in a soft or hard water region or in both. No oils will yield soaps having identical qualities, and the manufacturer seeks, within the limits of reasonable cost, the oil or the combination of oils which will give a soap of the characteristics desired. He gives particular attention to the properties of the soap obtainable from each oil or combination with respect to the following qualities or properties:

(1) *Consistency.*—The great demand is for hard soaps of firm texture which will not become brittle or crack.

(2) *Solubility.*—Up to a certain point any increase in solubility improves the quality of a soap; beyond that point increased solubility becomes a defect, as the soap becomes too soft or sticky and is consumed too rapidly.

(3) *Lathering properties.*—Not only must the ease and the abundance with which a soap will lather be taken into consideration but also the physical characteristics of the lather, such as closeness of texture, size of bubbles, and durability. These are associated with detergent or cleansing properties.

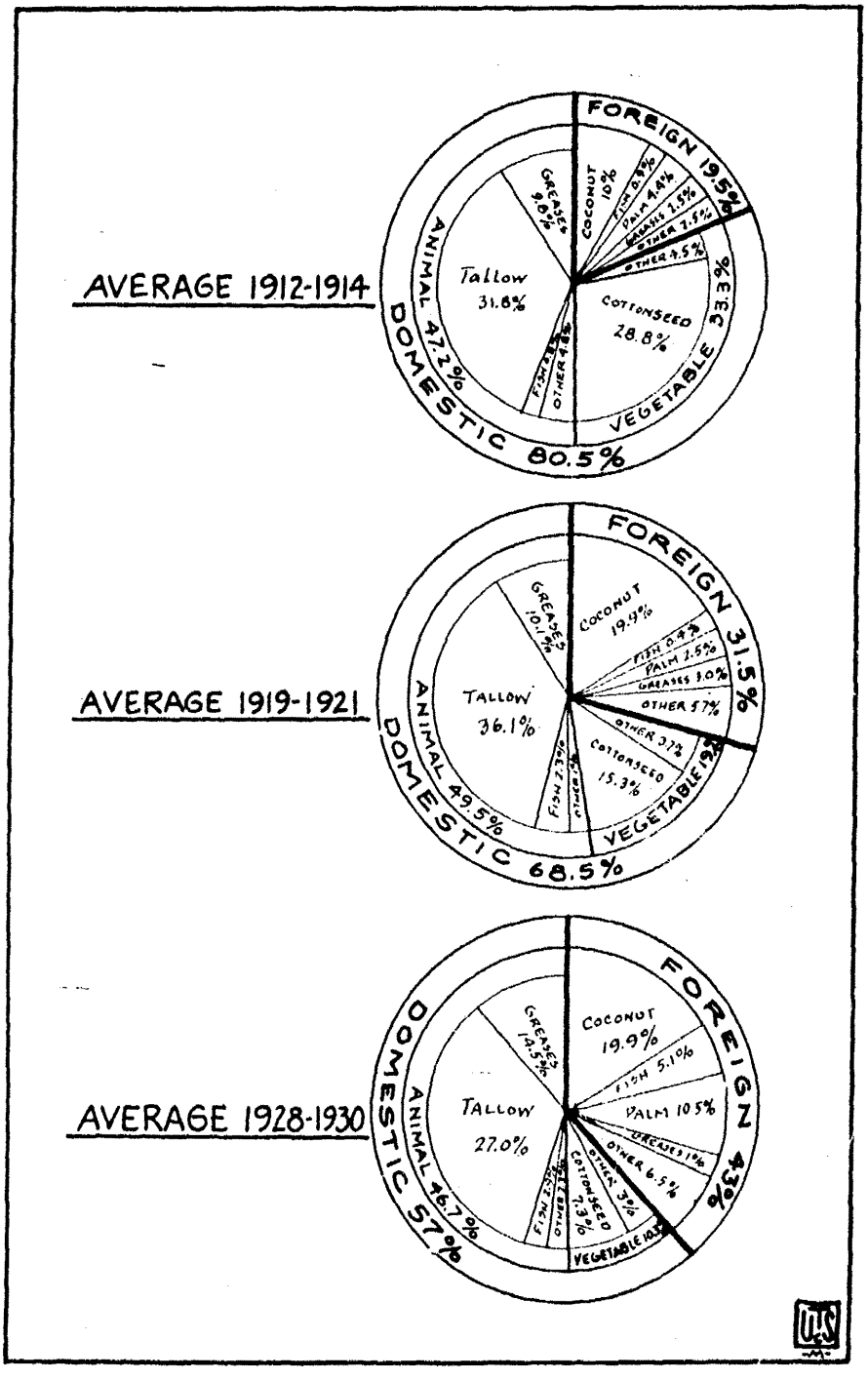
(4) *Cleansing properties.*—These may vary even among oils of similar lather.

(5) *Effect on the skin.*—Soaps made from some oils are pleasant to the skin; others are harsh and irritating.

(6) *Color.*—As already has been noted, white soaps are at present in greatest use both for toilet and for laundry. But other colors, particularly green, red, and yellow, are widely used in cake and bar soaps. Most laundry chips, flakes, beads, granules, and powders are white or buff.

CHART IV

SPECIFIED VEGETABLE OILS, WHALE OIL, AND COPRA: — PERCENTAGES OF DOMESTIC AND FOREIGN OILS CONSUMED IN SOAPMAKING.



(7) *Odor.*—Care must be taken to prevent soap having a high and objectionable odor.

(8) *Keeping qualities.*—Soaps made from some oils tend to keep well, others become rancid quickly.

(9) *Other qualities.*—In selecting oils for soap making, the manufacturer must consider also such technical matters as the percentage of glycerin recoverable, the ease of saponification, and the amount of processing required before saponification. Technical differences of this sort result in differences in the cost of soap manufacture, and cost is a factor affecting the economic interchangeability of oils in the soap industry.

Classification of oils used in soap making.

With respect to the first three properties listed above soaps may be classified into three general groups as follows:

(1) *Hard oils which yield quick-lathering soap.*—Hard oils are those solid at ordinary room temperature. Only two commercially available oils of this type, coconut and palm-kernel, yield quick-lathering soap.

(2) *Hard oils which yield slow-lathering soap.*—These include tallow, animal greases, palm oil, and hydrogenated whale oil and fish oils.

(3) *Soft vegetable oils.*—Although showing considerable diversity in soap-making qualities, the soft vegetable oils, liquid at ordinary room temperatures, make soap of a softer texture than that made from hard oils of either type and intermediate between the two types in lathering qualities. The characteristics of the individual oils of this class—cottonseed, corn, soybean, peanut, and inedible olive oils and cottonseed-oil and olive-oil foots—will be more fully discussed later.

Table 121 comparing the consumption of each of these three groups of oils in soap manufacture, indicates an increase from 1912 to 1929 amounting to 317 per cent in hard oils which yield quick-lathering soap, and of 171 per cent in hard oils which yield slow-lathering soap. The use of soft oils, however, declined 16 per cent. In proportion, their decline was much greater, from 35 to 13 per cent of the total consumption of oils in soap making. Chart V shows the same data graphically.

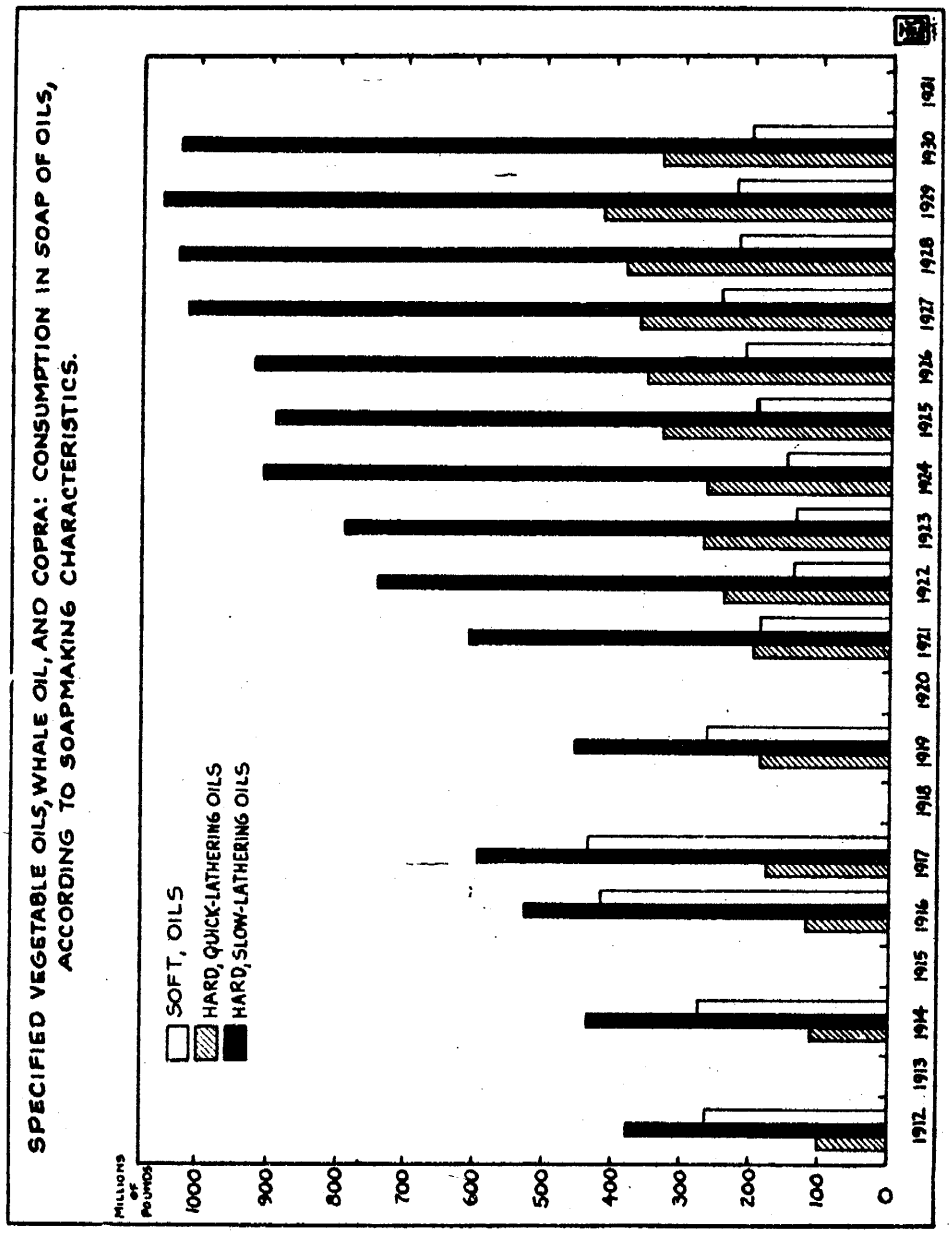
TABLE 121.—*Consumption in soap of oils according to soap-making characteristics*

Calendar year	Hard oils making quick-lathering soaps			Hard oils making slow-lathering soaps			Soft oils		
	Imported	Domestic	Total	Imported	Domestic	Total	Imported	Domestic	Total
	In millions of pounds								
1912	100	.....	100	33	345	378	7	256	263
1914	109	.....	109	39	395	434	12	263	275
1916	117	.....	117	46	482	528	68	346	414
1917	174	.....	174	121	474	595	141	292	433
1919	188	.....	188	68	388	456	65	198	263
1921	196	.....	196	51	557	608	28	159	187
1922	239	.....	239	101	641	742	23	115	138
1923	271	.....	271	179	613	792	31	102	133
1924	264	.....	264	141	769	910	35	112	147
1925	331	.....	331	195	697	892	51	141	192
1926	354	.....	354	208	715	923	55	154	209
1927	366	.....	366	229	787	1,016	50	194	244
1928	386	.....	386	271	758	1,029	51	169	220
1929	417	.....	417	312	740	1,052	59	163	222
1930	332	.....	332	291	735	1,026	55	147	202
	Percentages								
1912	13.4	.....	13.4	4.4	46.7	51.1	1.0	34.5	35.5
1914	13.4	.....	13.4	4.7	48.1	52.8	1.6	32.2	33.8
1916	11.1	.....	11.1	4.3	45.6	49.9	6.4	32.6	39.0
1917	14.4	.....	14.4	10.1	39.4	49.5	11.7	24.4	36.1
1919	20.6	.....	20.6	7.4	43.0	50.4	7.1	21.9	29.0
1921	19.7	.....	19.7	5.2	56.3	61.5	2.8	16.0	18.8
1922	21.3	.....	21.3	9.0	57.3	66.3	2.2	10.2	12.4
1923	22.7	.....	22.7	15.0	51.2	66.2	2.7	8.4	11.1
1924	20.0	.....	20.0	10.7	58.1	68.8	2.7	8.5	11.2
1925	23.4	.....	23.4	13.7	49.2	62.9	3.7	10.0	13.7
1926	23.8	.....	23.8	13.6	48.6	62.2	3.7	10.3	14.0
1927	22.5	.....	22.5	14.1	48.4	62.5	3.1	11.9	15.0
1928	23.6	.....	23.6	16.7	46.3	63.0	3.1	10.3	13.4
1929	24.6	.....	24.6	18.5	43.7	62.2	3.6	9.6	13.2
1930	21.3	.....	21.3	18.7	47.1	65.8	3.5	9.4	12.9

List of oils technically available for soap making.

Soap can be made from any animal or vegetable oil but in practice the soap maker is restricted to those available regularly in large quantities and at moderate prices, and to those possessing, to a fair degree at least, solubility, lathering, and detergent qualities. The figures in Tables 115 to 120 indicate that domestic soap makers in the

CHART V



last two decades have confined themselves largely to inedible tallow, coconut oil, animal greases, palm oil, cottonseed oil, and cottonseed-oil foots. The relative importance of each of these oils has changed considerably, but together they have supplied about the same percentage of the total consumption of soap oils at both the beginning and the end of the period, 82 per cent in 1912 and about 79 per cent in 1929. Other oils used in appreciable quantities were olive-oil foots, palm-kernel oil, soybean oil, whale oil, fish oils, and red oil.

Oils of less importance separately shown were inedible olive oil, peanut oil, vegetable tallow, corn oil, and lard. Castor oil, linseed oil, sesame oil, and sunflower oil should be added. The list would then read as follows, the oils in each group being listed in the approximate order of their importance in soap making in recent years.

Hard oils which yield quick-lathering soap	Hard oils which yield slow-lathering soap	Soft vegetable oils and foots
Exclusively domestic: None	None	Cottonseed oil foots, cottonseed oil, corn oil.
Principally domestic: None	Inedible tallow, greases, lard	Soybean oil, peanut oil.
Exclusively foreign:		
Coconut oil	Palm oil	Olive-oil foots.
Palm-kernel oil	Vegetable tallow	Inedible olive oil, sesame oil, sunflower oil, castor oil.
Principally foreign: None	Whale oil, hydrogenated	
About equally divided between domestic and foreign: None.	Fish oil, hydrogenated	Linseed oil.

Under present conditions not all or even the greater number of the oils included in the list given are available in any considerable quantity to the domestic soap makers. The list contains three classes of oils: (1) Those used to a considerable extent at some time in the last two decades, (2) those used to a minor extent in the same period, and (3) those which might be used in future should conditions change materially. The discussion of interchangeability can not be confined to oils actually used in substantial quantities in soap manufacture any more than it can be extended to include fats, like butter, entirely unavailable economically.

Of the oils made from foreign materials included in the list, five—coconut, palm, palm-kernel, sesame, and whale oil—are named in the resolution pursuant to which this report is made. To them and to the competitive, or potentially competitive, domestic oils attention will hereafter be chiefly confined.

Oils made of foreign materials but not mentioned in the resolution do not come directly into the purview of this investigation. These latter include:

1. Olive oil, edible and inedible, which enters to a small extent into the manufacture of high-grade toilet soaps, particularly castile soap. Olive oil is one of the few oils which, used alone, makes a good soap. By reason of its high price, however, the total quantity entering into soap manufacture in the United States forms less than 1 per cent of the consumption of all oils in soaps.

2. Olive-oil foots are also used in making textile and toilet soaps. They are used in toilet soaps, largely in combination with coconut oil and palm oil, and impart an attractive green color. As shown by Table 117, their use has been increasing and they now represent 2 to 3 per cent of the consumption of oils in soap manufacture.

3. Vegetable tallow, which is finding increased use but is still less than 1 per cent of total consumption.

4. Sunflower oil, which has been used in the United States to a very limited extent in soap making. So far as can be learned no sunflower oil has been produced in the United States.

5. Castor oil, hitherto imported or made in the United States entirely from imported castor beans, is used in the manufacture of transparent soaps and certain soaps for use in the textile trade. The quantity of castor oil used in soap making has not been separately recorded but is doubtless small.

Oils included in formulas for production of different types of soap.

The art of soap making lies largely in the selection and the proper blending of oils to produce the qualities desired. Sometimes these qualities may be produced by the use of one oil, as for example, olive oil for castile soap and coconut oil for soaps which will lather well in salt or other hard water. But most soaps are made by blending two or more oils. For example, coconut oil and tallow blended together make a soap which lathers more quickly and more abundantly than an all-tallow soap, also which has a closer, firmer, more durable lather than an all-coconut-oil soap.

There follows a discussion of the character of the blends in most general use in the United States in the manufacture of soaps of different types.

Toilet and general household soaps.—Soaps for toilet and general household use are made in great variety. Specialties are, however, omitted from this discussion, which is confined to types produced in large volume.

In the United States white soaps have increasingly predominated in toilet uses. Most of them have as a basis a combination of tallow and coconut oil. Ordinarily coconut oil forms from 15 to 33 per cent of their total oil content—in instances, however, as low as 10 per cent, and in others, particularly in soaps specially designed for use in regions having very hard water, as high as 40 or 50 per cent. Tallow often constitutes the entire remainder, but often other ingredients are included. Some manufacturers use hydrogenated whale and fish oils up to one-third of the noncoconut oil content. Many also use a small percentage of high-grade grease to increase the softness and to improve the texture of the soap.

The colored toilet soaps most widely used are made with about the same combination of oils, except that tallow is frequently replaced in whole or in part by palm oil, and that there is frequently a considerable admixture of olive-oil foots or, in high grades, of inedible olive oil.

White laundry bar soaps.—White bar soaps for laundry use are made from a blend of oils containing 30 to 60 per cent coconut oil, usually from 40 to 60 per cent. The proportion of coconut oil varies according to whether for household or public laundry, according to the hardness or softness of the water in which the soap is to be used, and according to the character of the other oils in the blend. The other oils used in the blend vary from time to time according to price and from firm to firm according to the location of the firm and its business connections. Tallow is probably the largest other ingredient, but considerable quantities of white grease and of hydrogenated whale oil and fish oils are used. Some distilled fatty acids—usually from cottonseed-oil foots—and some cottonseed oil are also used. Cottonseed oil formerly was more widely used than now, white laundry bars often being made, exclusively as far as oil content was concerned, of it and of coconut oil.

As a rule, white laundry soaps contain a considerable admixture of a solution of sodium silicate, amounting often to from 30 to 40 per cent [6] of the weight of the soap. Sodium silicate is a detergent and

[6] One authority states that on the average anhydrous sodium silicate forms about 14 per cent of the weight of white laundry soaps. In dilution ordinarily used this would make a solution equal to about 37 per cent of the weight of white laundry soap.

a water softener and acts to retard the development of rancidity in soap.

White laundry flakes, chips, and granules.—Soaps grouped under this heading are for use in household and in public laundries. Those for household use have much the same constituent materials as white laundry bar soaps, except that they contain somewhat less coconut oil and sodium silicate; the coconut content sometimes falls to 20 per cent and the solution of sodium silicate to 15. Those for use in public laundries frequently contain as high as 100 per cent of tallow. Laundries prefer soaps with a close lather composed of small bubbles. The high temperature at which they operate makes it possible for them to use a finely divided all-tallow soap.

Yellow laundry bar soaps.—The rosin content of yellow laundry bars is from 5 to 25 per cent; usually from 15 to 20 per cent, of the combined rosin and oil content. The largest oil ingredient usually is either low-grade tallow or palm oil which, for this purpose, are interchangeable. The next most common ingredient is grease, but hydrogenated whale and fish oils are also used. Formerly considerable quantities of cottonseed oil were also used. Rosin alone makes a soft, sticky soap; the more rosin included in the mix, the less the cottonseed oil and grease and the more (or harder) the tallow, or the palm oil which must be used.

Some manufacturers use a very small proportion of coconut oil to improve the lathering qualities of yellow laundry soaps; others use none at all. Sodium silicate is practically always an ingredient but is used in a much smaller proportion than in white laundry soap.

Shaving creams.—Most shaving soaps contain mainly coconut oil, tallow or palm oil, or both, and stearic acid to insure a lasting lather. Some of them also contain olive oil or olive-oil foots.

Textile soaps.—The manufacture of textile soaps (i. e. soaps used in textile manufacturing industries) carried on by about 20 concerns, is to a large extent a separate industry. The main uses of these soaps are (1) in scouring wools and wool products; (2) in fulling wool cloth; (3) in degumming silk; (4) in cleansing cotton cloths before, during, and after dyeing; and (5) in calico printing. In soap for fulling, palm oil or tallow is used but palm oil is preferred and ordinarily is the principal ingredient. As a rule, some coconut oil is added to help "carry the suds" along. A small proportion of cottonseed oil is sometimes used in good grade fulling soaps; in lower grades it often forms a substantial proportion. In making soaps for degumming, olive oil and olive-oil foots are the materials mostly used, but considerable quantities of palm oil, red oil, coconut oil, and, for low grades, cottonseed-oil foots are now used. Manufacturers state that for ordinary grades of textile soaps, cottonseed oil, soybean oil, and corn oil can be used only sparingly, as they are semidrying oils, and the suds of soaps made from them are difficult to rinse out. When not entirely rinsed out they tend to become rancid and to impart to the cloth a cloudiness, stickiness, and odor.

Technical position of specific oils in soap making.

In the foregoing discussion the ordinary practice of domestic soap makers is outlined. But this practice is influenced by economic as well as technical factors and would have been different under different

economic conditions. At this point, however, economic considerations may be disregarded and the discussion confined to the technical suitability of specific oils for soap making; that is, to the question of what oils would be used in making the various soaps, if they were freely obtainable at the same price.

The data in Table 122 and the information on page 144 and following indicate the problems connected with the question of the interchangeability of coconut, palm-kernel, palm, whale, and sesame oils with oils made in the United States from domestic materials. For these five oils and for the principal oils made from domestic materials included in the list on page 142, Table 122, shows the melting point, titre, iodine value, saponification value, ease of saponification, and average yield of glycerin. The tabulation on page 143 gives information as to the characteristics—such as consistency, color, odor, and lathering and cleansing properties—of the soap made from each oil.

TABLE 122.—*Physical and chemical characteristics of certain oils*

[Source: J. Lewkowitsch, Chemical Technology and Analysis of Oils, Fats, and Waxes]

Oil	Melting point	Titre	Iodine value	Saponification value	How saponification takes place	Amount of crude (80 per cent) glycerin recoverable
						Per cent
Coconut	23–27	22–25	8–10	225–268	Very quickly with evolution of much heat.	18
Palm-kernel	23–30	20–25	10–17	242–254	do	18
Tallow	40–48.5	38–48	35–47½	193–200	With difficulty	12.5
Bone grease		39–41	45–56	191–195	do	12.5
Palm	27–42.5	35–45	53–57	196–205	Very easily	
Cottonseed	[1] 3–4	32–35	101–120	191–194	Fairly easily	13.0
Sesame	[1] −6–4		103–115	188–193		
Corn	[1] −15–10	19	121–131	180–193		
Soybean	[1] −15–8	21	124–143	191–193	Fairly easily	13.0
Whale			110–136	188–194	Very difficult when hydrogenated	12.5
Fish (menhaden)	[1] −4		139–193	189–193		
Fish			103–142	179–194		

[1] Solidifying point.

Characteristics of the soaps made from certain oils

[Source: E. T. Webb, Modern Soap and Glycerine Manufacture, p. 6]

Oil	Consistency	Color	Odor	Lather	Cleansing properties	Action on the skin	Type of soaps in which ordinarily used
Coconut	Extremely hard	Pale yellow to white.	Very slight	Quick, foamy, large bubbles, not lasting.	Excellent	Irritating to some skins.	Almost all sorts.
Palm-kernel	do	do	do	do	do	do	Do.
Tallow	Very hard	Pale buff to white	Scarcely perceptible.	Slow, thick, lasting	Good	Very mild	Do.
Bone grease	Hard	Dark yellow to dark brown.	Slightly offensive	do	do	Mild	Household.
Bleached palm	Very hard	Buff	Original oil	Medium to slow, close, lasting.	Very good	Very mild	Almost all sorts.
Cottonseed	Medium to soft	Buff to bright yellow.	do	Quick, abundant, thick, and greasy, medium, lasting.	Good	do	Laundry, household.
Soybean	Soft	Pale yellow to dull white.	do	Abundant, greasy, medium, lasting.	Fair	Mild	Household and laundry.
Hydrogenated whale oil and fish oils.	Exceptionally hard.	White	Peculiar to hardened fats.	Very slow, close, lasting	do	Very mild	Do.

Coconut and palm-kernel oils.—Coconut and palm-kernel oils are, roughly speaking, interchangeable, but most soap makers express a slight preference for coconut oil because it has less odor and is whiter. Both of them are specially valuable because they impart to soap the combination of hardness, of being easily soluble, and of lathering quickly and profusely. All other commercially available oils, such as tallow and palm oil, capable of hardening the soap into which they enter, go into solution with difficulty and lather slowly. Coconut and palm-kernel oils, moreover, yield a white soap of a pleasing odor, with high cleansing power. Nevertheless, for most purposes they make less satisfactory soap when used alone than when mixed with other oils. This is true because the lather of all coconut-oil soaps, although quick and abundant, is foamy, dries quickly, and sometimes has an irritating effect on sensitive skins.

In making many types of soap, now in strong demand, coconut (or palm-kernel) oil can be omitted or greatly reduced only by lessening either hardness or solubility and lather. In most toilet soaps it has been used by domestic manufacturers for many years, and in practically all grades of toilet soap (except all-olive oil castile soap) now being made it is used to a substantial extent. Coconut oil is an even more important ingredient in the production of dual-purpose, or household soaps, of white laundry bar soaps and of flakes, granules, and beads to be used in cold or moderately warm water. It, however, can be left out entirely in the manufacture of soaps to be used only in very hot water, such as those for exclusive use of public laundries. It is also used only to a small extent, or not at all, in the production of yellow laundry soaps containing rosin, and of soap powders for scrubbing purposes.

Although coconut oil (or palm-kernel) is an important ingredient in most types and grades of soaps now on the market, it is used in somewhat varying proportions by different manufacturers and in different types and grades by the same manufacturers. By varying, within limits, the other ingredients, approximately the same results may be obtained with somewhat more or less coconut oil. The tendency is for manufacturers to increase or decrease the amount of coconut oil used according to the price position of coconut oil with relation to other oils. The proportions of coconut oil used in the last decade probably do not represent the minimum for soaps of the grades and character now being made. If for any reason it should come to occupy a less advantageous price position, it seems likely that domestic soap manufacturers to some extent would economize in its use. Whether the quantity of coconut oil used could be reduced to its pre-war proportion of the total consumption of oils in soap manufacture, without at the same time changing materially the character of the soap produced, is problematical. Before the war, the industry as a whole used about 12 per cent of coconut and palm-kernel oils; in recent years it has used about 24 per cent. This increase has been due partly to changes in the kinds of soap demanded by consumers and partly to the economic factors which have given to coconut oil a favorable price position with reference to oils which might be partially substituted for it.

What would happen if coconut oil and palm-kernel oil increased materially in price as compared with competing oils is that the soap makers, wherever possible, would change their formula so as to reduce the use of these oils as much as could be done without altering notice-

ably the character of their product, particularly if it were a widely advertised trade-marked article. Something as to the general direction of the changes which would be necessary to accomplish this reduction will be indicated in the discussion of the technical position of other oils in soap making. The tendency also would be strong for the soap maker to "push" by advertising and otherwise those varieties of soap requiring least coconut oil. Should the change in the price position of coconut oil be great, yellow laundry soaps might regain, particularly in soft-water districts, some of the ground lost to white laundry soaps, and should it be extreme, a radical change might result in the character of soaps produced, in order to reduce costs by lessening the use of coconut oil.

Tallow and grease.—Tallow is more extensively used in soap making than is coconut oil, and may be said to form the base of most toilet, general household, and white laundry soaps produced in the United States. When used alone, it makes a hard, firm, white soap, of good detergent qualities and slow solubility—except in very hot water—and with a very slow but thick and lasting lather. Soaps made from grease, in general, resemble those made from tallow, except that they are somewhat softer, more soluble, usually darker in color, and more apt to become rancid.

Practically all the oils discussed in the pages that follow are more or less interchangeable with tallow or coconut oil, or with both. Only within narrow limits, however, can tallow and grease be substituted for coconut oil without altering the character of the resulting soap. To a small degree this substitution may sometimes be accomplished without any other change in formula; to a greater but still limited extent it may be accomplished by using less tallow and more grease or by using a different grade of tallow.[6] But more important than their restricted interchangeability is the fact that tallow and coconut oil supplement each other with respect to solubility and lather, and together make a much better soap than does either of them separately. In combination they yield a soap quickly soluble and with a lather which is dense and lasting. In consequence, most soaps produced in the United States are made mainly, and many of them entirely, from tallow and coconut oil.

Palm oil.—Palm oil makes a slightly harder soap than does tallow but one soluble at a lower temperature and forming a less dense lather. These differences are so small, however, that in making colored soaps, except those of the characteristic palm-olive color, the two oils are often regarded as completely interchangeable. Most soap makers probably prefer tallow but not many would pay a much higher price for it, except for white soaps, in which little palm oil is used. The color of palm oil can not be completely removed except by the most drastic treatment and at considerable cost. This greatly limits its interchangeability with tallow, for manufacturers having a trade in white soaps can not, at will, shift to colored soaps. This is particularly true of trade-marked and nationally advertised brands.

As shown in Table 117, page 130, the proportion of palm oil used in soap manufacture rose from about 1 per cent before the World War to more than 10 per cent in 1929. The question whether this increase may be regarded as in replacement of domestic tallow or supple-

[6] The substitution of white for yellow laundry soaps not only involves substitution of coconut oil for rosin but to some extent also for tallow and grease.

mentary to it must be postponed until the economic factors affecting interchangeability are considered.

Hydrogenated whale oils.—Unhydrogenated whale oil may be used to a considerable extent in the production of cheap soft soap for uses in which considerable odor is not objectionable. But hydrogenation which was put on a commercial basis in the period just preceding the World War, has made possible the use of whale oil in ordinary grades of hard soaps. Hardened by hydrogenation, whale oil ranks for soap making in the same general class as tallow and palm oil, and in the industry is considered a substitute for tallow; the resultant soap, however, is harder and lathers less easily and less abundantly than does tallow. In ordinary grades of laundry and general household soap, it may take the place of a substantial part of the usual tallow content. In soaps of some grades, the substitution for tallow may be almost complete if some soft oil, such as cottonseed, corn, sesame, or soybean, is blended with it.

As with palm oil, the question whether the increased use of whale oil (see Table 120, p. 132) may be regarded as replacing domestic tallow or as supplementing it depends on judgment as to the economic factors affecting interchangeability.

Hydrogenated fish oil.—Hydrogenated fish oil has approximately the same soap-making characteristics as hydrogenated whale oil. As a substitute for tallow there is not much preference between the two, although the consistency of fish oil is said to be somewhat inferior to that of whale oil.

Hydrogenated vegetable oils.—None of the soft vegetable oils available to the domestic soap manufacturer have been cheap enough, in comparison with other oils, to make it possible economically to hydrogenate them for use in soap manufacturing. The industry therefore has had little or no commercial experience in the use of hardened vegetable oils. Soap makers in a position to judge, however, think that their soap-making qualities would be somewhat similar to those of hardened whale and fish oils, and that they could, as far as technical factors are concerned, be used to a considerable extent as substitutes for tallow. The oils discussed on succeeding pages are the ones most likely to be hydrogenated.

Cottonseed oil.—Cottonseed oil, which is a semidrying oil, makes a somewhat softer soap than any of the oils so far discussed but one with greater solubility and better lathering qualities than any oil except coconut and palm-kernel. Its lather is quick, abundant, thick, and fairly lasting—much more lasting than that of coconut-oil soap. Alone and unbleached, it makes a yellowish soap. Bleached and mixed with tallow and/or coconut oil, it makes a fairly white soap. Cottonseed oil, however, has a tendency toward rancidity, which, even with the utmost care, can not be entirely overcome. This has prevented its use, to any considerable extent, in toilet soaps, but is no bar to its use in white laundry soaps, in which the larger admixture of sodium silicate acts as a preservative. At any rate, for such soaps, cottonseed oil substitutes not only for tallow, greases, and palm oil, but also to some extent for coconut oil. The partial or complete substitution of bleached cottonseed oil for tallow makes it possible to reduce the quantity of coconut used in white laundry soaps. Coconut oil and cottonseed oil together, in about equal propor-

tions, make a satisfactory white laundry soap without the admixture of any other oil but with the usual admixture of sodium silicate.

All that has been said refers to unhardened cottonseed oil. That the technically possible uses of cottonseed oil in soap making have been increased by the hydrogenation process seems certain, but so far its price has been too high as compared with other oils to permit it to be hardened for use in soap making. Moreover, changes in its economic position rather than any lack of suitability for soap making are the principal cause of the decline in its use in the unhydrogenated condition in the soap kettle.

Corn and sesame oils.—Technically, corn and sesame oils have about the same soap-making qualities as cottonseed oil, which, like them, is a semidrying oil. They make a soap of relatively soft texture, with a slight tendency to oxidize and become rancid. They may be used unhydrogenated or hydrogenated anywhere that cottonseed oil is used. That these oils are little used in soap making has been due to economic rather than technical causes.

Soybean oil.—Soybean oil is a drying oil which may, to some extent, be substituted for linseed oil in paints and varnishes. Being more highly unsaturated, it oxidizes more rapidly and has a greater tendency to rancidity than the semidrying cottonseed, corn, and sesame oils. These qualities are in some measure carried over into soap made from it, as are also its persistent color and odor, which without hydrogenation can be removed only with great difficulty and at considerable expense. For these reasons soybean oil is not so well liked as cottonseed oil for soap making purposes. Nevertheless it is an acceptable material for laundry soaps, in which it may form a substantial but limited proportion of the oil content. It will, in fact, be used in such soaps whenever it is available at a price sufficiently lower than any of the soft oils so far discussed to more than offset the higher cost of preparing it for the soap kettle.

As shown by the statistics in Table 117, page 130, imported soybean oil supplied from 5 to 10 per cent of the consumption of oils in soap making in the World War period; before the war and since 1919 much less than 1 per cent. Its use during the war was due to its relatively low price at that time. Its small use since that time has been due to its higher relative price position, partially as a result of the imposition of a duty in the emergency tariff act of 1921 and to the continuance of a duty in the acts of 1922 and 1930.[7]

The shortage created by the practical disappearance of soybean oil from the soap kettle and by the great decrease in the use of cottonseed oil, which occurred concurrently, was filled in part by a number of oils, and the shift involved substantial changes in soap formulas. These changes made possible the increased use of tallow, grease, palm oil, whale oil, fish oils, and to some extent, coconut oil.

Linseed oil.—Linseed oil is a stronger drying oil than soybean oil and is the principal one used in paints and varnishes. Because of its odor and oxidizing tendencies, it is even more difficult to use in hard soaps, but where available at a very low price as compared with other oils, it is used. In Europe it has a considerable use in the making

[7] In reply to the question as to whether a reduction in the tariff on soybean oil would lead to its increased use in soap making, a witness for the soap industry testified at the hearing in May, 1926, in the investigation of vegetable oils under section 315 of the tariff act of 1922, as follows: "I should say it would depend entirely on the matter of price and if my knowledge of the industry serves me right, it would go back into the soap kettle." Hearings of the Tariff Commission in the investigation of the cost of production * * * with respect to vegetable oils (sec. 315, Doc. 34, 1939), testimony of F. N. Barnes, June 26, 1926.

of soft soaps, and in this country a slight use in the making of transparent and other special soaps.

Peanut oil.—Because of price, peanut oil has never been extensively used in soap making in the United States, and as a rule only in off grades. It is a good soap making oil, however, and is used to some extent in Europe, particularly in making Marseilles soap. According to authorities on the subject, it makes a harder and slower lathering soap than olive oil.[8]

3. OILS IN THE MARGARINE INDUSTRY

General position of margarine.

Margarine, a mechanical mixture of certain oils and fats emulsified in milk, is used as a substitute for butter. Its manufacture and sale in the United States are strictly regulated by State and Federal laws. Under the present Federal law it must be sold under the designation "oleomargarine," and must pay a Federal tax of one-fourth cent per pound if not yellow in color, or 10 cents per pound if yellow in color. Under the act of 1902 the 10-cent tax applied only to margarine artificially colored; all other margarine, including that made of naturally yellow materials, took a tax of one-fourth cent per pound. Under that act most of the margarine produced was white or buff, but in 1930 there was a wide-spread movement in the industry to produce margarine of a natural yellow, using palm, soybean, and yellow oleo oils for the purpose. This movement led to an amendatory act in 1931, applying the 10-cent tax to margarine naturally as well as artificially yellow, or of a "tint or shade containing more than 1.6 degrees of yellow, or of yellow and red collectively, but with an excess of yellow over red, measured in terms of the Lovibond tintometer scale or its equivalent." In effect, this amendatory act requires margarine to be practically white, if it is to escape the higher tax.

In general, three types of margarine may be distinguished:

(1) Margarines made entirely from vegetable oils, except for the small admixture of milk and of nonoleaginous material. Many of these are usually sold under the trade designation of nut oleomargarine, and when so sold are supposed to be made entirely of nut oils. The "oleo" in the title is required by law, although it is not at all applicable to a margarine made entirely of vegetable oil.

(2) Margarine made entirely of animal oils. This type was the original margarine, but none of it has been produced in the United States since 1925.

(3) Margarine made predominantly of animal oils but with an admixture of soft vegetable oil. This type has entirely superseded margarine made wholly of animal oils.

Trend of margarine production in the United States in quantity and kind.

Table 123 shows the annual production of margarine in the United States, by classes. Chart VI traces the trends graphically. The data indicate an almost threefold increase from 1912 to 1930 in the domestic production of margarine. This increase was, however, almost entirely in vegetable-oil margarines, which rose from 1,900,000 pounds in 1916 to 222,000,000 pounds in 1929. At the same time

[8] E. T. Webb, Modern Soap and Glycerine Manufacture, p. 6.

the production of animal-oil margarine, containing an admixture of vegetable oils, decreased from 184,000,000 pounds to 121,000,000 pounds, and that of margarine made exclusively of animal oils ceased entirely. In 1916 the vegetable-oil variety was less than 1 per cent of production; by 1929 it had risen to 65 per cent.

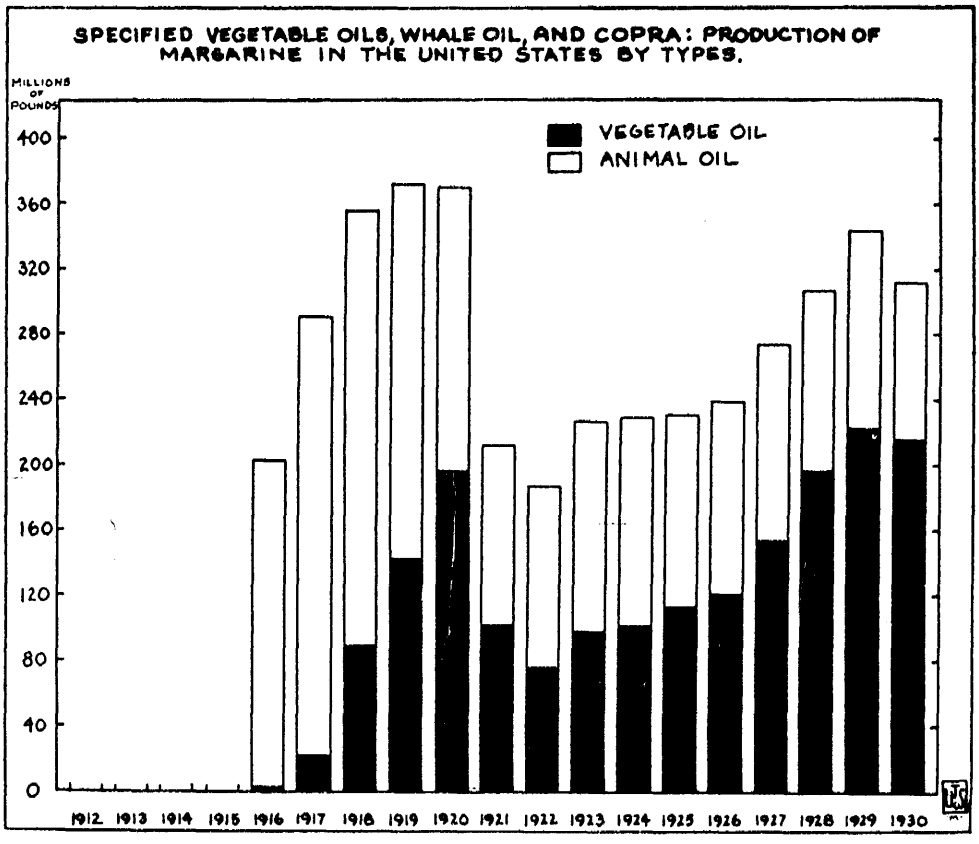
TABLE 123.—*Production of margarine in the United States by classes* [1]

[Quantity in thousands of pounds]

Calendar year	Total quantity	Vegetable-oil or nut margarine		Animal-oil margarine			
		Quantity	Per cent of total	Exclusively animal oil		With admixture of vegetable oils	
				Quantity	Per cent of total	Quantity	Per cent of total
1912	128,601	----	----	----	----	----	----
1914	144,021	----	----	----	----	----	----
1916	202,444	1,942	0.95	16,038	7.93	184,464	91.12
1917	290,903	21,804	7.50	7,700	2.65	261,399	89.85
1918	355,537	88,974	25.02	4,310	1.21	262,253	73.77
1919	371,317	142,699	38.43	4,556	1.22	224,062	60.35
1920	370,163	195,639	52.84	3,937	1.07	170,587	46.09
1921	211,867	101,291	47.81	654	.30	109,922	51.89
1922	185,075	75,510	40.80	304	.16	109,211	59.04
1923	225,578	96,779	42.90	450	.20	128,349	56.90
1924	229,031	101,130	44.15	413	.18	127,488	55.67
1925	230,611	112,705	48.87	74	.04	117,832	51.09
1926	238,594	121,149	50.78	----	----	117,545	49.22
1927	272,602	153,623	56.35	----	----	118,979	43.65
1928	307,934	196,314	63.75	----	----	111,620	36.25
1929	342,230	221,632	64.76	----	----	120,593	35.24
1930	311,755	215,879	69.25	----	----	95,876	30.75

[1] Compiled from data from the Bureau of Agricultural Economics, Department of Agriculture.

CHART VI



Oils used in margarine.

Table 124 shows, for specified fiscal years from 1914 to 1930, the quantity, both absolute and relative, of the different edible materials in margarine manufacture, in total and classified as (1) vegetable oils, (2) animal oils (except butter and milk), (3) butter, and (4) milk. Chart VII traces graphically the trend of consumption with respect to the total and with respect to animal oils and vegetable oils. As would be expected from the increased production of vegetable-oil margarines and the decreased production of animal-oil margarines (shown in Table 123), the consumption of vegetable oils rose from 29,697,000 pounds in 1914 to 222,765,000 pounds in 1930 at the same time that the consumption of animal oils fell from 86,165,000 pounds to 72,428,000 pounds. The proportion of vegetable oils used in the industry rose from 19 to 56 per cent, while that of animal oils fell from 56 to 18 per cent.

TABLE 124.—*Consumption in margarine of edible materials by major classes*

[Source: For 1914 to 1920, Institute of Margarin Manufacturers; for 1921 to 1931, Bureau of Internal Revenue]

Fiscal year	Total oils and fats	Butter	Fluid milk	Vegetable and animal oils and fats		
				Total	Animal except butter and milk	Vegetable
	In thousands of pounds					
1914	154,764	1,123	37,779	115,862	86,165	29,697
1916	189,246	2,152	21,343	165,751	107,454	58,297
1917	275,626	3,316	24,498	247,812	146,734	101,078
1918	338,603	4,548	61,128	272,927	153,047	119,880
1919	372,007	5,680	68,000	298,327	152,037	146,290
1920	387,708	6,845	76,000	304,863	136,248	168.615
1921	316,505	1,499	79,716	235,350	89,317	146.033
1922	217,671	1,107	53,039	162,625	78,186	84,439
1923	239,014	1,576	59,835	177,603	86,268	91,335
1924	273,786	1,000	69,090	202,796	92,572	110,224
1925	247,426	1,509	61,924	183,993	78,334	105,659
1926	287,033	2,330	72,662	212,041	81,346	130,695
1927	294,425	2,070	73,700	218,645	81,650	136,995
1928	336,053	2,484	83,115	250,454	77,976	172,478
1929	383,468	2,611	94,752	286,105	78,528	207,577
1930	395,562	2,616	97,753	295,193	72,428	222,765
1931	311,616	1,013	77,251	233,352	44,729	188,623
	In percentages of total consumption of oils and fats					
1914		0.7	24.4	74.9	55.7	19.2
1916		1.1	11.3	87.6	56.8	30.8
1917		1.2	8.9	89.9	53.2	36.7
1918		1.3	18.1	80.6	45.2	35.4
1919		1.5	18.3	80.2	40.9	39.3
1920		1.8	19.6	78.6	35.1	43.5
1921		.5	25.2	74.3	28.2	46.1
1922		.5	24.8	74.7	35.9	38.8
1923		.7	25.0	74.3	36.1	38.2
1924		.7	25.2	74.1	33.8	40.3
1925		.6	25.0	74.4	31.7	42.7
1926		.8	25.3	73.9	28.4	45.5
1927		.7	25.0	74.3	27.7	46.6
1928		.8	24.7	74.5	23.2	51.3
1929		.7	24.7	74.6	20.5	54.1
1930		.7	24.7	74.6	18.3	56.3
1931		.3	24.8	74.9	14.4	60.5

CHART VII

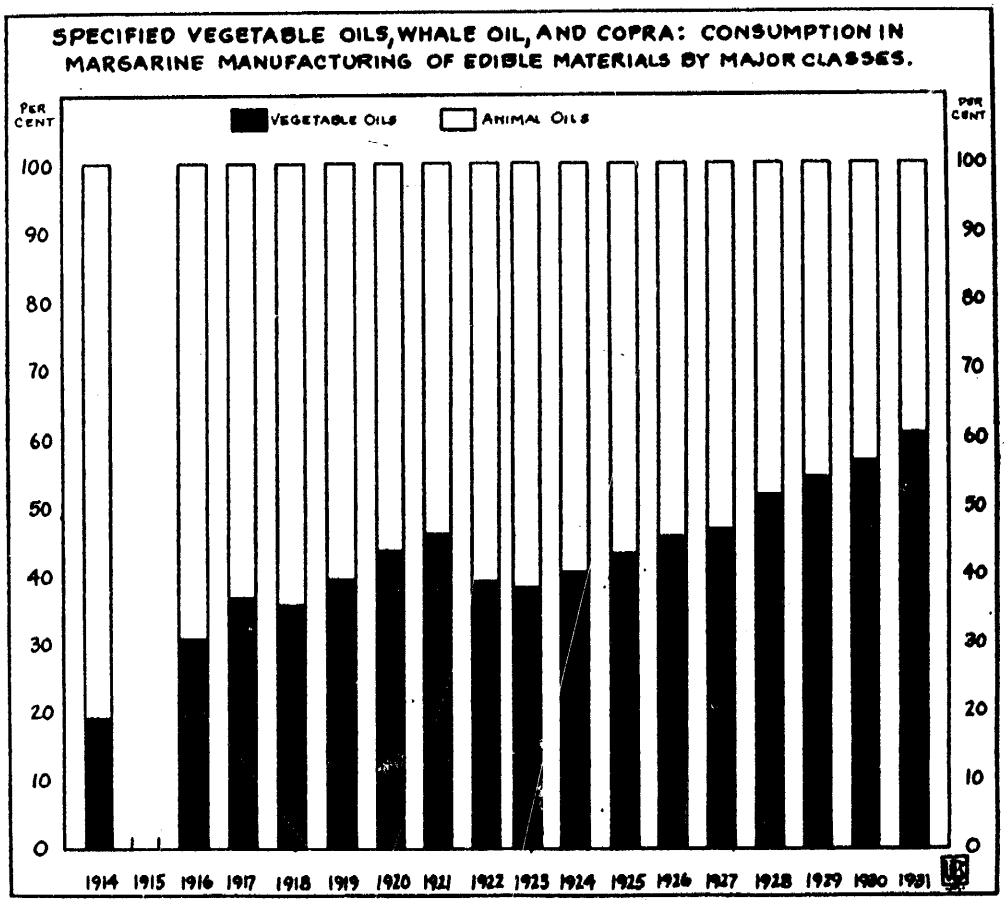


Table 125 carries the analysis further by showing the consumption of the principal individual vegetable oils in margarine manufacture. The figures indicate the declining importance of cottonseed oil and peanut oil, particularly cottonseed oil, and the increasing importance of coconut oil and of miscellaneous oils.

Table 126 is an analysis of the consumption of the minor vegetable oils in margarine. Taken together, these oils have in most years constituted less than 1 per cent of the total consumption of edible products in margarine manufacture.

Table 127 shows the consumption in oleomargarine of the principal animal oils (except butter and milk). It will be noted that the leading animal ingredient is oleo oil, followed in order by neutral lard, oleostearin, and oleo stock. Oleo stock when pressed yields oleo oil and oleostearin. Neutral lard is made from the leaf and back fat of hogs rendered at a low temperature.

TABLE 125.—*Consumption in margarine of specified vegetable oils*

Source: For 1914 to 1920, Institute of Margarin Manufacturers; for 1921 to 1931, Bureau of Internal Revenue]

Fiscal year	In thousands of pounds					In percentages of total consumption (except milk and butter) of oils in margarine			
	Coconut oil	Cotton-seed oil	Peanut oil	Miscel-laneous vegetable oils	Total	Coconut oil	Cotton-seed oil	Peanut oil	Miscel-laneous
1914	322	23,206	4,214	1,955	29,697	0.3	20.0	3.6	1.7
1916	563	49,959	5,335	2,440	58,297	.3	30.1	3.2	1.5
1917	19,614	63,497	10,493	7,474	101,078	7.9	25.6	4.2	3.0
1918	61,773	36,454	21,593	60	119,880	22.6	13.4	7.9	----------
1919	69,640	37,846	38,764	40	146,290	23.3	12.7	13.0	----------
1920	80,784	39,450	48,346	35	168,615	26.5	13.0	15.9	----------
1921	103,112	18,533	16,332	8,056	146,033	43.8	7.9	6.9	3.4
1922	57,394	15,420	11,625	----------	84,439	35.3	9.5	7.1	----------
1923	65,656	18,757	6,922	----------	91,335	37.0	10.6	3.9	----------
1924	83,059	20,640	5,656	860	110,224	41.0	10.2	2.8	.4
1925	79,449	20,966	4,392	852	105,659	43.2	11.4	2.4	.5
1926	98,307	25,608	5,257	1,523	130,695	46.4	12.1	2.5	.7
1927	107,654	23,372	4,872	1,087	136,995	49.2	10.7	2.2	.5
1928	141,000	24,801	5,459	1,218	172,478	56.3	9.9	2.2	.5
1929	171,411	28,173	6,617	1,376	207,577	59.9	9.8	2.3	.5
1930	185,066	30,213	5,714	1,772	222,765	62.7	10.2	1.9	.6
1931	155,954	22,037	5,291	5,341	188,623	66.8	9.4	2.3	2.3

TABLE 126.—*Consumption in margarine of miscellaneous vegetable oils*

[Source: For 1914 to 1920, Institute of Margarin Manufacturers; for 1921 to 1931, Bureau of Internal Revenue]

[In thousands of pounds]

Year [1]	Palm oil	Palm-kernel oil	Soybean oil	Corn oil	Sesame oil	All other oils
1912	----------	----------	708	----------	----------	197
1914	----------	----------	715	1	746	493
1916	----------	----------	2,123	147	----------	170
1917	----------	----------	6,570	858	----------	46
1918	----------	----------	----------	60	----------	----------
1919	----------	----------	----------	40	----------	----------
1920	----------	----------	----------	35	----------	----------
1921	----------	----------	461	926	----------	6,669
1922	----------	----------	----------	----------	----------	----------
1923	----------	----------	----------	----------	----------	----------
1924	----------	26	----------	457	348	38
1925	347	----------	----------	196	268	41
1926	861	268	1	174	186	34
1927	585	54	33	183	130	112
1928	955	129	----------	38	40	56
1929	1,349	15	----------	----------	----------	12
1930	1,101	3	619	1	----------	48
1931	2,773	----------	2,262	159	99	48

[1] Fiscal years except 1912, see Tariff Commission, Certain Vegetable Oils (Preliminary statement of information, 1926).

TABLE 127.—*Consumption in margarine of specified animal oils (except butter and milk)*

[Source: For 1914 to 1920, Institute of Margarin Manufacturers; for 1921 to 1931, Bureau of Internal Revenue]

Year [1]	Oleo oil	Oleo stearin	Oleo stock	Neutral lard	Miscellaneous (including edible tallow) [2]
	In thousands of pounds				
1912	28,145	906	92	14,794	16
1914	47,549	1,698	----------	23,287	3,631
1916	68,986	2,030	397	29,522	6,513
1917	95,933	2,459	3,458	38,566	6,318
1918	96,378	3,427	7,526	45,702	14
1919	97,464	2,456	6,342	45,764	11
1920	89,842	2,132	5,804	38,456	14
1921	49,676	4,858	2,065	29,268	3,450
1922	41,000	4,574	2,143	27,057	3,412
1923	46,645	4,815	2,322	29,508	2,918
1924	52,265	5,317	2,756	32,210	24
1925	44,102	5,250	3,183	25,674	125
1926	47,418	5,313	3,082	25,172	361
1927	48,741	5,144	2,552	24,872	341
1928	45,477	5,532	1,738	25,036	198
1929	47,185	5,834	1,294	24,189	26
1930	45,322	6,269	1,189	19,632	16
1931	28,040	5,484	1,025	10,180	----------
	In percentages of total consumption of oils used in margarine (except milk and butter)				
1914	49.7	1.5	----------	20.1	3.1
1916	41.7	1.3	----------	17.8	3.9
1917	38.7	1.0	1.4	15.6	2.6
1918	35.3	1.3	2.8	16.7	----------
1919	32.7	.8	2.1	15.4	----------
1920	29.4	.7	1.9	12.6	----------
1921	21.1	2.0	.9	12.5	1.5
1922	25.2	2.8	1.3	16.7	2.1
1923	26.3	2.7	1.3	16.6	1.6
1924	25.8	2.6	1.3	15.9	----------
1925	24.0	2.8	1.7	13.9	.1
1926	22.3	2.5	1.4	11.9	.2
1927	22.4	2.3	1.1	11.4	.2
1928	18.1	2.2	.7	10.0	.1
1929	16.5	2.0	.5	8.5	----------
1930	15.4	2.1	.4	6.7	----------
1931	12.0	2.4	.4	4.4	----------

[1] Fiscal years except 1912, see Tariff Commission, Certain Vegetable Oils, (Preliminary statement of information, 1926).

[2] May include negligible quantities of vegetable oils for some years.

Composition of different types of margarine.

In the preceding discussion little is said of the differences in the composition of vegetable oil and animal oil margarine. A statement of such differences will serve to illuminate the statistics which have been given.

Vegetable oil, or nut margarine.—The base of this type of margarine is always a hard vegetable oil—that is, one that is solid at ordinary room temperatures. Coconut oil is usually the base but sometimes the closely similar palm-kernel oil is used. With the hard oil is mixed less than 10 per cent, and often less than 5 per cent, of a soft vegetable oil, that is, one that is liquid at ordinary room temperatures. Peanut and cottonseed are the oils most frequently used for this purpose.[9]

[9] By a ruling of the Department of Agriculture a margarine specifically labeled "nut margarine" must be made entirely of nut oils, and cottonseed oil is not classified as a "nut oil."

The melting point of the mixture must be raised to about 90° F., the exact temperature depending on the season of the year. To so raise it, part of the coconut oil and part or all of the peanut or cottonseed oil used are hydrogenated to the degree desired. To the coconut oil is added a small proportion of a softer oil, as by itself the coconut oil is difficult to hydrogenate.

Before the law was amended in 1931 to levy a tax of 10 cents a pound on margarine of a natural as well as of an artificial yellow, palm oil was used, particularly in 1930, largely to impart a natural yellow color. When so used, it formed 10 to 20 per cent of the oil content of margarine, and usually replaced coconut oil to that extent but sometimes replaced in part peanut or cottonseed oil. The use of palm oil under the present law is discussed on page 148.

A few typical formulas for the oil content of vegetable-oil margarine follow:

(1) Ninety-four per cent coconut oil, 6 per cent peanut oil or cottonseed oil.

(2) Ninety-five per cent coconut oil, 5 per cent peanut or cottonseed oil.

(3) Ninety-two per cent coconut oil, 8 per cent peanut oil.

(4) Eighty per cent coconut oil, 20 per cent peanut oil.

(5) Eighty per cent coconut oil, 15 per cent palm oil, 5 per cent cottonseed or peanut oil.

Animal-oil margarine.—Oleo oil is the principal ingredient of margarine made from animal oils for household use. It forms from 40 to 70 per cent of the total oil content, exclusive of the milk content of such margarines. In general, the higher the percentage of oleo oil, the higher grade the margarine. With the oleo oil there is usually from 20 to 40 per cent of neutral lard; also occasionally a small proportion of oleo stock and as much as 10 per cent of butter. With it is always from 10 to 20 per cent of a soft vegetable oil, as a rule cottonseed oil or peanut oil, but sometimes soybean, palm, corn, sesame, or sunflower oil. In 1930 certain manufacturers used soybean oil, and others palm oil, to the extent of 10 to 25 per cent of the oil content, in order to produce naturally colored yellow margarine. These two oils replaced mainly cottonseed and peanut oil but, to some extent also, oleo oil.

Typical formulas for the oil content of animal-oil margarines for the household trade follow:

(1) Seventy per cent oleo oil, 20 per cent neutral lard, 10 per cent cottonseed oil unhydrogenated.

(2) Forty per cent oleo oil, 40 per cent neutral lard, 20 per cent cottonseed oil.

(3) Seventy per cent oleo oil, 6 per cent oleo stock, 24 per cent cottonseed oil.

(4) Seventy per cent oleo oil, 20 per cent cottonseed oil, 10 per cent butter.

(5) Fifty per cent oleo oil, 35 per cent neutral lard, 15 per cent soybean oil.

(6) Seventy per cent oleo oil, 18 per cent neutral lard, 12 per cent soybean oil.

Formulas (4), (5), and (6)[10] probably would not be used under the amended law, including under the 10-cent tax on colored margarine

[10] Formulas (2), (3), (4), and (5) were presented by the Institute of Margarine Manufacturers at the hearings before the Committee on Agriculture on H. R. 15934, Jan. 21-31, 1931, Serial T, pt. 2, p. 249.

any which tests more than 1.6 degrees of yellow. (See the discussion under soybean oil and butter, pages 157 and 158.)

In addition to their household use animal-oil margarines with a lower melting point are prepared for the baking trade, mainly for making puffed pastries and other specialties. Ordinarily, they contain from 25 to 65 per cent oleostearin, the remainder being cottonseed oil. The proportion of oleostearin is varied according to requirements of the users and according to the season of the year, more being needed in the winter than summer. When low enough in price, oleo oil is sometimes used as an ingredient.

(A) HARD OILS

Technical interchangeability of oils in margarine manufacture.

In considering the subject of the interchangeability of oils in margarine manufacture two questions arise. Which oils may be used in making the different types of margarine? How far may the different types be used interchangeably?

An attempt is made to answer the first question in the discussion of individual oils immediately following. The oils discussed include not only those in actual use in the United States but those which might be used under conceivable conditions.

Coconut and palm-kernel oil.—Coconut and palm-kernel oils are used, almost exclusively, as the hard-fat base of vegetable oil, or nut margarines. These have certain physical qualities specially fitting them for such use. Some of these qualities are here enumerated:

(1) *Hardness.*—Both coconut and palm-kernel oil have a melting point of about 77° F. and, therefore, need not be completely hydrogenated. Usually 10 to 30 per cent of amount of these oils is hydrogenated after mixture with a small quantity of peanut or cottonseed oil.

(2) *Texture.*—Coconut oil in its natural state is smooth and firm of texture.

(3) *Taste and odor.*—Coconut oil is mild in taste and odor and may easily be rendered almost entirely neutral.

(4) *Sharpness of melting point.*—Having a sharp melting point coconut oil melts quickly in the mouth and does not leave a sensation of greasiness.

(5) *Color.*—Because it is white, or easily bleached white, coconut oil is desirable under the existing Federal margarine law.

(6) *Processing.*—By reason of its physical fitness for margarine manufacture, coconut oil requires comparatively little processing.

As between coconut and palm-kernel oils, most manufacturers of margarine prefer coconut oil, if the price is the same, because it is more nearly neutral in taste and has less odor. Coconut oil, therefore, requires less processing before going into margarine.

The discussion of other vegetable oils is concerned largely with the question of their interchangeability with coconut oil. The relation of coconut oil to animal oils has to do with the competition between vegetable-oil and animal-oil margarines.

Palm oil.—With the exception of coconut and palm-kernel oils and cocoa butter, palm oil is the only vegetable oil, available in considerable quantities, that is solid at ordinary room temperature.

As its melting point is higher than that of coconut oil, it may be used in margarine without hydrogenation. In the matters of plasticity, which is of importance in emulsification, and of vitamin content, which increases its food value, it is superior to coconut oil. On the other hand it does not have the sharp melting point which is a factor in the use of coconut oil, and is much more difficult to refine. For the last-named reason it was impracticable, until recently, to use it to any appreciable extent in margarines. Palm oils from Africa at that time made up practically the entire importation. These were all more or less high in free fatty acids and were objectionable in odor and taste. It was, therefore, practically impossible to refine them to the degree necessary to make them usable in margarine manufacture. In recent years, however, there has been a growing importation of purer grades of palm oil from Sumatra. These Sumatran oils have been refined sufficiently to render them neutral in odor and taste, and in 1930 were used in making yellow margarine. Refinement to this degree was made possible by recently perfected methods of treatment, which leave the yellow color unaffected.

Palm oil is usually reddish yellow and imparts that color to margarine. For yellow margarine this is an advantage but for white margarine, to which domestic manufacturers are by law now practically restricted, it is a disadvantage. Not only is the color of palm oil difficult to remove, but the bleaching process is said to lessen the vitamin content of the oil. Sumatran oil, refined and bleached white, is available but at a price somewhat higher than that of the unbleached oil. Compared with coconut oil, the cost of bleaching is, in some measure, offset by the fact that palm oil requires no hydrogenation.

Oleo oil, neutral lard, and other animal oils, except marine oils.—Oils obtained from cattle, sheep, and hogs, supply the hard base for all animal-oil margarines. Unlike coconut oil used as the hard base of most vegetable-oil margarines, they do not have to be partly hydrogenated. Being harder than coconut oil, they require the admixture of a larger proportion of soft oils.

(B) SOFT OILS

The oils so far discussed have all been hard oils. Those remaining are soft oils, which are used in margarine either unhardened, as an admixture with hard oils to increase their softness and improve their texture, or hardened, as a substitute for the hard oils.

Whale oil and fish oils.—Whale oil and fish oils, unhydrogenated, could be used in margarines only after much refining and then, because of their low melting point, only in small quantities. As a matter of fact, they are practically never so used. So far as can be learned, they have never been used in the United States even after hardening by hydrogenation. In Europe, however, hardened whale and fish oils are being used increasingly, and are said to make a palatable margarine of good texture. They are usually blended with other oils, animal and vegetable, but whale oil alone is sometimes used. In Germany in 1928 about 16 per cent of the total oils and fats consumed in margarine were whale oil and fish oils. In Denmark, which has the largest per capita consumption of margarine of any country, these oils seem not to have been used in 1921 but to have been used to the extent of 10.6 per cent in 1927. In Norway, with the next largest per capita consumption of margarine, they were not used at all in

1916 but were used to the extent of 9 per cent in 1927. Furthermore, indications are that the relative importance of these oils increased after 1927 and 1928. To a substantial degree whale oil seems to be replacing vegetable oils, which previously had largely displaced oleo oil, neutral lard, and similar materials in European margarine manufacture.

Cottonseed and peanut oils.—Cottonseed and peanut oils are the soft oils most used in the United States for blending with hard oils in both animal-oil and vegetable-oil margarines. As between the two, most domestic producers of margarine prefer peanut oil. According to a ruling of the Department of Agriculture, producers of goods labeled "nut margarine" must use peanut or some other nut oil. For these reasons a price premium is frequently paid for peanut oil. Those who have no preference, or only a slight preference in favor of peanut oils use principally cottonseed oil because it is usually the cheaper.

Whether an acceptable margarine for table use could be made, as are lard substitutes, entirely from cottonseed oil (or peanut oil) is yet to be demonstrated, for no such margarine has been made commercially. To make the experiment on a commercial scale the price of cottonseed oil would have to be much lower than that of coconut oil. When used in margarine, cottonseed oil requires much more hydrogenation than coconut oil—that is, more of it must be hydrogenated and the hydrogenation must be carried further.

Sesame oil, corn oil, and soybean oil.—Sesame, corn, and soybean oils at various times have been used in the United States as soft oils in both animal-oil and vegetable-oil margarines, replacing the cottonseed oil or peanut oil ordinarily used. Hydrogenation of these oils for use as the hard-oil base for margarine has never been attempted on a commercial scale, although it is perhaps technically possible. In this respect they are in the same position as cottonseed and peanut oils.

As far as physical characteristics are concerned, sesame oil and corn oil could entirely replace cottonseed oil. Corn oil, however, requires somewhat more processing than cottonseed oil to render it sufficiently neutral to use in margarine, and it has a lower melting point and a higher iodine value. In consequence, it must be hydrogenated to a greater degree or mixed with a larger quantity of harder oils.

Because of its refractory taste, color, and odor, soybean oil is naturally less suited to margarine production than sesame or corn oil. That most of the taste and odor can be removed seems established, for in 1930 and 1931 the oil was successfully used in making a natural yellow animal-oil margarine. Very little soybean oil has been used in vegetable-oil margarine because when blended with coconut oil its flavor is too pronounced and its appearance unattractive.[11] The tax of 10 cents per pound now imposed on natural yellow margarine will probably prevent the use of soybean oil as it must be bleached to be used in white margarine. It would be bleached for this purpose only if it were sufficiently lower in price than unbleached cottonseed oil to offer an incentive to perfect means of completely and permanently removing its color.

[11] Dr. Clary Grant testifying at hearings before Committee on Agriculture, 71st Cong., 2d sess., H. R. 15934, Serial T, pt. 1, p. 166.

Interchangeability of vegetable-oil and animal-oil margarine.

The question of the interchangeability of oleo oil and coconut oil, the two basic hard oils used in margarine manufacture, is really that of the interchangeability of vegetable-oil and animal-oil margarines. In consistency and taste, the vegetable-oil margarine bears less resemblance to butter than does animal-oil margarine, but it spreads easily and has a taste which is pleasing to many. Preference for the one or the other appears to be a matter of taste or habit; which is used is largely a matter of price. This phase of the subject is discussed in Part V. As a rule, vegetable-oil margarine sells for less than animal-oil margarine, and thus is used both by those who prefer it as a matter of taste and by those who buy according to price.

Interchangeability of margarine and butter.

As with the two types of margarine, the choice between margarine and butter depends upon price and upon the taste or habit of the consumer. Between good creamery butter and margarine probably few customers would prefer margarine except for reasons of price, but between lower grades of butter and high-grade margarine preference might be more equally divided.

In food value there is little to choose between butter and margarine with respect to fat content and digestibility. Butter is said to be superior in that it usually has a higher vitamin content, as it averages fairly high in vitamin A and contains a little of vitamin D. But its content of both is said to vary greatly, being highest in the spring and summer when the cows are grazing on green grass and lowest in the winter when they are stall fed. Likewise, margarine is said to vary in vitamin content, from none to considerably above the minimum found in butter. There is some vitamin A in oleo oil, which is the base of animal-oil margarine. Coconut oil, which is the base of vegetable-oil margarine, is said to have no vitamin A but to contain some vitamin B.

The recent law imposing a tax of 10 cents a pound on margarine that is naturally yellow probably had the effect of reducing the vitamin content of margarine. The chief sources of vitamins for margarine are yellow oleo oil and palm oil. These can not be used unbleached in any substantial proportion if the 10-cent tax is to be avoided. Bleaching is said to lesssen the vitamin content.

Of course the matter of vitamin content is of importance only in relation to the entire diet. There is no objection to the use of a food that contains few or no vitamins if an ample supply is obtained from other articles of the diet.

4. OILS IN THE LARD-COMPOUND INDUSTRY

Introductory information.

Lard compounds, or substitutes, are usually vegetable oils or combinations of vegetable and animal oils specially prepared for shortening and for cooking purposes. When entirely of vegetable oils, they are made either by hardening (hydrogenating) the entire quantity of oil used to the desired consistency and melting point or by hardening a portion of the oil to a higher melting point than is desired in the finished product and then mixing with unhardened oil. According to the best available data, the production and consumption of lard compounds in the United States have fluctuated as shown in Table 128.

TABLE 128.—*Production and consumption of lard compounds in the United States* [1]

[In thousands of pounds]

Calendar year	Production	Consumption	Calendar year	Production	Consumption
1912	876, 927	.....	1925	1, 152, 620	1, 135, 215
1914	1, 136, 522	.....	1926	1, 140, 708	1, 130, 377
1919	1, 350, 000	.....	1927	1, 178, 995	1, 166, 413
1920	747, 255	.....	1928	1, 143, 340	1, 135, 659
1921	811, 095	.....	1929	1, 220, 102	1, 214, 986
1922	784, 180	752, 413	1930	1, 211, 268	.....
1923	750, 522	747, 899	1931 (first half)	569, 602	.....
1924	830, 435	814, 308			

[1] Figures from 1912 to 1918, Department of Agriculture, Supplement to Bulletin No. 769; 1920 and 1921, estimated on basis of data obtained by Tariff Commission by questionnaire; for 1922 to 1931, Bureau of the Census, Animal and Vegetable Fats and Oils.

Complete statistics are not available for the production of the different types of lard compounds, but data obtained by the commission in response to a questionnaire sent out to representative producers in 1924 show that from 54 to 59 per cent of production in the period 1920–1923 was made entirely of vegetable oils. These data cover all types of producers, including those engaged primarily in meat packing. Separate census figures for the two types are reported only since 1927 and only for concerns engaged primarily in the manufacture of lard compounds. Of the total production of these concerns, 69 per cent in 1927 and 79 per cent in 1929 were made solely of vegetable oils. Had the production of the packers been included the percentages would have been probably closer to those for the 1920–1923 period. In 1930 and 1931, the proportion made solely of vegetable oils probably declined, for according to trade reports the mixed variety has increased in importance, owing to conditions which become apparent in the subsequent discussion.

Oils used in producing lard compounds.

The consumption of oils in the lard-compounds industry in specified years from 1912 to 1929 is shown in Table 129, in total and classified according to source as animal and vegetable. As will appear from the discussion of subsequent tables, these statistics may be taken only as rough approximations.

TABLE 129.—*Consumption of oils and fats for specified years in the manufacture of lard compounds* [1]

[In thousands of pounds]

Calendar year	Total	Vegetable		Animal	
		Quantity	Per cent	Quantity	Per cent
1912	944, 659	874, 981	92. 6	69, 678	7. 4
1914	1, 143, 190	1, 063, 029	93. 0	80, 161	7. 0
1916	1, 043, 288	982, 874	94. 3	60, 414	5. 7
1917	1, 222, 116	1, 156, 200	94. 6	65, 916	5. 4
1918	1, 222, 411	1, 154, 602	94. 4	67, 809	5. 6
1920	756, 151	694, 654	91. 9	61, 497	8. 1
1921	818, 610	746, 412	91. 2	72, 198	8. 8
1922	773, 843	704, 964	91. 0	68, 879	9. 0
1923	757, 858	681, 454	89. 9	76, 404	10. 1
1929	1, 220, 101	1, 104, 810	90. 5	115, 291	9. 5

[1] For sources, see text immediately following.

Table 130 gives for specified years from 1912 to 1929 the quantities of the individual vegetable oils used in producing lard compounds. The figures for 1912, 1914, 1916, 1917, and 1918 are taken from a supplement to Bulletin No. 769 of the Department of Agriculture; those for the later years are unsatisfactory in many respects. For 1920 to 1923, inclusive, they are estimates based on data supplied in response to questionnaires sent out by the commission to producers of all types, whether or not primarily engaged in the production of lard compounds. For 1929 the Bureau of the Census issued a special report on the consumption of the various oils in specified industries. These statistics, however, do not segregate consumption in the lard-compound industry. But they furnish, with other available figures, the basis for estimating the quantities of the various oils used in that industry. (See footnotes to the table.)

TABLE 130.—*Consumption, in specified years, of the several vegetable oils in the manufacture of lard compounds* [1]

Year	Total vegetable oils	Cotton-seed oil	Coconut oil	Peanut oil	Soybean oil	Corn oil	Palm oil	Miscellaneous [2]
	In thousands of pounds							
1912	874,981	866,096	.....	1,687	.....	.....	[3]	6,598
1914	1,063,029	1,053,142	.....	2,144	1,585	.....	[3]	6,158
1916	982,874	919,447	.....	17,869	14,247	13,105	[3]	30,715
1917	1,156,200	1,009,214	5,545	12,209	34,351	4,166	[3]	12,742
1918	1,154,602	1,015,051	13,168	27,912	56,517	2,288	[3]	39,426
1920	691,654	605,309	9,714	48,209	17,607	7,095	[3]	6,720
1921	746,412	709,002	3,011	15,761	8,166	2,960	[3]	7,449
1922	704,984	655,675	16,099	9,841	.....	14,200	[3]	9,149
1923	681,454	640,630	21,205	3,813	681	6,721	[3]	8,404
1929	1,104,810	1,083,202	20,000	.....	.....	.....	1,191	417
	In percentages of total oil consumed in lard compounds							
1912	92.6	91.7	.....	0.2	.....	.....	[3]	0.7
1914	93.0	92.2	.....	.2	0.1	.....	[3]	.5
1916	91.3	88.1	.....	1.7	1.4	1.3	[3]	1.8
1917	91.6	87.5	0.5	1.0	2.8	.3	[3]	2.5
1918	94.4	83.0	1.1	2.3	4.6	.2	[3]	3.2
1920	91.9	80.1	1.3	6.4	2.3	.9	[3]	.9
1921	91.2	86.6	.4	1.9	1.0	.4	[3]	.9
1922	91.0	84.7	2.1	1.3	.....	1.8	[3]	1.1
1923	89.9	84.5	2.8	.5	.1	.9	[3]	1.1
1929	90.5	[4] 88.8	[5] 1.6	[6]	.....	[6]	[7] 0.09	.03

[1] For sources, see text immediately preceding.
[2] Includes vegetable stearin, miscellaneous vegetable oils, including sesame oil and hydrogenated oils.
[3] Included in miscellaneous.
[4] Obtained by subtracting from the lard-compound production in 1929 the estimated consumption of the other oils used in their manufacture.
[5] From the quantities of coconut and palm-kernel oils shown by the Bureau of the Census as consumed in 1929 in food industries other than margarine, there were deducted sales of these oils to the confectionery and baking trades by six leading refiners. The remainder, which is the figure given, is probably only a slight overstatement of the consumption of those oils in lard compounds.
[6] Peanut and corn oils shown by the Bureau of the Census as used in 1929 in food industries other than the margarine industry were regarded as used solely in making salads and table oil. This involves a slight error, for it is probable that small but indeterminate quantities of these oils were used in lard compounds.
[7] Palm oil shown by the Bureau of the Census as used in 1929 in food industries other than the margarine was taken as used entirely in lard compounds. An estimate made by one of the leaders in the trade showed 10,000,000 instead of a little over 1,000,000 pounds.

Table 130 indicates the predominance of cottonseed oil in the lard-compound industry. In each year it supplied 80 to 90 per cent of the consumption in that industry. No other vegetable oil was used in substantial quantities. The same may be said of animal oils, except oleo stearin. Table 131 shows the consumption of animal oils in the industry.

TABLE 131.—*Consumption in lard compounds of animal oils and fats* [1]

Calendar year	Total animal oils	Oleo stearin	Tallow, edible	Pork fat and lard	Oleo oil	Fish oils
	In thousands of pounds					
1912	69,678	57,644	10,834	1,200	.....	.....
1914	80,161	64,926	13,945	1,290	.....	.....
1916	60,414	49,493	9,852	1,069	.....	.....
1917	55,916	51,959	9,953	1,004	.....	.....
1918	67,809	54,598	11,361	1,850	.....	.....
1920	61,497	41,871	9,925	9,604	97	.....
1921	72,198	46,779	10,142	15,042	235	.....
1922	68,879	43,916	10,683	11,489	2,791	.....
1923	76,404	43,075	23,408	7,066	2,655	.....
1929 [2]	115,291	44,138	25,556	23,123	7,553	14,921
	In percentages of total oils consumed in lard compounds					
1912	7.4	6.1	1.1	0.2	.....	.....
1914	7.0	5.6	1.3	.1	.....	.....
1916	5.7	4.7	.9	.1	.....	.....
1917	5.4	4.5	.8	.1	.....	.....
1918	5.6	4.5	.9	.2	.....	.....
1920	8.1	5.5	1.3	1.3	.....	.....
1921	8.8	5.7	1.2	1.8	0.1	.....
1922	9.0	5.7	1.4	1.5	.4	.....
1923	10.1	5.7	3.1	.9	.4	.....
1929	9.4	3.6	2.1	1.9	.6	1.2

[1] Source, except as stated, Tariff Commission, Certain Vegetable Oils, 1926, pt. 2, p. 161.
[2] Data obtained from Bureau of the Census on the assumption that all these oils reported as consumed in food industries other than margarine manufacture were consumed in making lard compounds. The assumption is probably substantially correct.

Oils used in different types of lard compounds.

Since about 1870, when the production of lard compounds is said to have begun on a considerable scale, the industry has undergone a steady process of change in methods, materials used, and quality of product. From time to time new combinations of materials have come into use, without entirely superseding older combinations. The order of appearance of the different combinations which at one time or another have been of major importance is about as follows:

1. Lard mixed with tallow. This seems to have been the original compound. It is said still to be produced by some of the smaller packers.
2. Lard and cottonseed oil.
3. Vegetable oil and oleo stearin.
4. Vegetable oil and whole rendered beef fat.
5. Blends of unhydrogenated and fully hydrogenated vegetable oils.
6. Vegetable oils hydrogenated to the desired consistency.

At present (1932) all these combinations and others are being made to some extent, but the last four are of most importance. As has been noted the last two, taken together, predominate.

A common practice in making mixed animal and vegetable oil compounds is to use 15 to 20 per cent oleo stearin and 80 to 85 per cent cottonseed oil. Another combination used in 1930 and 1931 is approximately 25 to 30 per cent tallow, 10 per cent coconut oil, and the remainder cottonseed oil. Still another is about 45 per cent oleo oil and/or edible tallow and the remainder sesame oil and/or cottonseed oil with a little coconut oil. These are only a few of the many combinations now being used in this type of lard compound, which,

owing to the relatively low price of animal fats, as compared with cottonseed oil, has been of increasing importance in the current depression (1929–1931).

On the Pacific coast, as in Europe, hydrogenated fish oils have also been used to a considerable extent, both alone and in combination with other oils.

Most lard compounds made solely of vegetable oils consist entirely of cottonseed oil, or of cottonseed oil mixed with 1 to 2 per cent of coconut or palm-kernel oil. The necessary hardness, which in the mixed varieties is obtained by blending the soft vegetable oils with hard animal fats, in this variety is obtained by hydrogenation. The vegetable oils which have at different times been substituted for cottonseed oil are peanut, corn, sesame, soybean, sunflower seed, palm. Moreover, small percentages of coconut and palm-kernel oil are sometimes used.

Technical interchangeability of oils in the manufacture of lard compounds.

Under the captions immediately following an estimate is made of the present and the possible future position of each of the animal and vegetable oils used in lard compounds.

Cottonseed oil.—To a large extent lard compound is refined and processed cottonseed oil. The original causes of the predominance of cottonseed oil may be briefly outlined. In seeking to perfect a cooking fat at once high grade and lower in price than lard, manufacturers found at hand a large and cheap supply of cottonseed oil capable of considerable expansion through a greater utilization of the available supply of cottonseed. Although then being used mainly for soap, this oil proved well suited to their purpose, because of its high shortening value and of the ease with which it is processed. By persistent effort over a period of years, they succeeded in bringing it to a high degree of perfection as a cooking fat, and with its increasing use as a lard substitute less and less of it was used in soap making until finally it all but disappeared from the soap kettle and came to occupy a higher price range than soap oils.

But to recount the history of the use of cottonseed oil in making lard compounds does not explain the persistence of its use for this purpose. Its continued predominance in lard compounds is largely a matter of readily available supply on one side and of habit on the other. Manufacturers know well how to process cottonseed oil and what sort of product it will yield. Other oils require different treatment, and experiment is necessary in order to determine the best methods of processing them. The resulting compound, if just as good as that made from cottonseed oil, nevertheless may have certain more or less superficial differences that will arouse prejudice against it. Producers can not always foresee whether consumers will notice such differences or what the effect will be on future sales. Considerations such as these deter manufacturers from experimenting with other oils, particularly manufacturers of nationally advertised trade-marked brands.

On the question whether cottonseed oil is really superior to other oils for making lard compounds opinions differ. Several other oils seem equally well suited physically, but whether consumers would buy compounds made from them as readily as compounds made from

cottonseed oil will not be known until the price of cottonseed oil becomes sufficiently higher than the price of other suitable oils to induce manufacturers to shift to their use on a large scale. In the discussion of other oils, the question of their interchangeability with cottonseed oil is emphasized.

Oleo stearin, edible tallow, and other beef, sheep, and hog fats.—The question of interchangeability resolves itself into one of the comparability of the mixed and vegetable oil varieties of lard compounds, as to which there is great diversity of opinion. The answer is of little importance for purposes of this investigation as the competion is largely between domestic materials. It seems reasonably certain, however, that the predominace of compounds made exclusively of vegetable oils is largely due to the fact that cottonseed oil has usually been lower in price than the competitive animal oils. Should this relationship be reversed the vegetable oil compound might lose its predominance. On this point, consideration should also be given to questions of supply, which will be discussed in the section on the economic factors affecting interchangeability.

Peanut oil.—Some producers prefer peanut oil for the reason that it requires less processing than cottonseed oil, and state that they would use it at the same price. A few, however, prefer cottonseed oil at the same price. The small use of peanut oil in the past has doubtless been due to its relatively high price. If the price position of the two oils were reversed, their position in the manufacture of lard compounds would probably also be reversed.

Sesame oil.—Sesame oil may be regarded as largely interchangeable with cottonseed oil for lard compounds. On the Pacific coast some producers who have had considerable experience with it prefer it. In other sections cottonseed oil is generally preferred, and sesame oil is used only when the price is lower, and then not to the complete replacement of cottonseed oil. Some refiners have found difficulty in removing permanently the pinkish color of sesame oil.

Corn oil.—It is generally agreed that corn oil could be used as a material for lard compounds. So far, however, conditions of supply have been such that it has been used only to a minor extent.

Soybean oil.—Soybean oil occupies about the same position in the lard-compound as in the margarine industry. It has been used to some extent when prices have been favorable, but some difficulty has been experienced in refining it to the point where it will be permanently white and permanently neutral in taste and odor. Moreover, some producers state that compounds made from it spoil more quickly than those made from the oils so far discussed. For these reasons it has ordinarily been used sparingly. Hydrogenation, however, is said to improve it; and if its price were sufficiently low to make it economical to do so, means might possibly be devised for overcoming the objections to its use on a large scale.

Sunflower oil.—Little could be learned about the use of sunflower oil in lard compounds except that it was used in 1930 and 1931 by some producers apparently with success.

Palm oil.—In the last few years refined and bleached Sumatran palm oil has been used by a few producers in making lard compounds. For low-grade compounds it can be used up to, say, 40 per cent. It does not require hydrogenation, and, mixed with unhardened cottonseed oil, it makes a product of good consistency. It is possible that

future improvements in refining methods may result in making it usable to a larger extent and in the better grades.

Whale oil and fish oils.—If whale and fish oils are properly refined and hydrogenated, they make a satisfactory lard compound. In this country whale oil is not used, but fish oils are used on the Pacific coast. Both are reported as being used in Europe.

Coconut oil and palm-kernel oil.—The use of coconut and palm-kernel oils in making lard compounds is fairly general. In ordinary practice, however, they are used only as a minor ingredient to impart certain desired qualities. From 1 to 2 per cent is the usual proportion, and 10 per cent generally is the maximum. The principal reasons given for the sparing use of coconut oil are its low shortening value and its tendency to foam and smoke when used in frying. For these reasons cottonseed oil continues to predominate, even though coconut oil is usually available at a substantially lower price.

5. OILS IN THE SALAD OIL AND SALAD DRESSINGS INDUSTRY

Introductory information.

The products of the salad oil and salad dressings industry may be classified as follows:

1. Salad and cooking oils, under which designation are grouped all oils specially refined and prepared for salad, cooking, and general culinary purposes. Such oils are usually sold under trade-marked names.
2. Mayonnaise.
3. Miscellaneous dressings, including Thousand Island, French, and Russian, and sandwich spreads.

Census figures, which are probably not quite complete, show a production of salad dressing valued at about $35,000,000 in 1927, and at about $43,000,000 in 1929. The production of salad and cooking oils, designated as vegetable cooking oils, was shown as 509,388,000 pounds, valued at $49,453,000 in 1927, and 497,876,000 pounds, valued at $50,887,000 in 1929. The total reported value of salad and cooking oils and salad dressings amounted to $84,500,000 in 1927, and to $94,000,000 in 1929.

As reported by the Department of Commerce,[12] 71 concerns, estimated to represent 65 to 70 per cent of the output of the industry in the United States, produced mayonnaise and other salad dressings, including sandwich spreads but excluding salad and cooking oils, to the value of $25,994,000 in 1928, $30,582,000 in 1929, and $31,308,000 in 1930. Taking 65 per cent as the proportion represented by these 71 concerns, the total value of domestic production of these articles was about $39,990,000 in 1928, $47,049,000 in 1929, and $48,166,000 in 1930. Increases in the value of production occurred despite slightly decreasing prices, and may indicate even greater increases in the quantity of production, which for the concerns reporting in 1930 amounted to 19,009,000 gallons, roughly equivalent to 150,000,000 pounds. On the 65 per cent basis, total domestic production amounted to approximately 230,000,000 pounds in that year.

[12] Bureau of Foreign and Domestic Commerce, A Survey of the Mayonnaise, Salad, and Related Products Industries, 1930.

Technical interchangeability of oils.

The oils used in the salad oils and salad dressings industry should be liquid in form, clear, and unclouded at ordinary winter as well as summer temperatures; that is to say, they must have a low solidifying point. In addition, it is necessary that they keep well, be of medium consistency, and readily emulsify when mixed with other materials. These requirements practically eliminate, on one hand, oils hard at ordinary temperatures, such as coconut, palm, and palm-kernel oils, and on the other hand, oils which oxidize easily, such as linseed oils and fish oils.

The oils well suited by physical characteristics for salad oils and salad dressings, and at the same time commercially available in the United States, are olive, cottonseed, corn, peanut, and sesame oils. Except for cold pressed olive and peanut oils, these oils can be used only after refining; often also they are bleached and "winterized"; that is, treated at the proper temperature (usually by "pressing") to remove the stearin and other glycerides of high solidifying point.

The technical position of the five oils named is discussed separately for the individual oils in the pages immediately following. In addition consideration is given to the possibility of using soybean and whale oils.

Olive oil.—Olive oil, owing to its characteristic taste and other qualities, is widely preferred and commands a high price premium over other salad and cooking oils. It is also used as a spread on bread. But it is not used in the commercial manufacture of salad dressings in the United States. For this purpose it seems to have no advantage over cheaper oils, such as cottonseed and corn oils. In the early days of the mayonnaise industry it was used to some extent, but its use ceased during the World War period.

Cottonseed oil.—In the United States cottonseed oil is the principal oil used in making salad oils and salad dressings. Its predominance is due primarily to economic causes rather than to superiority over several other oils for these purposes. Cottonseed oil is used not only refined but winterized; that is, with its stearin removed by pressing. Thus treated it is a clear liquid at ordinary temperatures and is used directly as a salad and cooking oil and in making salad dressings. For these purposes it is sometimes preferred to any other oil obtainable at the same price.

Corn oil.—Next to cottonseed oil, corn oil is the leading material used in the United States as salad and cooking oils and for salad dressings. Corn oil has the lower solidifying point, and, when winterized, is better suited for use in the colder sections of the country in the winter months. In warm weather, however, cottonseed oil is preferred for its greater thickness and its keeping qualities. The practice of many producers, therefore, is to use cottonseed oil in spring, summer, and fall, and to use corn oil in the winter. Some producers, however, use cottonseed oil throughout the year partly because of price and partly because of preference for its flavor and keeping qualities. Some few producers, however, use corn oil in all seasons, or whenever price permits. The choice between the two oils turns partly on custom, partly on the territory served, and partly on taste. But the general practice is to use whichever is cheaper except in the winter when a small price premium is often paid for corn oil. As will be seen later the tendency to a higher price for corn than for cottonseed oil is related mainly to conditions of supply.

Peanut oil.—If peanut oil were on a price parity with cottonseed and corn oil it would be a strong competitor as a material for salad and cooking oils and salad dressings. The consensus of opinion is that in physical characteristics it is well suited to the industry. Many consider its flavor as superior to that of either cottonseed or corn oil.

Sesame oil.—From time to time, when in a favorable price position, sesame oil has been used by leading domestic producers in making salad and cooking oils and salad dressings. Those who have used it extensively consider it equal to cottonseed and corn oils. Although about the consistency of cottonseed oil, it has a lower solidifying point. As it contains little stearin it does not have to be winterized. Some manufacturers consider sesame oil a better keeping oil than cottonseed oil or any other available oil, and on this account are willing to pay a price premium for it. Others would perhaps use it if it were available at the same price as cottonseed oil, and still others if it were available at a considerably lower price. After price, the chief obstacle in the way of its use has been the uncertain supply, and the fact that some producers have had difficulty in properly refining it.

Soybean oil.—Soybean oil has never been used to any considerable extent in the production of salad or cooking oils and salad dressings. It could be used only if its strong tendency to rancidity could be overcome and if it could be refined so as to improve its flavor. By present processes the flavor can be removed temporarily, but it tends to recur. Hydrogenation would remove it permanently, but hydrogenated oils are not suitable for use in this industry.

Whale oil.—As far as is known whale oil has never been used in salad oils and dressings. It would probably be even more difficult to refine to the desired blandness than soybean oil.

6. OILS IN THE CONFECTIONERY AND BAKING INDUSTRIES

The industries so far considered are those in which animal and vegetable oils form the principal raw materials. In the confectionery and baking industries, however, oils are only secondary materials. This section deals with the use, in the confectionery industry, of oils in preparing fillings, centers, and coatings of cakes and candies, in cooking and salting nuts, and in making hard "chewy" confections, such as caramels. It is not concerned with the use of oil as shortenings in the baking industry.

Position of cocoa butter, coconut oil, and palm-kernel oil.

The principal oils used in the confectionery and baking industries other than for shortening purposes are cocoa butter, coconut oil, palm-kernel oil, and dairy butter. With the exception of dairy butter, these are all imported or made from imported materials. They predominate in making fillings, centers, and coatings for candies and cakes. Between cocoa butter and coconut and palm-kernel oils, competition is limited for the following reasons:

(1) Because of the lower melting point—74° F. to 77° F. for coconut and 74° F. to 86° F. for palm kernel, as compared with 84° F. to 91° F. for cocoa butter, the two oils can be used for purposes for which it is impracticable to use cocoa butter.

(2) Cocoa butter usually has been much higher in price than the separated hard portion of coconut and palm kernel oil, which can be made of any melting point up to 105° F. according to the degree of pressing and hydrogenation.

(3) Pure food laws require that cocoa butter be used in the coatings and bodies of cakes and candies specifically labeled chocolates. As a rule, coconut and palm-kernel oils are used in fillings for all types of candies and cakes, and in coatings and bodies of goods not labeled chocolates.

Coconut and palm-kernel oils also predominate in cooking and salting nuts and are of importance in making caramels and other hard "chewy" candies.

Consumption of coconut and palm-kernel oils.

Official statistics are not available as to the consumption of oils in the confectionery and baking industries. But six large oil refiners supplied the commission with a record of their sales of coconut and palm-kernel oils to such industries in each year from 1927 to 1930, inclusive. These sales, which may be taken as approximately equal to the consumption of coconut and palm-kernel oils in candy and cake manufacture, are shown in quantity in Table 132.

TABLE 132.—*Sales of coconut and palm-kernel oils, by six leading refiners, to the confectionery and baking industries*

[In thousands of pounds]

Calendar year	Coconut oil	Palm-kernel oil	Calendar year	Coconut oil	Palm-kernel oil
1927	47,660	5,284	1929	53,598	11,392
1928	48,185	9,247	1930	[1] 49,976	[1] 10,998

[1] For 1 of the largest of the 6 refineries the figures cover only 11 months.

Forms in which coconut and palm-kernel oils are used.

Coconut and palm-kernel oils enter into candy and cake manufacture in the following forms:

(1) *As whole refined oil, not hydrogenated.*—In this form coconut oil is used largely in certain types of relatively soft sugar-cream fillings, and for the cooking and salting of nuts, particularly almonds and peanuts.

(2) *As whole refined and hydrogenated oil.*—For this purpose it is usually mixed with a small proportion of peanut oil, which acts as a starter for the hardening process. Its uses are similar to those of (3).

(3) *As hard butter or stearin.*—For this purpose the oils are chilled and pressed. The resulting hard portion, consisting of the glycerides of high melting point, is usually known in the trade as "hard butter" or as "coconut or palm-kernel stearin," and is the portion most nearly comparable with cocoa butter. Coconut-oil stearin has a melting point of about 84° F., palm-kernel stearin of about 90° F.

Hard butter is used in making hard fillings, centers, and coatings for both cakes and candies, and in making caramels, butterscotch candies, and the like. It is also used to a small extent in salting nuts. Palm-kernel butter, with or without a small admixture of coconut butter, is used particularly in making coatings of the type known as substitute grease coatings. These are used mainly in the cracker and biscuit industry but also in the candy industry.

(4) *As pressed oil, or olein, unhydrogenated.*—This type, which is the soft oil left after pressing out the stearin, is used particularly in cooking and salting nuts, but has other less important uses.

(5) *As soft butter, or hydrogenated olein.*—Soft butter is the soft or liquid portion of coconut and palm-kernel oils, with a small admixture of peanut or cottonseed oil, refined and hydrogenated up to the desired consistency and melting point. This form is being increasingly used, particularly in fillings for layer cakes and certain types of sandwich cakes, and for icings and other coatings.

The data obtained from the six refining companies represented in Table 132 show that during the 4-year period, 1927 to 1930, the consumption of coconut and palm-kernel oils in the confectionery and baking industries was roughly in the following percentages of the total consumption of these oils:

Form:	Per cent
Whole unhydrogenated	26. 0
Whole hydrogenated	4. 4
Hard butter	26. 2
Soft portion, unhydrogenated	34. 2
Soft butter	9. 2

Properties causing preference for coconut and palm-kernel oils.

Coconut and palm-kernel oils are preferred to other commercially available oils (except cocoa butter) in the uses which have been discussed, largely because they possess the following characteristics:

(1) They keep well. That is to say, they are unusually resistant to rancidity. One manufacturer states that by actual test cakes made with coconut oil keep without spoiling eight times longer than those made with lard, and three times longer than those made with cottonseed oil. Keeping quality is of particular importance in products which must be prepared far in advance of their consumption, as are cakes and candies manufactured in centralized plants for wide geographical distribution. It is also of primary importance in the cooking and salting of nuts.

(2) Coconut and palm-kernel oils have a melting point just high enough to remain solid at ordinary room temperature. The hard portion (stearin) of coconut oil when separated out has a melting point of about 84° F.; of palm-kernel oil, about 90° F. Other available oils, unless fully hydrogenated, are not hard enough; if fully hydrogenated, their melting point is higher than is generally desired.

(3) These oils have comparatively sharp freezing and melting points, and thus "set" quickly and remain firm over a wide range of temperatures, and they melt rapidly without leaving a sticky or greasy sensation in the mouth. These qualities can not be created artificially in oils by any known method of treatment. A sharp melting point is of importance in manufacturing on a large scale by machine. The firmness under varying conditions is important in insuring a firm dry texture and the permanent gloss, much desired in coatings.

(4) In whatever form coconut and palm-kernel oils are used, they create a pronounced sense of coolness in the mouth, as the heat used up in melting materially reduces the temperature of the mouth. This property is associated with what is known technically as "latent heat of fusion." It is also connected with (2) and (3).

(5) Refined, these oils are almost odorless, tasteless, and colorless, and thus make a good neutral base upon which to build desired flavors and colors. These characteristics are not as important as the others in creating a preference for coconut and palm-kernel oils, for many other refined oils make as good a neutral base.

Interchangeability of coconut and palm-kernel oils with other oils.

Other oils can be and are, to some extent, used for some of the same purposes as coconut and palm-kernel oils, but ordinarily the results differ. With the exception of cocoa butter, other commercially available oils do not have in as high a degree the first four properties listed; that is, resistance to rancidity, high melting point, narrow setting and dissolving range, and ability to create a sense of coolness during and after chewing. Confectioners and bakers state that, if necessary, they would be willing to pay a price premium for coconut and palm-kernel oils for many types of fillings and coatings.

Here, as elsewhere, however, the question of the interchangeability of oils is largely a matter of degree. In many uses, particularly in certain types of coatings, the special properties of coconut and palm-kernel oils are needed to produce the type of article desired; in other uses, these oils are preferred because they make a somewhat more attractive and more durable article; in still other uses, there is little, if any, preference over other oils, and price determines the selection.

In making hard chewy candies, such as caramels, both butter and coconut oil are used, but candy of a different kind results according to which is used.

Tallow can not be used because, for most purposes, its melting point is too high (about 100° F.); it does not mix well, does not have a sharp enough melting point, and becomes gummy in the mouth. Palm oil, with similar qualities in many respects, has a lower melting point and greater plasticity but is probably not otherwise greatly superior to tallow.

Cotton, peanut, corn, and sesame oils may possibly be used unhydrogenated in cooking and salting nuts, but coconut oil is preferred as much for its keeping qualities and its stability at ordinary room temperature, as for its low price. For the other uses under discussion they could be used only after hydrogenation, which, however, does not change the melting range or create the other characteristics which commend coconut oil. Moreover, cottonseed oil and the other oils mentioned, if hydrogenated sufficiently to give the desired consistency and cause substantial improvement in keeping qualities, would have a melting point higher than body temperature and be waxy in the mouth.

7. OILS IN OTHER INDUSTRIES

The remaining oil-consuming industries are less important for the purposes of this report than those so far discussed. With the exception of the paint and varnish, the marine-lubricating oil, and the rubber-substitute industries, into which perilla and rapeseed oils enter, they are relatively unimportant in the consumption of the oils named in the resolution. For each industry the discussion is confined largely to the uses of the oils mentioned in the resolution and the possibility of substituting other oils for them as far as physical characteristics are concerned.

In the paint, varnish, and enamels industry.

In 1929 the factory consumption of vegetable and animal oils in the paint and varnish industry was 452,207,000 pounds. In general, they were used in making the following classes of products.

(1) Paints: Pigments mixed with oils, which harden on exposure to the air, forming a tough, durable, and solid coating

(2) Varnishes: Liquids designed to harden on exposure to the air, and forming a more or less transparent glossy coating.

(3) Enamels: Varnishes used as a medium for applying pigments.

For these products it is necessary to use highly unsaturated oils which will absorb oxygen quickly and at the same time form a hard, durable film. Such oils are known as drying and semidrying oils. The semidrying oils, with few exceptions, can be used to only a limited extent in this industry, and the drying oils vary greatly in their usability. The drying qualities of specific oils are roughly indicated by their iodine values, the higher the value the greater the possible oxygen absorption. The iodine value of the principal oils of both classes is as follows:

	Iodine value		Iodine value
Drying oils:		Semidrying oils:	
Perilla	181–206	Sardine	161–192
Linseed	170–205	Menhaden	139–193
Tung	149–176	Corn	121–131
Soybean	124–143	Whale	110–136
Sunflower	120–135	Herring	103–142
Poppy seed	133–158	Cottonseed	101–121
Hempseed	141–166	Sesame	103–115
Walnut	132–152	Croton	102–109
		Rapeseed	94–106

Perilla oil has the highest iodine value, but for various technical reasons its drying power is less than that of tung oil but more than that of linseed oil. Its use in the United States and elsewhere is small compared with the use of either linseed or tung oil. This is indicated by Table 133 which shows the quantities of the various oils used in paints, varnishes, and enamels in the United States. A much larger quantity of linseed oil is used in paints and varnishes than is indicated, for the figures in the table represent only the factory consumption although a large part of the total consumption is by individual painters for thinning purchased paints and varnishes.

TABLE 133.—*Consumption of specific oils in the paint and varnish industry, 1929* [1]

Oil	Quantity	Per cent of total	Oil	Quantity	Per cent of total
	1,000 lbs.			*1,000 lbs.*	
Linseed	340,166	75.3	Corn	364	
Chinawood, or tung	88,386	19.6	Cottonseed	96	
Fish oils	10,602	2.4	Rapeseed	95	
Soybean	5,815	1.3	Other	280	
Castor	3,287	.8			
Perilla	2,573	.6	Total	452,207	100
Grease	524				

[1] Source: Bureau of the Census, Factory Consumption of Animal and Vegetable Oils, 1931

Linseed oil constitutes 75 per cent of the consumption of oils in the factory production of paints and varnishes; perilla oil, less than 1 per cent. This disparity is partly accounted for by the limited and uncertain supply and usually higher price of perilla oil as well as by custom, the domestic paint and varnish industry having been developed with linseed oil as the basic oleaginous material. Not only does each oil require special treatment for the specific use it is to serve, but it requires a different technique in its preparation, and this is acquired only after research and experiment. For this reason manufacturers are averse to changing their formulas.

But probably as important as the factors of supply, price, and custom is the fact that linseed oil seems better adapted than perilla oil, or any other oil, for general use in the preparation of paints and varnishes. Although it does not dry as quickly as perilla oil, it dries more smoothly. Perilla has a tendency to "sweat"—that is, to run into drops and streak in drying. This tendency can be overcome by proper treatment, but even then linseed oil is generally preferred. Whether a larger supply and a lower price for perilla would, in time, overcome the preference is a question. Certainly under present conditions of supply there is little tendency to substitute perilla oil for linseed oil, except for special uses in which it is definitely superior. Even when the price of perilla is below that of linseed oil, paint and varnish manufacturers as a rule continue to use linseed oil for most purposes.

Practically the entire consumption of perilla oil in this industry, therefore, goes into making special varnishes and enamels, which would be difficult or impossible to produce without it. Such are certain special high-gloss enamels and certain "baking" varnishes used when an exceptionally hard film is required. Baking varnishes are made hard by exposure to intense heat in ovens rather than by natural air drying. Tung oil is ordinarily the main base, but in special products perilla oil may be the basic oil or the required ingredient.

Under certain conditions of supply and price, perilla oil doubtless also would be, to a considerable degree, used interchangeably with linseed oil. In rare instances, it might also be used interchangeably with tung oil. But a study of the table of iodine values given above, indicates that soybean oil and fish oils differ so widely from perilla oil as to make substitution improbable.

Tung, fish, and soybean oils are quantitatively more important than perilla oil as substitutes for linseed oil. Tung oil is used mainly for making special marine and waterproof varnishes, but to some extent for making products in which linseed oil could be used with approximately the same results. Fish and soybean oils are sometimes mixed with linseed oil merely to reduce cost but sometimes to produce a paint with special properties. Fish oils, although inferior in drying power to linseed, are said to be superior for certain paints, as for instance, those to be used on smokestacks, where they must withstand the action of excessive heat and light and exposure to the elements. Soybean oil, although not as strong a drying oil as linseed, is said to be superior for certain specific uses, particularly where a water-white or pale color is desired.

In the linoleum and oilcloth industry.

In the linoleum and oilcloth industry 133,018,000 pounds of animal and vegetable oils were consumed in 1929.[13] Of this quantity, 112,855,000 pounds, or 85 per cent, was linseed oil; 10,141,000 pounds, or 7½ per cent, fish oils; 5,963,000 pounds, or 4½ per cent, tung oil. No perilla oil was recorded. The standard practice is to use linseed oil. One of the largest producers informs the commission that he does not use perilla oil on account of its limited supply and of the fact that it is usually higher in price.

In the printing-ink industry.

Printing inks are composed of lampblack or other pigments ground in a varnish. In the industry, 25,000,000 pounds of oils were used in 1925, of which 24,000,000 pounds were linseed oil, 437,000 pounds tung oil, and 71,000 pounds soybean oil.[13] Only 10,000 pounds [13] of perilla oil were used. Perilla oil is used only in making special printing ink varnishes not obtainable from other materials.

In other drying-oil industries.

In addition to their use in paints, varnishes, enamels, linoleum, oilcloths, and printers' inks, drying oils are used, largely for their drying property, in making casting cores, putty, patent leather, mitation leather, oiled clothing, and window-shade materials. In most of these the standard practice is to use linseed oil, but for special types fish oil, tung oil, soybean oil, and perilla oil are used. Putty, for example, is a mixture of whiting and linseed oil. Cores are molding sands for casting, held together with a material which usually includes a drying oil, and baked to hasten the necessary coagulation. Linseed oil seems to be the most commonly used material, but some perilla oil is used and is considered by some to be at least equally good. Some soybean oil is also used.

In the fatty-acid industry.

In this industry oils are first separated into fatty acids and glycerin. The fatty acids, purified by distillation, are separated by pressing into the liquid fatty acids, or "red oil," and the solid acids, or "stearic acid." Red oil is used chiefly in the production of textile soaps; stearic acid, as a plasticizer in rubber compounds, in candles, in shaving soaps, and in cosmetic materials. The production of the two acids is shown in Table 134 for the years 1920 to 1930, inclusive. As about 114 pounds of oil and grease produce 100 pounds of red oil and stearic acid, the quantity of oil consumed may be taken as 14 per cent higher than the total figures shown in the table.

TABLE 134.—*Production of red oil and stearic acid* [a]

Year	Red oil	Stearic acid	Total	Year	Red oil	Stearic acid	Total
	Pounds	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
1920	43,036,000	24,372,000	67,408,000	1926	49,864,000	32,724,000	82,588,000
1921	31,944,000	17,037,000	48,981,000	1927	55,684,000	36,265,000	91,949,000
1922	44,347,000	23,808,000	68,155,000	1928	64,426,000	44,270,000	108,696,000
1923	45,191,000	27,865,000	73,056,000	1929	57,187,000	40,179,000	97,366,000
1924	44,966,000	24,311,000	69,277,000	1930	33,799,000	26,893,000	60,692,000
1925	50,443,000	27,874,000	78,317,000				

[a] Bureau of the Census.

[13] Bureau of the Census, Factory Consumption of Animal and Vegetable Oils, 1929.

In general, the lowest grade of inedible tallow, yellow grease, yellow-grease stearin, brown grease, and garbage grease are used. Palm oil has been used to a small extent. It is preferred by some producers to tallow and the greases, but ordinarily its price is prohibitive. Others say that red oil obtained from it is not so suitable for certain purposes as that obtained from tallow and greases. Like tallow, it must be blended with the greases.

In the tin-plate industry.

Tin plate is produced by feeding steel plates into a molten pot of tin covered by a layer of palm oil. The sheet is run on rolls through the tin and then up through the palm oil which floats on top of the molten tin. The oil serves to keep air away from the sheet before and after it leaves the molten metal, and helps to give the sheet a smooth, bright, light finish. According to tin-plate manufacturers, no other oil gives even approximately the same permanent finish. Tallow gives a bright, clear, clean plate, but the tin so treated turns yellow in a few days. Manufacturers of tin cans, therefore, do not use tallow because the changing color would create suspicion on the part of the users of tin cans who are accustomed to a bright finish. Cottonseed oil also has been tried, but as it is a semidrying oil, it becomes thick and gummy when subjected to intense heat. The sheet in going through the roll drags the oil with it, leaving dark specks on the sheet.[14] Laboratory and plant experiments conducted by the Bureau of Chemistry in 1919 indicate that hydrogenated cottonseed oil "operates somewhat better than palm oil,"[15] but it has never been used commercially.

In making sulphonated oils.

Sulphonated oils, which are oils treated with concentrated sulphuric acid, dissolve and emulsify in water. They are much used in the textile and leather industries, and, to a smaller extent, in making glue and preventing foam in the manufacture of certain kinds of coated paper. In textiles they are used as wetting-out agents or aids to the penetration of dyes in dyeing, as aids in scouring cotton before bleaching, as softening agents before dyeing and in finishing, and for other similar purposes. In the leather industry, sulphonated oils are used as softening and emulsifying agents to improve the flexibility, appearance, and general working properties of leather.

Castor oil predominates in sulphonated oils for the textile industry and cod and neat's-foot oils in the leather industry. Inedible olive oil and olive-oil foots, which are preferred on a quality basis in the treatment of fine worsted, silk, and rayon fabrics, are the next most important sulphonated oils for textile use. Other oils used to a limited extent are corn oil, red oil, and sperm oils, and tallow and grease. Rapeseed oil is used only in minor quantities if at all. One of the leading producers holds sulphonated rapeseed oil to be inferior to other sulphonated oils, because of its gumminess and stickiness.

According to the census report for 1929 on factory consumption of animal and vegetable oils, the following oils were used in textiles, probably in making soap, and for miscellaneous purposes as well as in making sulphonated oils.

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[14] F. R. Crawford testifying at hearing held by the commission February 17, 1931.
[15] Journal of Industrial and Engineering Chemistry, File 1920, pp. 149–151.

	Pounds
Castor oil	13, 115, 000
Inedible olive oil	2, 508, 000
Tallow, inedible	1, 351, 000
Palm oil	540, 000
Grease	344, 000
Soybean	267, 000
Olive-oil foots	262, 000
Other oils	713, 000
Total	19, 100, 000

In the lubricating industry.

Many kinds of lubricating oils and greases are on the market. They are specially prepared for specific uses and are made to withstand varying degrees of temperature, pressure, and moisture. Most of them consist of emulsions of mineral lubricating oils and water stabilized by a soap, usually a calcium soap, made on a base of tallow, lard oil, or red oil. Some lubricating oils, however, are made of mineral oils, of animal and vegetable oils, such as castor and sperm, or of a blend of mineral and animal and/or vegetable oils. The leading oil of the blended type is that used in lubricating marine-reciprocating engines. It is made of a mechanical mixture of petroleum and blown, or oxidized, rapeseed oil. As far as the commission could learn, no other oil has ever been successfully used for this purpose, although experiments have been made with such oils as cottonseed, corn, peanut, and fish. The properties which peculiarly fit rapeseed oil to this use may be listed as follows:

1. Rapeseed oil can be easily blown—that is, oxidized—with little tendency to rancidity and without the attendant break-up into free fatty acids and glycerin. On the average, blowing increases the free fatty acids in rapeseed oil about 1 per cent.[16] All other oils experimented with show a much greater tendency to spoil in blowing. For example, peanut oil shows an 8 per cent increase in free fatty acids after being subjected to blowing. In addition, the color of some oils becomes black.

2. When blown, rapeseed oil will blend with petroleum in the proportions desirable for the different types of lubricating marine engines. Most other vegetable oils do not blend well with petroleum; cottonseed oil, for example, even when mixed with an equal proportion of rapeseed. Difficulty is experienced in maintaining the cottonseed oil in solution with the petroleum.[17] Peanut oil is said to blend even less satisfactorily. Much of the oil used for marine engines is fed through strands of zephyr yarn by siphoning from a central supply. If any of the vegetable oil separates and is deposited on these strands the rate of inflow of the remaining oil is reduced and its lubricating value lessened.[18] This debars drying oils.

3. A lubricant compounded of petroleum and rapeseed oil has a marked affinity for water, forming with it an emulsion which adheres tenaciously to the engine bearings and is not easily washed off by water. Most other animal and vegetable oils emulsify in water with difficulty and the emulsion, when formed, does not have the desired properties. In this respect no satisfactory substitute for rapeseed oil has so far been found.

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[16] Figures supplied by a prominent producer.
[17] See Hearings before Subcommittee of the Committee on Finance, H. R. 2667, 1929, p. 345.
[18] *Loc. cit.*

Some oils from their physical characteristics are unsuited to use in compounded oils for marine engines. For example, oils of high iodine value, such as corn oil, soybean oil, and fish oils, can not be used because of their strong drying qualities. Castor oil is insoluble in petroleum at ordinary temperature. Degras, or wool grease, can not be used because of its stickiness.

In making rubber substitutes.

Rubber substitutes, made by the action of sulphur or sulphur chloride on a vegetable oil, are used for two purposes:

(1) Alone in making certain types of erasers.

(2) Combined with real rubber in producing many types of rubber goods. In these compounds, rubber substitutes are sometimes used merely as a cheapener but probably more often because they impart certain desirable qualities, such as softness, the ability to stand in extension without collapsing, and abrasiveness. Softness not only improves the appearance and the workability of finished articles of rubber but also facilitates certain processes to which the articles are subjected in manufacture. The ability to stand in extension without collapsing is particularly important in the production of tubings, of hot-water bags, and of similar articles. Abrasiveness is of value in making rubber erasers.

The lower the price of rubber substitutes compared with rubber prices the greater the tendency to use them, but recently, even though the price of substitutes has at times been higher than that of rubber, their use continues in making goods to which they impart essential or desirable properties.

Rubber substitutes, which usually appear on the market in powdered or cake forms, are white and brown; they are made of rapeseed oil and of corn oil. White substitutes are made by treating rapeseed or corn oil with sulphur chloride; brown substitutes, by heating one of these oils with sulphur in the presence of heat. Corn and rapeseed oils are sometimes mixed to obtain substitutes with characteristics midway between those made entirely from one of them alone. In some grades a small quantity of castor oil is added to the rapeseed or corn oil to give certain special properties.

Rubber substitutes made of rapeseed and corn oils differ materially and, only to a limited degree, are interchangeable. Rapeseed oil makes a white or light brown substitute, dry, crumbly, low in content of free oil and free sulphur, and easy to incorporate with rubber. Corn oil makes a cream or dark brown substitute, moist, and containing much larger quantities of free oil and sulphur. The most significant difference is the sulphur content, which in the rapeseed product is never more than 2 per cent and in the corn product never less than 5 per cent.

In making gum erasers the substitute made from corn oil is generally used, as it "binds up" better in cake or block form. For compounding with rubber, however, the substitute made from rapeseed oil is as a rule preferred. Substitutes made from corn oil can not be used as generally as those made from rapeseed oil, but in some uses in the rubber industry the corn-oil substitute is preferred. In other uses there is little preference and a substantial price difference in its favor would cause its use in place of the rapeseed-oil substitute. If the sulphur content of corn-oil substitute could be lowered, it would

replace the rapeseed-oil substitute much more widely. The free sulphur and oil can be extracted by the use of acetone but, under existing conditions, the process is a long and expensive one.

As far as is known, no other oil makes as satisfactory a rubber substitute for compounding with rubber as rapeseed oil. Sunflower oil is said to come nearest to it. A leading producer, however, is of the opinion that corn oil could be replaced almost entirely by soybean oil if available at the same price. He states that it makes a substitute almost indistinguishable from that made with corn oil. Cottonseed oil has been tried without favorable results as substitutes made from it do not vulcanize well. Fish oils also have been tried but, as far as could be learned, without success.

PART V

ECONOMIC FACTORS AFFECTING INTERCHANGEABILITY OF OILS—THE QUESTION OF REPLACEMENT

1. General Considerations

In discussing the question of the extent to which foreign oils can be said to replace domestic oils in specific uses, consideration must be given not only to technical factors affecting their physical availability for these uses but also to economic factors affecting their commercial availability. In other words, if there were no technical differences between domestic and foreign oils affecting the character of the products made from them, it would not necessarily follow that the entire quantity of foreign oils used in the United States could be regarded as in replacement of domestic oils. It would be necessary first to give consideration to the question of how far and under what conditions the supply of domestic oils available for domestic consumption could be increased, either by a reduction in exports or by an expansion of production, or both. Substantial increase could be accomplished in neither of these two ways, particularly not in the production, except as a result of changes in the price relationships of the different oils, involving a higher general price level for both oils and the finished products made from them. The magnitude of the increase would depend upon the effect of higher prices not only on the production of oils but also on demand for the finished products made from them. It would also depend upon the extent to which cottonseed oil could be diverted from food uses to the soap kettle and to which lard, the only domestic fat exported in large volume, could be diverted from exports and used in the United States in place of lard compounds, made largely of cottonseed oil. These matters have been discussed briefly in the general summary statement and will be discussed more fully in the pages which follow.

In the later sections of Part V are discussed the economic factors affecting the interchangeability of the oils named in Senate Resolution No. 323, all of which are imported or made from imported materials, with domestic oils made from domestic materials. This discussion is with special reference to the "kinds and amounts" of domestic oils replaced in domestic industry by the specified foreign oils. In no case can the amount of replacement be definitely established, for it is impossible to determine the quantities of oils made from domestic materials which would have been consumed had there been no competition from foreign oils. This is true, if for no other reason, because of the impossibility of predicting the course of demand and supply under different economic conditions, causing differences in price relationships among oils and involving higher prices for products made of oils.

Another reason why the amount of "replacement" can not be definitely determined is the question of the proper interpretation of that term as used in the Senate resolution. So far as domestic oils, if available, could be substituted for foreign oils without materially changing the character of the resulting product, and so far

as domestic production would be sufficiently increased by reason of a reduction in imports, replacement, under any interpretation, may be said to have occurred. But, as was indicated in Part IV, a great reduction or the entire elimination of the foreign oils would necessitate material changes in the character of many domestic products, particularly domestic soaps. It must be a matter of judgment, on which the commission expresses no opinion, whether so much foreign oil as may be involved in the production in approximately the present proportions of the various types of products now being made in the United States, is to be considered as replacing domestic oils, assuming that domestic production could be increased correspondingly.

In the general summary statement (Pt. I, sec. 2, p. 13 and following), the question of replacement was approached, as in the preceding paragraphs, by considering what might happen in the future if the importation of foreign oils and oil-bearing materials should be entirely eliminated or greatly reduced by the imposition of additional and higher duties, or otherwise. In the remainder of this part, however, the approach, in the main, is historical, with a view to giving all the information available as to the extent to which replacement has actually occurred in recent years. For this purpose, the 20-year period 1912 to 1931, inclusive, is studied with respect to changes in price relationships, in consumption of different oils in different uses, and in domestic production and exports. But in order more fully to elucidate the problems arising in connection with the question of replacement, consideration is given at various points to the possible effects, on domestic production and exportation of oils, of material changes in conditions, particularly of a drastic curtailment of imports and of a substantial rise in prices of domestic oils.

Before proceeding with a discussion of particular oils in specific uses, a brief introductory account is given of some of the major factors, affecting interchangeability, which must be considered in connection with the question of replacement, viewed historically.

Supply factors.

Supply factors are of special importance in the question of replacement, which, as has already been noted, turns to a large extent on the question of the expansibility of the supply of oils, particularly of domestic oils. The question of the possibility of expanding the production of an oil involves complex economic factors. These have to do not merely with physical possibilities of production as dependent upon soil and climate but also with the possibility of increasing production at stationary, increasing, or decreasing costs, and on the extent to which the production of an oil is related to the production of other commodities. Costs of production include the farm cost of producing the oil-bearing materials, many of which are produced under primitive tropical conditions, and in addition, the cost of crushing, which is usually a much smaller item. These costs rarely apply solely to oil, as there are usually joint products or by-products, such as oil cake and oil-cake meal, in which case the share of the total joint costs which can be attributed to oil will be largely determined by the relative prices of the several products. Moreover, frequently the oil-bearing material, as for example cottonseed, is itself a by-product, and its supply is limited to the quantity produced as a result of demand for the major product.

Another point of importance is the length of time required to effect an increase or decrease in supply. Thus some vegetable oils are the product of annual plants, production of which can, at least from the purely physical standpoint, be increased or decreased promptly. Others are products of perennial plants which usually require several years to come into bearing and which, once in bearing, continue to produce for a long period. Again, the production of meat animals, a major source of by-product oils, involves processes of much longer duration than those in the production of annual plants.

With respect to whether by-products or principal products, and with respect to the duration of the process of production, six groups of oils may be distinguished as follows:

1. *Animal oils which are themselves principal products.*—Into this group fall whale oil and some fish oils, such as menhaden oil; whaling and the catching of certain fish have as their principal purpose the production of oil.

2. *Animal oils which are by-products.*—In this class fall all the oils derived from domestic animals—lard, oleo oil, tallow, etc.—and a limited quantity of fish oils; the major products of the industries producing these oils are meat and fish for food.

3. *Oils which are the principal products of annual plants.*—The principal example, as far as the United States is concerned, is linseed oil, flax being raised primarily for the purpose of producing this oil, with cake as a by-product. About the only other domestic example is soybean oil. Peanut oil as made in Europe belongs in this class, but in this country it is rather a by-product oil, being usually made from cull peanuts not used for direct consumption. Sesame, perilla, and rapeseed oils are other examples.

4. *Oils which are made from by-products of annual plants.*—This class includes domestic cottonseed and corn oils, the former being by far the most important domestic vegetable oil.

5. *Oils which are the principal products of perennial plants.*—The four outstanding oils of this group are coconut oil, palm oil, palm-kernel oil, and oilve oil, the first three of which are tropical products. No oil of this class is now produced in the United States, except small quantities of olive and tung oils. The oil-bearing trees take a number of years to come into production but thereafter continue for a long period.

6. *Oils which are the by-products of perennial plants.*—Such are almond, apricot-kernel, grapeseed and raisin oils, all of which are produced on a small scale in the United States and elsewhere, but are of negligible importance as far as this study is concerned.

Other supply factors of importance are the size and regularity of supply and its dependability in quality. Coconut oil, for example, is often preferred to palm-kernel oil, partly because of its superiority in these respects. For the same reason, linseed oil is usually preferred to perilla oil.

Prices.

Prices of domestic and foreign oils and their changing relationships form part of the available data having a bearing on the question of replacement of specific domestic by specific foreign oils. In order to show in a general way the price relationships existing between the different oils and groups of oils, a summary comparison of the prices

of the individual oils is here presented. These summary data, as well as the more detailed data presented in later sections, are usually taken directly from trade journals or from bulletins of the Bureau of Labor Statistics. Those for the major domestic oils—lard, tallow, and cottonseed oil—may be taken as representing prices prevailing in actual transactions although often for different markets and for different containers. Those for the other oils are given to the periodicals, usually by sellers of the commodities, and may average somewhat higher than prices in actual transactions. Most of the prices in Table 135 and in succeeding tables are averages for a year or a longer period of once-a-month quotations. The data taken from bulletins of the Bureau of Labor Statistics, however, are usually based on monthly averages representing once-a-week quotations. The difference between averages of once-a-month and once-a-week quotations was found to be insignificant.

Comparisons based on data described in the preceding paragraph, particularly when for different markets and different containers, leave much to be desired. They may not be taken as indicating exact average price differences, but as reasonably reliable, although rough, indications of the character and trend of price relationships.

Table 135 gives the average monthly prices of different oils in the 5-year period 1926–1930. Although for different stages of refinement, different markets, and different containers, they suffice to show the approximate price position of each oil in recent years.

TABLE 135.—*Average monthly prices of different oils in the 5-year period 1926–1930* [1]

[In cents per pound]

Oil	Market	Container	Average price
1. Mainly for edible use:			
Lard	Chicago	Hardwood tubs	13.8
Neutral lard	do	Tierces	14.0
Oleo oil	do		12.2
Cottonseed oil—			
Refined	New York	Barrels	9.8
Crude	Southeast	Tanks	8.3
Tallow, edible	Chicago	Tank cars	8.7
Sesame oil, refined	New York	Drums	12.9
Peanut oil, refined	do	Barrels	13.8
Corn oil, refined	do	Drums	12.0
2. For edible use and for making soaps: Coconut oil.	Pacific coast	Tanks	7.7
3. Mainly for making white soaps:			
Tallow, inedible	Chicago	Tank cars or drums	7.5
White grease	do	Tank cars or returnable drums.	7.3
Whale oil, crude—			
No. 1	Coast	Tanks	7.2
No. 2	do	do	6.8
4. Mainly for making colored soaps:			
Palm oils—			
Lagos	New York	Casks	7.6
Niger	do	do	7.2
Yellow grease	Chicago	Tank cars or drums	6.9
House grease	New York	Tierces	6.9
Brown grease	Chicago	Tank cars or drums	6.4
Rosin	Savannah	Barrels of 280 pounds	3.0
5. Mainly for use in paints and varnishes:			
Linseed oil, raw	New York	Tanks	10.5
Perilla oil	do	Barrels	14.0
Soybean oil, crude	do	do	12.0
6. For miscellaneous uses:			
Rapeseed, oil—			
Blown	do	do	13.1
Refined	do	do	10.6

[1] Trade journals and Bureau of Labor Statistics, the former price-once-a-month quotation, the latter once-a-week.

The most obvious fact brought out by this table is that oils used mainly in soaps command relatively lower prices than those used mainly for food, for paints and varnishes, and for special uses. This is what might be expected from the relatively large number of oils technically suitable for soap making. A more limited number of oils are suitable for food—at least, without expensive processes of refining—and a still more limited number are suitable for paints and varnishes and for special uses, such as marine-engine lubrication. Naturally, the soap kettle, for the most part, gets only oils which are in a sense left overs, not demanded in other industries in sufficient volume to absorb their entire production. Such oils must take the prices fixed in competition with other soap oils. On the other hand, oils which are not produced in greater quantity than can be absorbed in their special uses ordinarily will be consumed in those uses at higher prices than they would bring for soap. Coconut oil commands a somewhat higher price than most soap oils, owing to competitive demand from the food industries, in which it is being used increasingly, and to its special adaptability to the production of the types of soap which increasingly predominate in domestic consumption.

Aside from this broad price distinction as between food and paint oils on one hand and soap oils on the other, differences among the several oils with respect to prevailing price level are affected by their special qualities and their adaptability to special uses. It goes without saying that if two oils are equally fitted for a specific use, price as a rule will determine which will be used. Rarely, however, are two oils equally fitted for the same purpose; and in comparing prices in order to determine which will be used, differences in their adaptability must be weighed. In soap making, for instance, it is necessary to consider the quality of soap and the quantity of glycerin obtainable from the two oils. Frequently, also, one oil requires more processing (refining) to fit it for a given use than another oil, involving a greater cost. Moreover, if the properties of the finished product are to be kept uniform, substituting one oil for another or changing materially the proportions used may necessitate changes in the kinds and proportions of other ingredients. Before making the substitution, the manufacturer, therefore, must consider the total price of the ingredients in the old formula and of those in the new.

Demand factors.

Factors of demand must also be considered in the replacement problem, partly because of their direct effect on relative prices and partly because of the limitations they may place upon the interchange of oils.

The price of an oil is influenced from the demand side by the number of its uses and by the intensity of the demand in each of these uses. From time to time new uses with greater intensity of demand—measured by the price which will be paid—may arise and cause the diversion of an oil from lower to higher price uses. That seems to have happened when cottonseed oil came to be absorbed almost entirely in food uses and virtually disappeared from the soap kettle.

The price which a given industry will pay for an oil, in the face of the competitive demand of other industries, depends in part upon the demand for and the price of the product made from it. Thus, it is affected by changes in the kinds of finished products demanded

by consumers, such, for example, as the trend toward preference for hard, quick-lathering soaps. But the causation may work partly in the reverse direction, as changes in the demand for the finished products are influenced, to a considerable extent, by advertising, which may be undertaken in order to provide a market for products made from oils obtainable at low prices.

The kinds of finished products demanded by consumers may be influenced by the reputation of established brands built up by advertising, uniformity in quality, and by other means. Brand reputation plays a large part in soaps, margarine, lard compounds, and salad oils and dressings. Makers of such brands are limited in the changes they may make in the oils used for their manufacture. Unless forced to do so by great price changes in the oils, they will not risk the loss in sales which might result from noticeable changes in manufacturing formulas.

2. Economic Factors Affecting the Interchangeability of Coconut and Palm-Kernel Oils With Various Domestic Oils

SUMMARY OF TECHNICAL AND STATISTICAL INFORMATION

Statistical and technical information given in Part IV as to the interchangeability of coconut and palm-kernel oils with domestic oils is summarized below with especial emphasis on its economic bearing:

(1) The approximate consumption of coconut and palm-kernel oils—imports less exports plus domestic production from imported copra—rose between 1914 and 1920 from 115,000,000 pounds to 746,000,000 pounds, an increase of more than fivefold. In proportion to total domestic consumption of animal and vegetable oils (except butter), it rose from less than 4 per cent to more than 12 per cent. In 1920 coconut and palm-kernel oils occupied fourth place, being exceeded only by cottonseed oil with about 25 per cent, lard with about 28 per cent, and linseed oil 13 per cent.

(2) Coconut and palm-kernel oils are important ingredients of most types of soap now being produced in the United States and can be omitted or greatly reduced only by lessening either hardness or solubility and lather according to the ingredients with which they are blended. From 1914 to 1920 the quantity of these oils used in soap making rose from 109,000,000 to 417,000,000 pounds, an increase of almost four-fold, and from 13 to about 25 per cent of the total consumpsion of oils in the soap industry. By suitable changes in formulas, however, the proportions in which they are now used might be somewhat reduced without noticeably changing the kinds of soap produced. Thus, to a limited extent inedible tallow and grease, principally grease, may be subsituted for coconut oil; to a somewhat greater, but still limited extent, cottonseed oil or another soft vegetable oil may be substituted. But by a material change in the type of soap produced, substitution may be carried much further. A change from white to yellow laundry soaps, for example, involves the substitution of rosin, with some cottonseed oil or inedible tallow and grease, for coconut oil.

(3) In physical properties coconut and palm-kernel oils are specially adapted for use in vegetable-oil margarines, usually forming 90 to 96 or 97 per cent of their total oil content. The quantity of these oils—almost exclusively coconut oil—used for this purpose rose from 322,000 pounds in 1914 to 171,000,000 in 1929, and from less than one-half of 1 per cent to 60 per cent of the total consumption of oils (except milk and butter) in margarines. In essence competition between vegetable-oil and animal-oil margarines is competition between coconut oil, on the one hand, and oleo oil and neutral lard, on the other. But the use of soft vegetable oils, mainly cottonseed and peanut, is affected, for coconut oil, having a lower melting point, requires the admixture of a smaller proportion of soft oils than do the animal oils.

(4) In recent years more than 50,000,000 pounds of coconut and palm-kernel oils have been used annually in the confectionery and baking industries in making fillings, centers and coatings for both cakes and candies, in making certain types of hard chewy candies, and in salting nuts. This is probably many times the quantity so used before the World War. These oils are specially adapted physically to making certain types of fillings, centers, and coatings for cakes and candies, and only cocoa butter is to any large degree interchangeable with them for these purposes. In the case of hard chewy candies both coconut oil and dairy butter are used, but ordinarily with different results. In salting nuts, coconut oil and coconut-oil olein have certain qualities which cause them to be preferred to other oils.

(5) Between 90 and 95 per cent of the consumption of coconut and palm-kernel oils is in the soap, margarine, confectionery, and baking industries. Apparently the largest single other use is in lard compounds, where however they are used in proportions ordinarily smaller than 5 per cent and practically never above 10 per cent. Because of relatively low shortening value and the tendency to smoke and foam in frying, they are not used to a larger extent.

ECONOMIC AND COMPETITIVE POSITION OF COCONUT AND PALM-KERNEL OILS

(A) WITH REFERENCE TO EACH OTHER

Palm-kernel and coconut oils are used for the same general purposes and may be regarded as practically interchangeable. But as a rule there is a small price differential for coconut oil over palm-kernel oil; this is because coconut oil is more nearly neutral in odor and is more dependable in quality. In certain uses, however, palm-kernel oil is preferred because of its higher melting point, and a price premium is sometimes paid for it. An example is in making hard butters used in hard fillings and coatings of cakes and candies.

Table 136 presents a comparison of the annual average prices of the two oils over a series of years. Comparative price data from the pre-war period to the present are available only for coconut oil in tanks at Pacific coast mills and palm-kernel in barrels in New York. It should be borne in mind that these differences in containers and in place of quotation affect the comparison. Coconut oil in tanks ordinarily sells for from one-fourth to one-half cent a pound higher in New York than at Pacific coast mills. The Atlantic seaboard markets are

supplied directly from the Philippines, and from those markets Philippine oil moves to middle western points, where it encounters the competition of coconut oil crushed on the Pacific coast and moved inland by rail. At present the difference in rates from New York and San Francisco to middle western soap-producing centers varies from 0.27 cent to 0.43 cent per pound, which may be taken as about the usual range of differences in price[1] between the New York and Pacific coast markets, for Philippine oil and Pacific coast oil meet at a price parity in the Middle West.

Spot prices of crude coconut and palm-kernel oils in barrels in New York for the years 1922 to 1931 afford a more exact basis for comparison. As would be expected, these indicate for all years a higher average price for coconut oil than for palm-kernel oil. As a rule palm-kernel oil is bought in the soap trade only at those times when it is lower in price than coconut oil by as much as one-fifth to one-fourth of a cent per pound. As indicated, the candy and cake industries will, when necessary, pay a higher price for palm-kernel oil.

TABLE 136.—*Comparison of prices of coconut and palm-kernel oils*

Year [1]	Price (cents per pound)			Production plus imports, less exports	
	Palm-kernel oil (in barrels) New York [2]	Coconut oil (in barrels)			
		Pacific coast mills [3]	New York [2]	Palm-kernel oil [3]	Coconut oil [3]
				Pounds	*Pounds*
1913	10.1	12.0	.....	22,570,000	.....
1914	10.4	12.2	.....	30,790,000	112,860,000
1915	10.5	12.3	.....	4,908,000	.....
1916	13.8	15.1	.....	14,890,000	171,301,000
1917	16.1	17.1	.....	12,724,000	267,847,000
1918	17.8	18.1	.....	3,802,000	600,240,000
1919	18.0	17.4	.....	4,502,000	837,059,000
1920	17.2	17.4	.....	4,365,000	319,539,000
1921	9.4	10.1	.....	3,710,000	294,871,000
1922	8.5	8.4	8.6	2,179,000	398,759,000
1923	8.7	8.2	9.5	2,566,000	401,166,000
1924	9.3	8.6	10.1	4,739,000	398,166,000
1925	10.3	9.8	11.5	52,024,000	422,655,000
1926	10.0	9.4	10.6	74,980,000	490,210,000
1927	9.1	8.2	9.7	43,128,000	554,044,000
1928	9.1	8.0	9.5	53,812,000	577,225,000
1929	8.4	7.1	8.5	69,909,000	734,902,000
1930	6.8	5.9	7.3	29,104,000	638,144,000
1931 [4]	5.8	4.5	5.9	.....	.....

[1] Calendar year.
[2] Bureau of Labor Statistics, Wholesale Prices.
[3] Tariff Information Surveys A-11, 1913-1919, fiscal years; Bureau of the Census, Animal and Vegetable Fats and Oils, for production data; Foreign Commerce and Navigation of the United States for import and export data, 1920-1930.
[4] Average for first 6 months.

Hereafter when the term "coconut oil" is used, it should be interpreted to include palm-kernel oil, except that statements as to price refer to coconut oil alone. The close relationship of palm-kernel prices, however, should be kept in mind.

(B) WITH REFERENCE TO COCOA BUTTER

There is practically no competition between coconut oil as such and cocoa butter, but the hard butter or stearin obtained from coconut oil is to some degree interchangeable and competitive with cocoa

[1] Until Nov. 17, 1930, the range was narrower—from 0.37 to 0.43 cent per pound.

butter. This competition is limited, on one side, by the fact that cakes and candies labeled chocolate must, under pure-food regulations, contain no oil other than cocoa butter except in fillings not having a chocolate flavor; a manufacturer may weigh the advantage of the chocolate label against the lower cost of a product made by using coconut oil in place of cocoa butter. This interchangeability is not, however, important for purposes of this report, as both coconut oil and cocoa butter are made from imported materials.

Table 137 shows a comparison of prices of cocoa butter and coconut and palm-kernel stearin in each month of 1930 and 1931. The price premium of cocoa butter over coconut oil has declined steadily, while its premium over palm-kernel stearin disappeared in the latter half of 1931. Palm-kernel stearin ranges higher in price than coconut stearin because of the strong preference for it for certain types of coatings for cakes and candies and because the "olein" of palm-kernel oil is ordinarily a less valuable product than the olein of coconut oil, which finds a ready market in nut salting and in the production of "soft butter." The olein of palm-kernel oil has a strong tendency to rancidity which makes it difficult to use for these purposes and confines it largely to the soap kettle.

TABLE 137.—*Comparison of prices of coconut and palm-kernel stearin and cocoa butter*

[In cents per pound]

Month	1930			1931		
	Cocoa butter [1]	Coconut stearin [2]	Palm-kernel stearin [2]	Cocoa butter [1]	Coconut stearin [2]	Palm-kernel stearin [2]
January	30.0	15.4	17.9	20.5	12.5	14.8
February	30.0	15.4	17.9	20.5	12.5	14.8
March	30.0	15.4	17.9	16.5	12.5	14.8
April	25.0	15.0	18.0	16.5	12.5	14.8
May	22.0	15.0	18.0	16.5	11.5	13.0
June	22.0	14.5	17.5	14.5	10.5	13.0
July	22.0	14.5	17.5	15.0	11.5	13.8
August	22.0	14.5	17.5	15.0	11.2	13.5
September	22.0	13.0	15.0	15.0	11.2	13.5
October	20.5	12.5	14.5	14.0	11.2	13.5
November	20.5	12.5	14.5	14.0	11.8	14.5
December	20.5	12.5	14.8	12.5	11.5	14.0

[1] Oil, Paint and Drug Reporter.
[2] Obtained from a domestic producer.

(C) WITH REFERENCE TO OLEO OIL AND OTHER DOMESTIC EDIBLE HARD OILS AND BUTTER

Comparison of price and consumption trends.

Table 138 shows for the years 1913 to 1931 comparisons of average prices of coconut oil and domestic oleo oil and neutral lard, and of the relative consumption of each in margarine manufacture. The prices for coconut oil are for the crude manila grade, f. o. b. Pacific coast mills plus freight to Chicago. For exact comparison with prices of oleo oil, neutral lard, and edible tallow, which require no refining, it would be necessary to add to the prices of crude coconut oil the costs of refining and deodorizing, and, for making white margarine, the cost of bleaching. Including a refining loss averaging 11 per cent, these costs are considerable and vary to some extent with the market

price of crude.[2] For the 6-year period, 1925–1930, it will be noted that the difference between the price of crude and of refined coconut oil in Chicago, shown in Table 139, ranged from 1.6 to 2.8 cents a pound and averaged 2 cents a pound. In the war period, when prices were on a higher level, the difference was greater. Moreover, consideration should be given to the fact that animal-oil margarine is produced largely by packers who use their own materials in bulk. For them the effective cost would be somewhat less than the prices shown in the table.

TABLE 138.—*Comparison of prices and consumption of coconut oil, oleo oil, and neutral lard in margarine*

Year [c]	Price (cents per pound) [a]			Ratio to total consumption of oils in margarine [b]		
	Coconut oil (plus freight rate from Pacific coast to Chicago) [d]	Oleo oil	Neutral lard	Coconut oil	Oleo oil	Neutral lard
				Per cent	*Per cent*	*Per cent*
1913	12.6	11.5	11.8			
1914	12.8	10.9	11.4	0.3	40.7	15.0
1915	12.8	12.2	11.0			
1916	15.6	14.0	14.0	.3	41.7	15.6
1917	17.6	21.7	23.5	7.9	38.7	14.0
1918	18.9	25.7	27.8	22.6	35.3	13.5
1919	18.5	30.6	31.8	23.3	32.7	12.3
1920	18.8	21.4	23.3	26.5	29.4	9.9
1921	11.3	11.3	13.3	43.8	21.1	9.2
1922	9.6	10.7	12.6	35.3	25.2	12.4
1923	9.0	12.8	13.3	37.0	26.3	12.4
1924	9.4	15.1	15.0	41.0	25.8	11.8
1925	10.6	13.8	18.6	43.2	24.0	10.4
1926	10.2	12.0	16.8	46.4	22.3	8.8
1927	9.0	13.4	14.3	49.2	22.4	8.4
1928	8.8	14.1	13.8	56.3	18.1	7.4
1929	7.8	10.9	13.0	59.9	16.5	6.3
1930	6.6	10.5	12.1	62.7	15.4	5.0
1931	[e] 5.2	[f] 6.8	[e] 9.5	66.8	12.0	3.3

[a] Bureau of Labor Statistics, Wholesale Prices (Chicago).
[b] Computed from data given in section on soap making.
[c] Prices, calendar year; ratios, fiscal year.
[d] Varied from 0.55 cent to 1.50 cents per pound during the period.
[e] Average for first 6 months.

[2] According to data obtained by the commission and published in 1926 Preliminary Statement of Information on Certain Vegetable Oils, pt. 1, p. 82, et seq., total costs of neutralizing, bleaching, and deodorizing coconut oil amounted to 0.81 cent per pound of refined oil in 1923 and 0.68 cent in 1924. On the crude basis these costs would be 0.72 cent and 0.52 cent per pound. Refining costs may be computed for the 6-year period, 1925–1930, by assuming the same refining cost as the average for 1923 and 1924, 0.62 cent per pound, and adding to it a refining loss of 0.88 cent per pound, which is based on the average price of crude coconut oil of 8 cents per pound in 1925–1930, less a by-product credit of about one-half cent per pound for foots. This gives a total refining cost of about 1 cent per pound.

TABLE 139.—*Comparison of annual average prices of crude and refined coconut oil in Chicago*

[In cents per pound]

Calendar year	Refined coconut oil, edible (in barrels)[1]	Crude coconut oil, manila grade in tanks (plus 0.75 cent per pound for freight rate from Pacific coast)[1]	Difference
1925	12.6	10.6	2.0
1926	12.9	10.2	2.8
1927	10.5	9.0	1.6
1928	10.3	8.8	1.6
1929	9.7	7.8	1.8
1930	8.9	6.6	2.3
Average for 6 years	10.8	8.8	2.0
1931 (average for first 6 months)	7.5	5.2	2.3

[1] The National Provisioner. [2] Bureau of Labor Statistics, Wholesale Prices.

Chart VIII affords a graphical comparison of fluctuations in prices of coconut oil and oleo oil, and in the proportions of each oil used for making margarines. It indicates that from 1913 to 1916, inclusive, coconut oil was higher in price than oleo oil even without taking into consideration the costs of refining. There was thus no price incentive to an increase in the use of coconut oil. In the next three years, however, the price incentive to such an increase was strong, as prices of oleo oil rose out of all proportion to prices of coconut oil, coconut oil underselling oleo oil by 4.1 cents per pound in 1917, 6.8 cents in 1918, and 12.1 cents in 1919. As a result, the use of coconut oil in margarine rose from less than one-half of 1 per cent of all oils used in the fiscal year 1916 to 23 per cent in the fiscal year 1919. Three war years with their scarcity of animal fats had been sufficient to establish practically a new industry, the manufacture of nut margarine on a large scale. The greater price decline of oleo oil in 1920 and 1921 finally brought it as low as crude coconut oil and gave a temporary setback to the expansion of production of vegetable-oil margarine. From 1923 through 1930, except in 1926, the premium on oleo oil usually was substantial, even after allowing for cost of refining. The proportion of coconut oil, therefore, steadily advanced until in the fiscal year 1931 it formed 67 per cent of all the oils used whereas oleo and neutral lard combined formed only 12 per cent.

Prices and consumption trend of animal-oil and vegetable-oil margarine.

Table 140 and Chart IX will throw further light on competition of coconut oil, with oleo oil and neutral lard. For the years 1920 to 1931 a comparison of prices of nut margarine with those of two grades of animal-oil margarine is shown; also the proportions of animal-oil and nut margarines in the total output of margarine. Enough buyers prefer the type of margarine containing oleo oil so that it sells at a higher price than nut margarine. This higher price is passed on to oleo oil, for the reason that its supply is much more limited than that of coconut oil. But the price premium for animal-

oil margarine varies, being lowest in years of depression, such as 1921, 1922, and 1931. In such years prices of coconut oil and oleo oil are nearer together than usual, also, as will be seen in subsequent tables, prices of margarine and butter are nearest together and margarine consumption is at a relatively low level.

CHART VIII

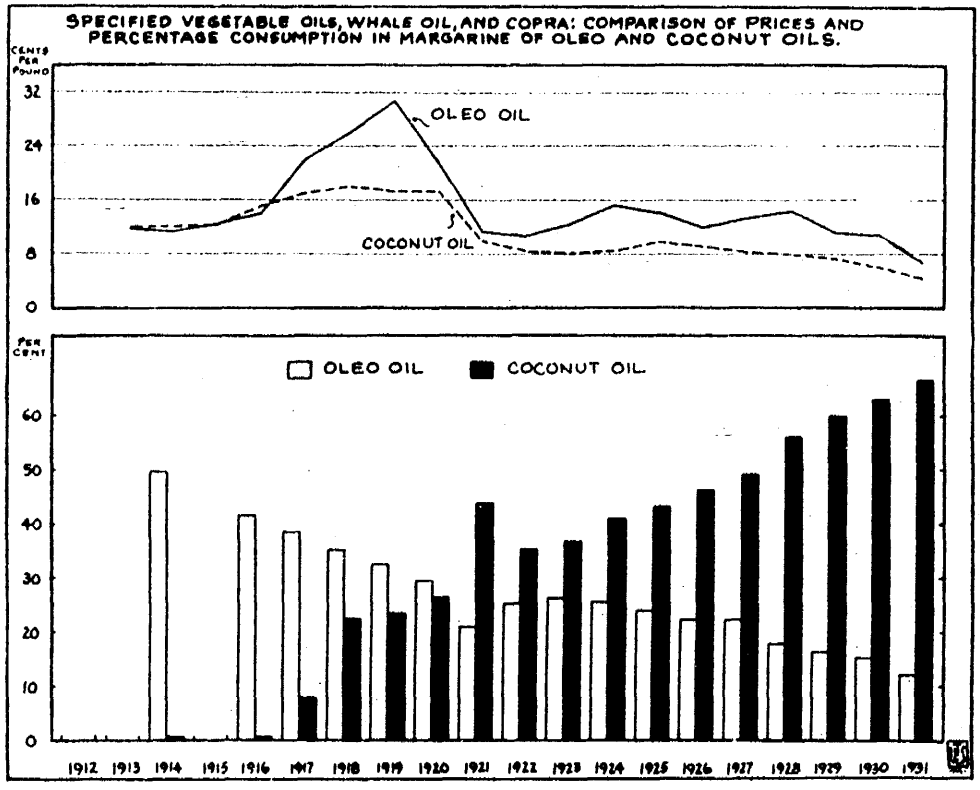


TABLE 140.—*Comparison of annual average prices* [1] *of vegetable-oil and animal-oil margarine, Chicago*

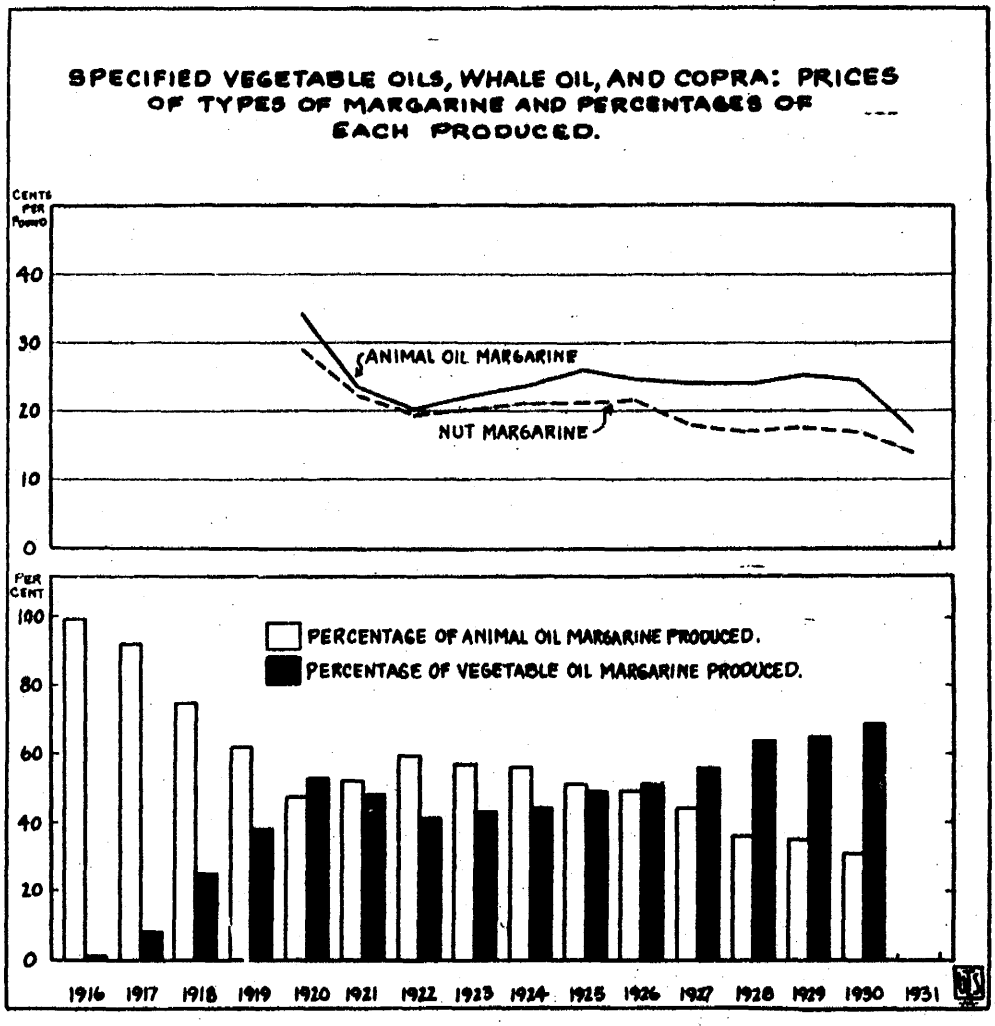
Calendar year	Nut margarine	Animal-oil margarine		Proportion of production composed of [2]	
		First grade [3]	Second grade [4]	Nut (vegetable-oil) margarine	Animal-oil margarine
	Cents per pound	*Cents per pound*	*Cents per pound*	*Per cent*	*Per cent*
1920	28.7	33.8	32.4	52.8	47.2
1921	22.1	22.9	21.9	47.8	52.2
1922	19.4	19.7	18.7	40.8	59.2
1923	20.2	22.3	21.3	42.9	57.1
1924	21.2	23.4	22.4	44.2	55.8
1925	21.2	25.8	22.6	48.9	15.1
1926	21.5	24.4	21.2	50.8	49.2
1927	18.2	23.8	21.1	56.4	43.6
1928	17.2	24.0	21.1	63.8	36.2
1929	17.5	25.0	20.6	64.8	35.2
1930	17.0	23.5	19.1	69.2	30.8
1931 [5]	14.1	17.2	14.4	.....	.....

[1] The National Provisioner.
[2] Calculated from data in section on margarine.
[3] Quoted as butterine, 1920–1924; highest grade animal-oil oleomargarine, 1925–1931.
[4] Quoted as natural-color butterine, 1920–1924; white animal-fat oleomargarine, 1925–1931.
[5] Average for first 6 months.

Conditions of supply of coconut oil.

The relatively low price of coconut oil and the relatively high price of oleo oil and neutral lard in recent years were due to the rapidly increasing supply of coconut oil and the relatively stationary supply of the two animal products. As shown by statistics given in Part III,[3] the estimated production of coconut oil in the principal producing countries increased from 1,436,000,000 pounds in 1923 to 1,896,000,000 pounds in 1930. The increased supply of the United

CHART IX



States came, of course, largely from the Philippines, either in the form of oil or copra. The output of copra in the Philippines increased from 261,000,000 pounds in 1910 to 1,059,000,000 pounds in 1929. The possibility of further expansion there is indicated by the fact that in 1929 of the 101,527,000 coconut trees planted only 65,083,000 were yet bearing. There are also good prospects for further expansion in the Dutch East Indies and in Malaya.[4] The conditions of supply of oleo oil and neutral lard are discussed below.

[3] See Table 57, p. 85.

[4] Katherine Snodgrass, Copra and Coconut Oil (Stanford University, the Food Research Institute, Fats and Oils Studies, No. 2).

The question of replacement.

It is an obvious fact that large quantities of coconut oil are used in the manufacture of margarine and that if none were so used, and if the total quantity of margarine produced should remain unchanged, a much larger quantity of oleo oil and neutral lard would be used in margarine than at present. A mere measurement of this quantity, however, does not afford an answer to the question to what extent coconut oil has replaced the domestic animal oils. Consideration must also be given to the factors which affect the production and consumption not only of oleo oil and neutral lard but also of margarine, and to the fact of a substantial export surplus of the two animal oils.

If a given quantity of vegetable-oil margarine, with coconut oil base, should be replaced by the same quantity of animal-oil margarine based on oleo oil and neutral lard, the amount of oleo oil and neutral lard so used would not be equal to the amount of coconut oil displaced. In making margarine the hard animal oils require a larger admixture of soft vegetable oil than does coconut oil. Table 141 shows for each year, 1917–1930, the quantity of vegetable-oil margarine manufactured and the estimated quantities of animal oils which would have been used if the same amount of animal-oil margarine had been made instead. In making the estimates it was assumed that about 50 per cent of the weight of mixed animal and vegetable oil margarine consists of animal oils (other than milk and butter), about 30 per cent of this being oleo oil, 15 per cent neutral lard, and 5 per cent oleo stearin and miscellaneous animal oils.[5] The table also shows for each year the quantity of exports of oleo oil.

TABLE 141.—*Estimated quantity of animal oil which would be required to produce animal-oil margarine equal in quantity to production of vegetable-oil margarine*

[In thousands of pounds]

Fiscal year	Production of vegetable-oil margarine	Quantity of oleo oil required for producing animal-oil margarine equal to total production of vegetable-oil margarine	Neutral lard which would be used with this quantity of oleo oil	Other animal oils which would be used with this quantity of oleo oil	Total	Export of oleo oil
1917	21,801	6,530	3,314	1,057	10,901	.....
1918	88,974	26,647	13,524	4,315	44,486	.....
1919	142,699	42,738	21,690	6,920	71,348	.....
1920	195,639	58,594	29,737	9,488	97,819	74,529
1921	101,291	30,336	15,396	4,913	50,645	106,415
1922	75,510	22,615	11,478	3,662	37,755	117,174
1923	96,779	28,965	14,710	4,694	48,389	104,956
1924	101,130	30,288	15,372	4,905	50,565	92,965
1925	112,705	33,755	17,131	5,466	56,352	105,145
1926	121,149	36,284	18,414	5,876	60,574	90,410
1927	153,623	46,010	23,350	7,451	76,811	92,720
1928	196,314	58,796	29,840	9,521	98,157	64,851
1929	221,622	66,378	33,688	10,750	110,816	63,187
1930	215,879	64,655	32,813	10,470	107,938	61,093

[5] These percentages were ascertained from data of the animal oils used in production of mixed animal-oil and vegetable-oil margarine during 1914 and 1916, the only years for which such data are available.

The production of vegetable-oil margarine first became important in 1918, and since that year the estimated quantity of oleo oil which would have been required to produce an equivalent quantity of animal-oil margarine has varied from about 22,000,000 to about 66,000,000 pounds annually with corresponding variations in the estimated quantity of neutral lard which would have been required from about 11,500,000 to nearly 34,000,000 pounds.

If no coconut oil had been available during the years covered by this table, the total consumption of margarine, animal or vegetable, might not have remained the same. The vegetable-oil margarines have been cheaper than the animal-oil margarines, and some of the purchasers of the cheaper product might have reduced their consumption of margarine had only the more expensive product been available, particularly since, without the competition of coconut oil at a lower level of prices, animal-oil margarine, and its principal constituents, oleo oil and neutral lard, might have risen even higher in price then they actually did. Moreover, there may be those who prefer the characteristic texture and flavor of the vegetable-oil product to such an extent that if they could not get it they would not use the animal-oil product in its place.

The next question to be discussed is how much the production of oleo oil and neutral lard could have been increased as a means of replacing coconut oil in margarine. Oleo oil is a by-product of beef. Table 142 shows for a series of years the relation between the production of oleo oil, the number of cattle slaughtered, and the weight of beef produced.

TABLE 142.—*Slaughter of cattle and production of beef and oleo oil*

Calendar year	Number of cattle slaughtered [1]	Production of beef [1]	Production of oleo oil [2]
	Thousands	*In 1,000 pounds*	*In 1,000 pounds*
1913	11,478	5,881,000	----------
1914	11,004	5,606,000	142,637
1915	10,822	5,779,000	----------
1916	12,027	6,075,000	150,794
1917	13,724	6,641,000	142,559
1918	15,750	7,279,000	147,866
1919	14,838	6,788,000	129,963
1920	13,885	6,713,000	132,112
1921	12,271	6,163,000	147,683
1922	13,148	6,706,000	164,780
1923	13,883	6,873,000	158,610
1924	14,400	7,065,000	156,334
1925	14,706	7,146,000	141,366
1926	14,971	7,458,000	161,427
1927	14,000	6,826,000	127,594
1928	12,452	6,082,000	124,166
1929	12,241	6,065,000	122,527
1930	12,168	6,076,000	----------

[1] Bureau of Agricultural Economics, Department of Agriculture.
[2] Institute of Margarin Manufacturers Bulletin, November, 1930.

It will be seen that the ratio of the weight of the oleo oil to that of beef is fairly constant and that production of neither has changed very materially since about 1917. Oleo oil alone represents somewhat less than 2 per cent of the weight of salable parts of slaughtered cattle, and with oleo stearin it represents approximately 3 per cent

of that weight. The corresponding proportions in terms of value are not very different. Any change in the price of oleo oil could therefore not be expected to affect appreciably the production of beef cattle.

Moreover, there is little possibility of a material increase in the quantity of oleo oil derived from a given volume of beef production. It would not pay farmers to add more weight of fat to cattle merely for the sake of additional oleo oil thereby obtainable. The large packers as a rule make the maximum recovery of oleo oil from the animals slaughtered. The same can not be said with respect to local slaughterhouses, but the fact that these are not Federally inspected and that only Federally inspected products may be used by margarine manufacturers who have an interstate trade limits the incentive of these slaughterhouses to increase the recovery of oleo oil. Under these circumstances there is little reason to suppose that, if there had been no importation of coconut oil for use in margarine, the production of oleo oil in the United States would have been materially greater than it has actually been.

But the question whether the production of vegetable-oil margarine based on coconut oil represents replacement of domestic oils may be considered in connection with the statistics of exportation of oleo oil. It is evident that exports of oleo oil were in excess of the quantity necessary to produce animal-oil margarine equal in quantity to the production of vegetable-oil margarine, except in the years 1929 and 1930 when the exports were somewhat less than required for that purpose. It must be a matter of speculation whether a reduction of exports of oleo oil in order to increase its use in the domestic production of margarine would be advantageous to farmers and others concerned with oleo oil.

The situation with respect to the exports of neutral lard is very similar to that with respect to oleo oil. On the average, during recent years the exports of neutral lard have been roughly equal to the quantity of neutral lard which would have been required if the vegetable-oil margarine produced had been replaced by an equivalent quantity of animal-oil margarine. The exports have ranged from about 13,000,000 to about 25,000,000 pounds; they fell off considerably in 1929 and 1930, the figure for the latter year being 13,531,000 pounds.

Competition of margarine and butter.

Through its use in vegetable-oil margarine, coconut oil competes not only with oleo oil and neutral lard but also with butter, although on a lower price level. [6] The domestic production of butter is about 2,000,000,000 pounds annually. The quantity of coconut oil used in margarine is somewhat less than 200,000,000 pounds. (See Part IV, Table 125, p. 152.) Points bearing on the question of how far this use is in replacement of animal oils have already been discussed. To the extent that coconut oil, in the form of vegetable-oil margarine, replaces oleo oil and neutral lard in the form of animal-oil margarine, it of course does not also replace butter. In other words, in so far as the use of coconut oil merely involves a change in the character and not in the quantity of margarine, it clearly does not affect the production and consumption of butter. The question of the degree

[6] Katherine Snodgrass, Margarine as a Butter Substitute (Fats and Oils Studies, No. 4), p. 253.

to which the development of vegetable-oil margarine caused an increase in the total domestic output of margarine turns upon the importance of a lower price and upon the extent of the preference by some consumers for the taste and texture characteristic of nut margarine. The further question of how far any increase in the total production of margarine was at the expense of butter, fat meats, lard, and other fatty foods, or of nonfatty foods, can not be answered, as it involves matters on which only speculation is possiple. The effect on production and consumption of butter hinges largely upon the extent to which the lower price of margarine, due to the use of coconut oil, caused the substitution of margarine for butter. The use of coconut oil not only provided a less expensive type of good-grade margarine—nut margarine—but in all probability had a moderating influence on the price of the competitive animal-oil margarine.

A large proportion of the people of the United States use butter exclusively, regardless of how much higher in price it is than margarine; another large proportion use margarine for cooking but not for table use. A smaller proportion always use margarine to the exclusion of butter, largely because of price. There is, however, still another and intermediate group which shifts from one to the other according to the extent of the price difference, or according to fluctuations in income. That some shifting of this sort has occurred in the past, with changing conditions of business and price, seems indicated by the data in Tables 143 and 144 covering (1) prices of butter, (2) prices of animal-oil margarine, (3) differences between the two, (4) the ratio of the price of margarine to the price of butter, (5) per capita consumption of butter in the United States, (6) per capita consumption of margarine in the United States, and (7) the ratio of margarine consumption to butter consumption. Chart X compares graphically fluctuations in differences in price of margarine and butter with fluctuations in the ratio of the consumption of margarine to the consumption of butter.

TABLE 143.—*Comparison of prices of butter and of margarine* [1]

Calendar year	Prices of—		Spread	Ratio of price of margarine to price of butter
	Butter	Margarine		
	Cents per pound	*Cents per pound*	*Cents per pound*	*Per cent*
1914	27.3	17.9	9.4	66.6
1917	40.3	23.5	16.8	58.3
1918	48.9	27.6	21.3	53.6
1919	57.2	33.6	23.6	58.7
1920	56.8	32.5	24.3	57.2
1921	40.0	21.6	18.4	54.0
1922	37.7	18.8	18.9	49.9
1923	44.4	21.4	23.0	48.2
1924	39.9	22.4	17.5	56.1
1925	42.6	22.5	20.1	52.8
1926	41.4	21.3	20.1	51.4
1927	44.3	21.1	23.2	47.6
1928	44.9	21.0	23.9	46.8
1929	43.7	20.5	23.2	46.9
1930	35.3	21.8	13.5	61.8

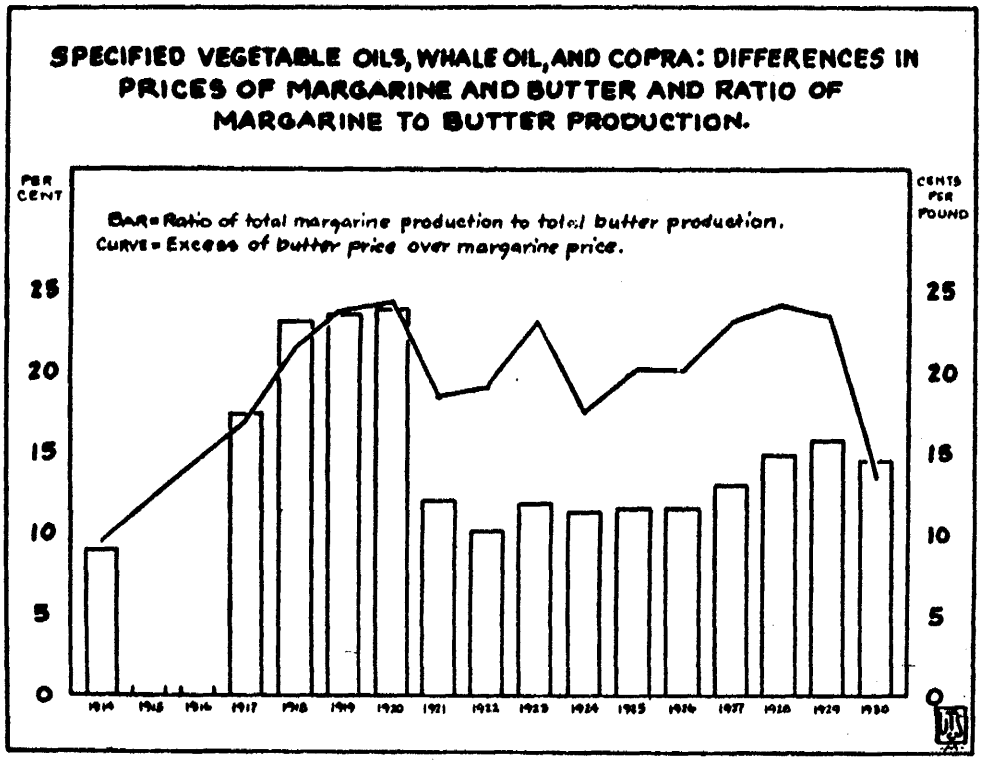
[1] Bureau of Labor Statistics: Butter, extra at Chicago; margarine, standard uncolored, Chicago.

TABLE 144.—*Per capita consumption of butter and margarine*

Year [1]	Consumption of—		Ratio of consumption of margarine to consumption of butter
	Butter	Margarine	
	Pounds per capita	*Pounds per capita*	*Per cent*
1914	16.5	1.4	8.5
1917	14.7	2.2	15.0
1918	14.4	3.1	21.5
1919	14.6	3.3	22.6
1920	14.6	3.5	24.0
1921	15.8	2.6	16.5
1922	16.2	1.7	10.5
1923	16.9	1.9	11.3
1924	17.3	2.1	12.2
1925	17.0	1.9	11.2
1926	17.8	2.1	11.8
1927	17.8	2.2	12.4
1928	17.4	2.5	14.4
1929	17.3	2.8	16.2
1930	17.6	2.5	14.2

[1] Calendar years for butter and fiscal years for margarine.

CHART X



Although the preceding tables and chart show data for margarine production for fiscal years and the other data for calendar years, they suffice to indicate the character of the competition between margarine and butter. From them the following conclusions seem warranted.

1. Taking the period from 1914 to 1930 as a whole, the per capita consumption of both butter and margarine increased. It is significant, however, that the period of smallest consumption of butter and of largest consumption of margarine was in 1918, 1919, and 1920. Since that period the trend in butter consumption has been upward; the trend of margarine consumption has varied, being radically downward from 1920 through 1922, upward from then until 1929, and in 1930 downward again.

2. In periods of industrial expansion the tendency is for the per capita consumption of butter to decline and of margarine to increase. In such periods butter prices rise to such a height as to cause a tendency to substitute margarine for butter, particularly since margarine prices do not rise to the same extent as butter prices.

3. In periods of depression, the tendency is for the per capita consumption of butter to rise and that of margarine to decline. Butter prices are then low both absolutely and relatively to the more stable margarine prices.

The tendency of some consumers to shift from butter to margarine as the price difference between the two widens and to shift from margarine to butter as this difference narrows is indicated by Table 145 and Chart XI which show a comparison of prices and production of the two commodities in each month in the years 1927, 1928, and 1929. In each year the largest production and the lowest price of butter came in May, June, and July. Both production and prices of margarine were at their lowest level for the year at approximately the same time. The smallest production and the highest price of butter came in November and December, when (except in 1929 when conditions were abnormal) both production and prices of margarine were at their height. It will be noted, however, that prices for margarine are much more stable from month to month than those for butter. In particular, they fall less in May, June, and July and rise less in November and December. This accounts for the decrease in consumption of margarine in the former months and its increase in the latter. By reason of its being a factory industry with a flexible supply of oleaginous materials, production of margarine responds more quickly to changes in demand than does the production of butter, farmers being unable in any particular season to expand or diminish materially the supply of milk. It should, of course, be noted that storage of butter tends to flatten out the curve of monthly consumption as well as of monthly prices.

TABLE 145.—*Prices and production of margarine and of creamery butter by months*

Year and month	Prices of—		Difference	Production		Ratio of production of margarine to production of butter	Ratio of price of margarine to price of butter
	Butter [1]	Margarine [2]		Creamery butter [3]	Margarine [4]		
1927	*Cts. per lb.*	*Cts. per lb.*	*Cts. per lb.*	*Pounds*	*Pounds*	*Per cent*	*Per cent*
January	48.7	21.5	27.2	97,700,000	22,300,000	23.7	44.1
February	50.7	21.5	29.2	95,500,000	21,900,000	22.9	42.4
March	49.2	21.5	27.7	111,400,000	24,900,000	22.4	43.7
April	49.5	21.5	28.0	126,400,000	23,200,000	18.4	43.4
May	41.7	21.5	20.2	168,800,000	20,500,000	12.1	51.6
June	40.3	21.5	18.8	188,700,000	19,900,000	10.5	53.3
July	39.9	21.5	18.4	170,400,000	16,900,000	9.9	53.9
August	41.2	21.5	19.7	146,800,000	20,400,000	13.9	49.8
September	44.9	23.9	21.0	113,500,000	22,800,000	21.1	53.2
October	46.4	24.5	21.9	102,300,000	25,800,000	25.2	52.8
November	48.3	23.5	24.8	86,000,000	26,300,000	30.6	48.7
December	50.7	23.5	27.2	88,200,000	27,100,000	30.7	46.4
1928							
January	48.4	23.5	24.9	110,000,000	25,000,000	22.7	48.6
February	45.5	23.5	22.0	99,300,000	27,600,000	27.8	51.6
March	48.6	23.5	25.1	111,700,000	26,500,000	23.7	48.4
April	44.1	21.5	22.6	118,800,000	23,600,000	21.1	48.8
May	43.4	21.5	21.9	156,200,000	23,200,000	14.8	49.5
June	43.1	21.5	21.6	181,000,000	21,100,000	11.7	49.9
July	43.6	21.5	22.1	167,600,000	21,000,000	12.5	49.3
August	45.8	21.5	24.3	145,400,000	22,400,000	15.4	46.9
September	47.1	22.0	25.1	119,400,000	27,600,000	23.1	46.7
October	46.5	23.5	23.0	105,800,000	29,800,000	28.2	50.5
November	48.8	23.5	25.3	87,700,000	29,600,000	33.7	48.2
December	49.0	23.5	25.5	92,400,000	28,000,000	30.3	48.0
1929							
January	46.6	23.5	23.1	103,500,000	28,500,000	27.5	50.4
February	49.1	23.5	26.6	99,900,000	28,100,000	28.1	47.9
March	48.0	23.5	24.5	114,400,000	28,700,000	25.0	49.0
April	44.4	23.5	20.9	133,000,000	27,400,000	20.5	52.9
May	42.0	23.5	18.5	174,300,000	27,300,000	15.7	56.0
June	42.4	23.5	18.9	192,800,000	23,300,000	12.1	55.4
July	41.2	23.5	17.7	185,300,000	24,100,000	13.0	57.0
August	42.4	23.5	18.9	152,100,000	27,100,000	17.8	55.4
September	44.8	23.5	21.3	123,500,000	29,200,000	23.6	52.5
October	44.2	23.5	20.7	118,100,000	34,900,000	29.5	53.2
November	41.4	23.5	17.9	97,100,000	31,600,000	32.5	56.8
December	39.7	23.5	16.2	101,800,000	31,300,000	30.7	59.2

[1] Bureau of Labor Statistics, Wholesale Prices, extra, Chicago.
[2] Ibid., standard, uncolored, Chicago.
[3] Department of Agriculture, Yearbook.
[4] Mimeographed reports, Bureau of Agricultural Economics, Department of Agriculture.

(D) WITH REFERENCE TO COTTONSEED OIL IN MANUFACTURE OF MARGARINE

Coconut oil, to a limited degree, competes with soft vegetable oils in the margarine industry. This competition is indirect and results from the fact that more of these oils is used in connection with hard animal oils than in connection with coconut oil, largely because of the lower melting point of the latter. Being the most important domestic soft oil and the principal one to meet the competition from coconut oil, cottonseed oil is taken as representative. Later the competition between the various soft oils will be separately considered.

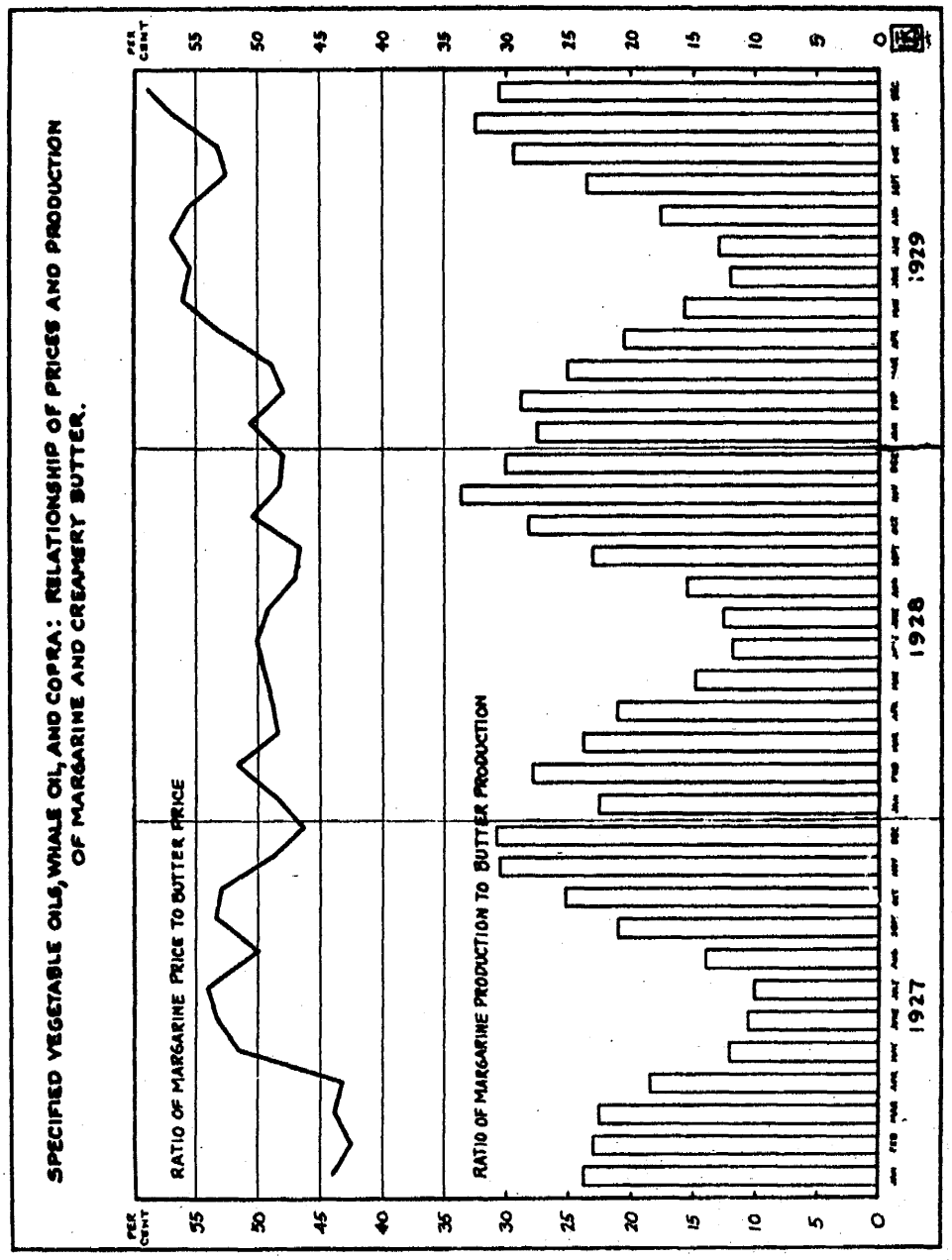
Comparison of price and consumption trends.

Table 146 shows fluctuations from 1913 to 1931, inclusive, in annual average prices of coconut and cottonseed oils, and in the consumption of the two oils in margarine manufacture. The data on prices may not be used in determining exact price difference between the two oils, but only as indicating trends in the price relationships. Prices

on coconut oil are f. o. b. Pacific coast mill, and prices on cottonseed oil for the product delivered at New York. Pacific coast prices of coconut oil are usually from one-fourth to one-half cent per pound lower than New York prices.

The table indicates another, though scarcely very strong, incentive for the increased use of coconut oil in margarine. Before 1918 crude coconut oil regularly sold for a much higher price than prime summer

CHART XI



yellow cottonseed oil; in 1918 and in most of the following years it sold for less. This change in relative price position occurred just a year later than the similar change in price positions of coconut and oleo oils shown in Table 138, page 186. Moreover, in the two years preceding 1918, the amount by which the price of coconut oil exceeded that of cottonseed oil had declined.

Table 147 gives a more exact comparison of prices of coconut and cottonseed oils for use in margarine. It shows prices of refined edible grades of these oils in Chicago in the years 1924 to 1931, inclusive. A study of these prices and those given in Table 146 leads to the conclusion that the cost of preparing crude coconut oil for use in margarine is somewhat higher than that of preparing prime summer yellow cottonseed oil. Nevertheless, the edible grade of coconut oil averages lower in price than the corresponding grade of cottonseed oil in all years except 1925, when the prices of the two averaged the same; the difference in most years, however, was less than 1 cent per pound.

TABLE 146.—*Comparison of prices and consumption of coconut oil and cottonseed oil in margarine*

Year [1]	Price (cents per pound) [2]		Per cent of oil consumption in margarine [3] supplied by—		Year [1]	Price (cents per pound) [2]		Per cent of oil consumption in margarine [3] supplied by—	
	Coconut oil, crude (in tanks), Pacific coast	Cottonseed oil, prime summer yellow (in tanks), New York	Coconut oil	Cottonseed oil		Coconut oil, crude (in tanks), Pacific coast	Cottonseed oil, prime summer yellow (in tanks), New York	Coconut oil	Cottonseed oil
1913	12.0	7.3	.....	.....	1923	8.2	11.3	37.0	10.6
1914	12.2	6.6	0.3	20.0	1924	8.6	10.8	41.0	10.2
1915	12.3	6.8	.....	.....	1925	9.8	10.8	43.2	11.4
1916	15.1	10.6	.3	30.1	1926	9.4	11.8	46.4	12.1
1917	17.1	15.4	7.9	25.6	1927	8.2	9.7	49.2	10.7
1918	18.1	20.1	22.6	13.4	1928	8.0	9.9	56.3	9.9
1919	17.4	24.1	23.3	12.7	1929	7.1	9.7	59.9	9.8
1920	17.4	15.4	26.5	13.0	1930	5.9	8.1	62.7	10.2
1921	10.1	7.9	43.8	7.9	1931	[4] 4.5	[4] 7.2	66.8	9.4
1922	8.4	10.1	35.3	9.5					

[1] Prices, calendar years; consumption, fiscal years.
[2] Bureau of Labor Statistics, Wholesale Prices.
[3] Calculated from data given in section on margarine.
[4] Average for first 6 months.

TABLE 147.—*Comparison of prices of white, refined, and deodorized cottonseed oil and refined coconut oil, Chicago* [1]

[In cents per pound]

Calendar year	Coconut oil	Cottonseed oil	Calendar year	Coconut oil	Cottonseed oil
1924 [2]	11.6	16.4	1928	10.3	10.6
1925	12.6	12.6	1929	9.7	10.6
1926	12.9	13.6	1930	8.9	9.7
1927	10.5	11.2	1931 [3]	7.5	9.2

[1] The National Provisioner. [2] Averages for last 6 months. [3] Averages for first 6 months.

Question of replacement.

Table 148 shows the estimated additional amount of cottonseed oil which would be used in the production of margarine if there were no use of coconut oil, and if an equivalent quantity of animal-oil margarine were substituted for vegetable-oil margarine. These estimates are based on the assumption that the only vegetable oil used in the animal-oil margarines would be cottonseed oil, and on the further

assumption that the same proportion of vegetable oils would be used as was actually used in the years 1914 and 1916, which are the only years for which reliable figures are available. The net domestic exports of cottonseed oil are also shown in the table.

The question to what extent, if there had been no importation of coconut oil, the production of cottonseed oil might have increased is discussed elsewhere. It is evident from Table 148 that the estimated quantity of cottonseed oil required for the replacement of vegetable-oil margarine by animal-oil margarine could, except in the last three years, have been supplied by reducing exports.

TABLE 148.—*Estimated quantity of cottonseed oil required to make animal-oil margarine equal in quantity to production of vegetable-oil margarine—Net exports of cottonseed oil*

Calendar year	Amount of cottonseed oil required for producing animal-oil margarine equal in quantity to the total production of vegetable-oil margarine	Net exports of cottonseed oil	Calendar year	Amount of cottonseed oil required for producing animal-oil margarine equal in quantity to the total production of vegetable-oil margarine	Net exports of cottonseed oil
	Pounds	*Pounds*		*Pounds*	*Pounds*
1917	5,996,000	[1] 145,951,000	1924	27,810,000	43,342,000
1918	24,467,000	[1] 86,402,000	1925	30,993,000	62,416,000
1919	39,241,000	165,327,000	1926	33,315,000	34,222,000
1920	53,800,000	175,296,000	1927	42,246,000	67,982,000
1921	27,854,000	251,881,000	1928	53,986,000	51,702,000
1922	20,765,000	75,283,000	1929	60,948,000	26,075,000
1923	26,613,000	48,583,000	1930	59,366,000	28,297,000

[1] Fiscal year.

(E) WITH REFERENCE TO COTTONSEED OIL, ROSIN, INEDIBLE TALLOW, AND GREASES IN MAKING LAUNDRY SOAPS

Competition among oils for use in soap making is rarely a "head-on" competition between two oils but a competition between formulas—that is, between different combinations or blends of oils. The limited interchangeability, for example, between coconut and cottonseed oils as ingredients of laundry soaps is thus in part incidental to the larger competition between yellow and white laundry soaps. Yellow laundry soaps may be made of rosin and inedible animal oils, palm, or whale oil or of rosin and cottonseed or other soft vegetable oil, the latter combination giving a softer, stickier product. White laundry soaps may be made of coconut oil and inedible animal oils or, without markedly different results, of coconut oil and cottonseed or other soft vegetable oil. In the substitution of white for yellow laundry soaps coconut oil substitutes for rosin as the quick lathering ingredient. But the change in formula involved also carries with it some substitution of coconut oil for inedible animal oils or for cottonseed oil. This is apparent from the fact that rosin usually constitutes 15 to 20 per cent of the oil and rosin content of yellow soaps, whereas coconut oil is usually from 40 to 60 per cent of the oil content of white laundry soaps. The substitution, however, is not so great as these figures indicate, for sodium silicate is a much more important ingredient of white than of yellow laundry soaps.

But interchangeability between coconut oil and cottonseed oil is not confined to that incidental to the competition between yellow

and white laundry soaps. To a limited extent it is also incidental to the possibility of substituting tallow and cottonseed oil for each other in making laundry soaps. In yellow laundry soaps where this substitution makes a substantial difference in the soap, coconut oil is not involved, as it does not mix well with rosin and therefore is used only in minor proportions. In white laundry soaps, however, it is involved, as the substitution of cottonseed oil for tallow reduces somewhat the proportion of coconut oil required to make a quick-lathering soap of good texture. The principal technical factor in both instances, however, is not the interchangeability of coconut and cottonseed oils, which is narrowly restricted, but of cotton seed oil and tallow and other inedible animal oils. The most significant factor affecting the use of both cottonseed oil and inedible animal oils and fats in soap making is, therefore, not the price relationship of each to coconut oil, but their price relationship to each other.

Comparison of price and consumption trends.

The changes in price relationships of the principal materials used in making laundry soaps and the trends in consumption of the materials which synchronize with them will be indicated in the discussion which follows.

Table 149 shows fluctuations in annual average prices, 1913 to 1931, of coconut oil, cottonseed oil, inedible tallow, and rosin. Because of differences in costs of preparing for soap making, as well as differences in the markets represented, these prices should not be taken as the basis for even an approximate determination of price differences in any given year. They may, however, be taken as roughly indicative of the direction of the changes in different oils.

Table 149 shows also the proportions of the total quantity of oils used in soap making consisting of (1) coconut and palm-kernel oils combined, (2) cottonseed oil, (3) combined inedible animal oils—tallow and greases—and competitive oils, principally palm, whale, and fish oils, and (4) the quantity of rosin used in soap making. When in the latter part of the period, 1913–1931, tallow supplied a somewhat reduced proportion of consumption, the oils competitive with it supplied a correspondingly increased proportion.

The decreasing use of rosin in soap making shown by the last column of Table 149 may be taken as directly indicative of the extent of the decrease in the production of yellow laundry soaps and the increase in that of white laundry soaps, including soap flakes, beads, granules, and powdered soaps. In these white soaps inedible animal oils (and competitive materials) almost entirely susperseded cottonseed oil, formerly used to a considerable extent in their manufacture. Moreover, in the yellow laundry soaps which continued to be made the same thing happened, with the result that cottonseed oil became a minor factor in the soap kettle at the same time that coconut oil and inedible animal oils increased in importance.

TABLE 149.—*Comparison of prices and consumption in soap making of coconut oil, cottonseed oil, rosin, and inedible tallow*

Year	Price (cents per pound) [1]				Percentage of consumption of oils in soap making supplied by [2]			Consumption of rosin in soap [5]
	Coconut oil, crude (in tanks), Pacific coast	Cottonseed oil, prime summer yellow (in tanks), New York	Tallow, inedible, packers' prime, Chicago	Rosin, K grade, Savannah [3]	Coconut and palm-kernel oils	Cottonseed oil	Inedible tallow and competitive materials [4]	
								1,000 lbs.
1913	12.0	7.3	7.1	1.7				
1914	12.2	6.6	6.9	1.5	13.4	14.6	47.8	185,310
1915	12.3	6.8	6.9	1.3				
1916	15.1	10.6	9.9	2.0	11.0	18.4	45.2	
1917	17.1	15.4	15.6	2.1	14.4	10.5	44.1	
1918	18.1	20.1	17.9	3.5				
1919	17 4	24.1	15.4	5.8	20.6	6.2	50.3	119,529
1920	17.4	15.4	13.1	5.3				
1921	10.1	7.9	6.4	1.5	19.7	4.8	59.0	
1922	8.4	10.1	7.1	1.7	21.3	1.8	64.6	
1923	8.2	11.3	8.2	1.7	22.7	.9	63.6	
1924	8.6	10.8	8.5	1.8	20.0	.8	66.9	104,956
1925	9.8	10.8	9.7	3.5	23.4	.6	61.2	140,615
1926	9.4	11.8	8.7	4.5	23.8	.3	60.6	118,257
1927	8.2	9.7	8.1	3.2	22.5	.5	60.9	100,227
1928	8.0	9.9	8.8	2.8	23.6	1.2	61.3	92,777
1929	7.1	9.7	8.5	2.7	24.6	.7	60.4	114,300
1930	5.9	8.1	6.8	1.9	21.3	.5	64.4	
1931 [6]	4.5	7.2	4.3					

[1] Bureau of Labor Statistics, Wholesale Prices.
[2] Computed from data given in section on soap making.
[3] Thomas Gamble. Yearbook, 1913-1918 (naval stores); Naval Stores Review, 1921-1930.
[4] Includes greases, red oil, palm oil, whale, and fish oils.
[5] Bureau of the Census, 1914, and 1919; Bureau of Chemistry and Soils, 1924-1929.
[6] Average for first six months.

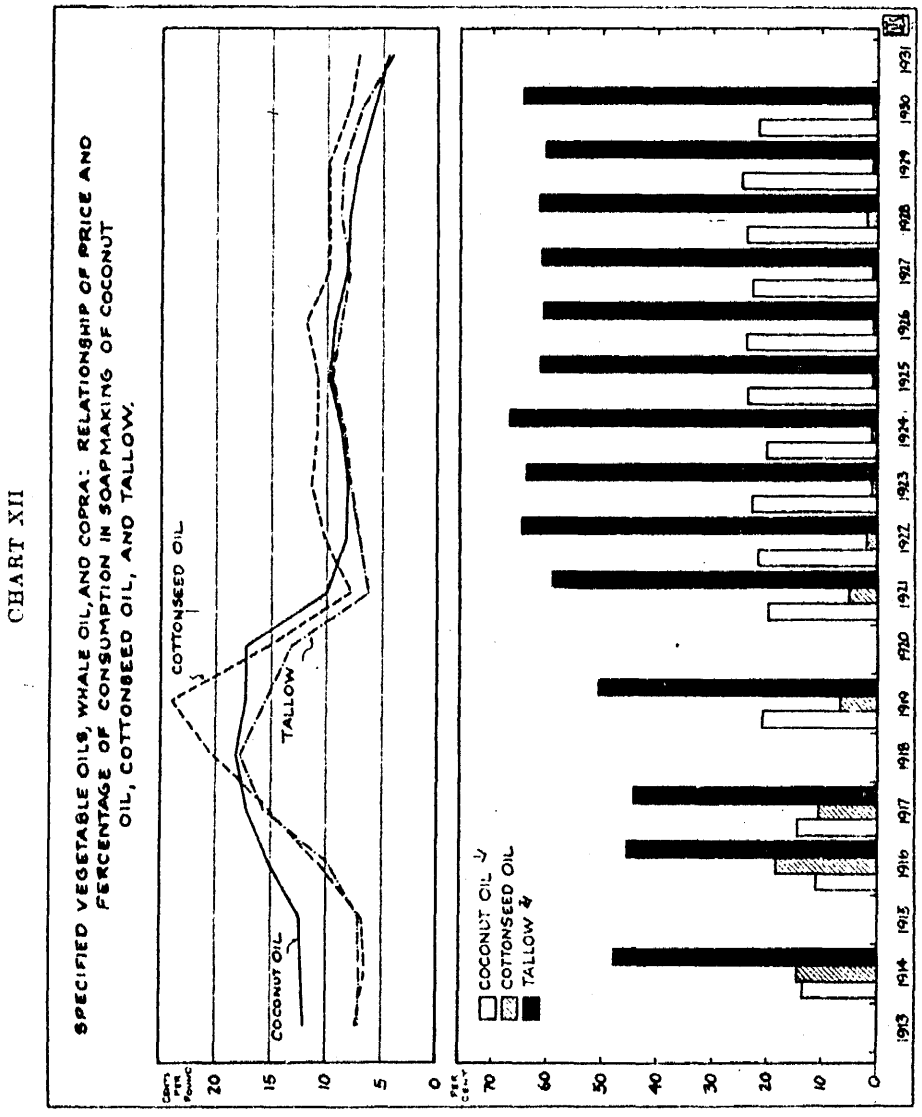
Prices and consumption of coconut oil, cottonseed oil, and tallow.—Table 149 shows that the change in the relative price positions of coconut and cottonseed oils was concurrent with a change in the relative importance of the two oils.[7] But the change in price positions can not be assumed to be the principal cause of the increased use of coconut oil and the decreased use of cottonseed oil. In both 1920 and 1921, indeed, cottonseed oil was lower in price than coconut oil and yet the use of coconut oil diminished only slightly, and the use of cottonseed oil continued to decline although at a slower rate. This may have been due, in part, to changes in the type of soap produced, but possibly more important was the fact that inedible tallow, which in the war period declined in relative price position, remained lower in price than cottonseed oil, with the result that it continued to be used in both yellow and white laundry soaps instead of cottonseed oil. As has already been indicated, the price of tallow in relation to cottonseed and coconut oils is a much more significant price comparison than that of the two vegetable oils in relation to each other.

Before 1918 tallow and cottonseed oil were about at a parity in price, whereas since 1918 tallow has averaged consistently lower in

[7] Not all the decrease in the use of cottonseed oil between 1916 and 1919 was due to the relatively low price positions of coconut oil nor to changes in the type of soaps produced. Part of it may be attributed to the competition of soybean oil, which in the greater part of 1917, 1918, and 1919, was in an advantageous price position as compared with cottonseed oil. This situation is set forth in the discussion of competition between soft vegetable oils.

price, usually by a considerable margin. This is indicated by Table 149; also by Chart XII, which traces graphically the course of prices of coconut oil, tallow, and cottonseed oil and the changes in the relative importance of each in soap making. With the consumption of tallow, as charted, are included competitive materials, such as grease, and palm, whale, and fish oils.

Table 150 affords another comparison of prices of coconut oil, cottonseed oil, and inedible tallow, with which are also shown prices



of brown grease. All these prices are for the Chicago market. The prices for coconut oil are based on those shown in Table 149 at Pacific coast mill plus freight to Chicago. Figures are given for two grades of inedible tallow—for the prime packers' grade, already shown in Table 149, and, from 1920 to 1931, for the No. 1 packers' grade, which is the highest grade ordinarily used in yellow laundry soap. The prices shown for cottonseed oil are for the soap grade, ordinarily used in yellow laundry soaps and probably inferior to that which would be used in white laundry soaps.

The comparison between packers' prime inedible tallow and cottonseed oil indicates the same course of price relationships as shown in Table 149, except that for 1920 and 1921 it indicates an approximate price parity for the two oils. In most months of 1920 to 1924, prices of this grade of cottonseed oil must have been nominal, actual transactions being infrequent. With prices moving rapidly downward, this factor probably served to give an annual average price (computed by dividing the sum of the monthly averages by 12) for this grade of cottonseed oil above the average at which sales were made. However, Table 149, which represents more nearly actual transactions, shows that in those years the regular bleachable prime summer yellow grade, which after bleaching would be used in white laundry soaps, brought a higher price than prime packers' tallow. Even the soap grade of cottonseed oil (Table 150) brought a higher price than the No. 2 grade tallow with which it would be competitive and a much higher price than brown grease with which it would also be competitive.

It will be noted that prices of coconut oil and the soap grade of cottonseed oil do not have a constant relationship. This denotes small competition between them. The soap grade of cottonseed oil is an off grade used mainly in yellow laundry soaps in which coconut oil does not enter as a significant factor, whatever competition this cottonseed oil encounters being with the lower grade tallows and greases.

TABLE 150.—*Comparison of prices of inedible tallow, brown grease, cottonseed and coconut oils, Chicago*

[In cents per pound]

Calendar year	Inedible tallow		Brown grease [1]	Prime summer yellow cotton-seed oil, soap grade [1]	Coconut oil [2]
	No. 1 packers [1]	Prime packers [2]			
1913	----	7.1	----	6.5	12.6
1914	----	6.9	----	6.2	12.8
1915	----	6.9	----	6.2	12.8
1916	----	9.9	----	9.8	15.6
1917	----	15.6	----	13.6	17.6
1918	----	17.9	----	19.2	18.9
1919	----	15.4	----	21.4	18.5
1920	11.9	13.1	9.6	13.3	18.8
1921	5.0	6.4	3.3	6.3	11.3
1922	6.2	7.1	5.1	9.3	9.6
1923	7.0	8.2	6.5	10.2	9.0
1924	7.6	8.5	6.2	9.5	9.4
1925	9.1	9.7	8.1	9.3	10.6
1926	8.1	8.7	7.0	10.3	10.2
1927	7.4	8.1	6.0	8.1	9.0
1928	8.2	8.8	7.0	8.4	8.8
1929	7.9	8.5	7.1	8.1	7.8
1930	5.7	6.8	4.6	6.9	6.6
1931 [4]	3.8	4.3	3.0	6.4	5.2

[1] The National Provisioner.
[2] Bureau of Labor Statistics, Wholesale Prices.
[3] Ibid, 1913–1922: Oil, Paint and Drug Reporter, 1923–1931.
[4] Average for first 6 months.

Prices of rosin.—By reference to Table 149, it will be seen that the tendency of rosin to rise in price as compared with coconut oil was a minor contributing cause of the shift from yellow to white laundry soap. Throughout the period 1913–1931 rosin was lower in price

than coconut oil or any other oil used in soap making. From 1914 to 1919, however, coconut oil increased in price about one-half while rosin more than trebled, with the result that the relative difference decreased. From 1921 to 1924, inclusive, the relative price differences were greater but not so great as before the war. After 1924, however, the differences became less, in most years less than in 1919. More than that, the spread between them in cents per pound became less than ever before.

Influence of glycerin yields and prices.—Still another price factor must be considered in explaining the increased use of coconut oil. Glycerin is a valuable by-product of soap manufacture, and the quantity of glycerin recoverable from a particular oil is a factor in choosing among oils which may be used for the same purpose. This factor always favors coconut oil as compared with other soap-making oils, as it yields 18 per cent of crude glycerin, which compares with 13½ per cent from tallow, 13 per cent from cottonseed oil, 12 per cent from palm oil, and none from rosin. The advantage of coconut oil in this respect was of most importance in the war period, as is shown by annual average prices of glycerin in Table 151. The high glycerin yield must have been a contributing cause of the increased use of coconut oil in that period.

TABLE 151.—*Annual average price of glycerin (C. P. grade)* [1]

[In cents per pound]

Calendar year	Price	Calendar year	Price
1913	19.7	1923	17.2
1914	21.5	1924	17.2
1915	29.6	1925	19.1
1916	50.8	1926	26.2
1917	61.1	1927	25.4
1918	60.5	1928	16.3
1919	22.0	1929	14.8
1920	24.3	1930	14.0
1921	17.0	1931 [2]	12.4
1922	16.6		

[1] War Industries Board reports 1913-1918; Oil, Paint and Drug Reporter, 1919-1923; Summary of Tariff Information (1921), 1921-1928; Chemical Markets, 1929-1931 (New York).
[2] Average for first 6 months.

Conditions of supply and demand.

In analyzing at this point the conditions of supply and demand underlying these changes in price relationship and in the materials used in soap making, attention is confined principally to cottonseed oil and rosin. The characteristics of coconut oil for soap making have been fully discussed as have also its rapid expansion in production since 1913 and its possible further expansion. Little need be said here about the conditions of supply of inedible animal oils. Shortage of fats during the World War period caused an increased production of these animal oils and led eventually to their fall in price and to a larger use in soaps; after 1923, their production increased more slowly than did the total consumption of oils in soaps but no increase in price resulted, largely because of the availability of substitute materials, which increasingly supplemented tallow and greases in soap making. The next section analyzes the competition between the inedible animal oils and the substitute materials—palm oil and hydrogenated whale and fish oils; for the purposes of the present

investigation, this is a more significant competition than the limited competition between inedible animal oils and coconut oil and between them and cottonseed oil, both being domestic products.

Cottonseed oil.—The supply of cottonseed oil does not respond readily to increases in price, for it is one of four joint products made from cottonseed, which itself is a by-product of the cotton crop. In any year the production of cottonseed oil is limited by the size of the cotton crop. The price received for the oil, of course, influences directly the price of cottonseed and the amount of income received from cotton products, but it can have little effect on the size of subsequent cotton crops. Should the farmers plant more cotton by reason of a favorable price for cottonseed, they would run the risk of lowering the price of the main product, with a resultant net loss in income. This point is clear from the statistics of the relative value of cottonseed oil as compared with cotton as a farm product. In the five years 1926–1930 the seed sold to crushers represented only about 15 per cent[8] of the farm value of cotton and cottonseed combined. Moreover, of the value of cottonseed crushed during this period, only about one-third may be attributed to the oil, the remaining two-thirds representing the combined value of the cake, hulls, and linters. To the farmer, therefore, cottonseed oil represents only about 5 per cent of the value of his cotton products.

Not all of the cottonseed produced is used for oil, but during recent years the great bulk of the output not required for planting has been subjected to crushing, and any increase in the price of cottonseed oil could have added only moderately to the proportion of seed crushed. Table 152 shows the relation between the estimated total production of cottonseed (these figures are less precise than those of the quantity crushed), the amount and percentage crushed, and the prices of cottonseed and cottonseed oil. The increase in the proportion of seed crushed during 1913 and 1914 as compared with the period 1909–1912 was a continuation of a trend which had prevailed since the initiation of the cottonseed crushing industry. The exceptionally large proportion crushed during the war years 1916–1919, when the total output of seed was relatively small, may no doubt be attributed in part to the very high prices. On the other hand, the exceptionally low price of cottonseed oil in 1921 presumably was a factor in the reduction in the proportion of seed used for oil during that year. During recent years, however, there has been no very close relation between the proportion of seed crushed and prices. The proportion has been generally from 75 to 80 per cent of the production. The farmers usually reserve about 20 per cent of their seed for planting, for although the quantity actually required for a single planting is only about 10 per cent (varying, of course, with the size of the given crop and the acreage to be planted for the next crop), provision must be made for the possibility of bad weather, necessitating planting two or even three times. If the planting season proves favorable, farmers may sell the surplus seed for crushing. The planting reserve, however, often is stored under such conditions as to cause waste and deterioration. Sometimes it is used as a feed or thrown on the compost pile to be used as a fertilizer.

[8] The total farm value of cotton in 1926–1930 was $5,446,290,000; the quantity of seed crushed, 53,189,614,000 pounds. Applying the average price (1.5 cents per pound) for seed, the total farm value of this seed was $797,844,210. Department of Agriculture Yearbook. The total value of crude cottonseed oil produced in those years was $407,568,000; of linters, hulls, and cake and meal taken together, $831,257,000. Department of Commerce, Bureau of the Census.

TABLE 152.—*Production and prices of cottonseed oil and the quantity and percentage of seed crushed* [1]

[Data relate to crop years ending June 30 or July 31]

Period	Cottonseed			Prices (cents per pound)		Production of cottonseed oil
	Production	Quantity crushed	Per cent of production crushed	Cottonseed [2]	Cottonseed oil [3]	
	Pounds	*Pounds*				*Pounds*
Average, 1908–1912	10,996,000,000	7,412,430,000	67.4	1.1	6.3	1,125,690,000
1913	12,208,000,000	9,159,016,000	75.0	1.1	7.3	1,393,125,000
1914	12,610,000,000	9,695,256,000	76.9	.9	6.6	1,449,975,000
1915	14,372,000,000	11,559,330,000	80.4	1.7	6.8	1,719,450,000
1916	9,984,000,000	8,404,626,000	84.2	2.6	10.6	1,253,325,000
1917	10,226,000,000	8,958,352,000	87.6	3.3	15.4	1,407,660,000
1918	10,080,000,000	9,503,360,000	84.4	3.3	20.1	1,312,470,000
1919	10,720,000,000	8,957,016,000	83.6	3.4	24.1	1,325,333,000
Average, 1916–1919	10,252,500,000	8,955,838,000	85.0	3.2	17.5	1,324,697,000
1920	10,148,000,000	8,025,408,000	79.1	1.1	15.4	1,211,404,000
1921	11,942,000,000	8,138,332,000	68.1	1.5	7.9	1,309,183,000
1922	7,052,000,000	6,015,434,000	85.2	1.7	10.1	930,475,000
1923	8,672,000,000	6,483,114,000	74.8	2.1	11.3	1,002,922,000
1924	9,004,000,000	6,615,196,000	73.5	1.7	10.8	979,617,000
1925	12,102,000,000	9,210,454,000	76.1	1.6	10.8	1,403,781,000
1926	14,300,000,000	11,116,480,000	77.7	1.1	11.8	1,617,015,000
1927	15,978,000,000	12,611,550,000	78.9	1.8	9.7	1,887,910,000
1928	11,516,000,000	9,308,034,000	80.8	1.8	9.9	1,476,609,000
1929	12,870,000,000	10,122,116,000	78.6	1.6	9.7	1,604,131,000
1930	13,180,000,000	10,031,428,000	76.1	1.3	8.1	1,572,322,000
Average, 1926–1930	13,568,800,000	10,637,923,000	78.4	1.5	9.8	1,631,597,000

[1] Bureau of the Census, Cotton Production and Distribution (published annually).
[2] Converted from dollars per ton.
[3] Bureau of Labor Statistics, Wholesale Prices, prime summer yellow (New York).

Should it be assumed that on the average over a period of years the proportion of seed crushed could be increased to 85 per cent, which was the average ratio for the years 1916–1919, this would represent only a relatively small total addition to the output of cottonseed oil. From 1922 to 1930 the proportion crushed averaged 78 per cent, or 7 per cent less than the theoretical maximum. This 7 per cent would represent about 120,000,000 pounds of oil annually, which is equal to only 6 or 7 per cent of the total quantity of oils now being used in soap making.

It appears clear, therefore, that any limitation of the production or importation of oils competitive with cottonseed oil, while it might result in increasing the price, could not be expected greatly to add to the output of that product unless it should become commercially practicable to adopt methods of oil extraction which will recover a much larger proportion of oil from the seed. This is true not only because a large increase in oil production would necessitate an increase in the cotton crop but also because it would necessitate an increase in the production of oil cake and oil cake meal, the principal joint products of cottonseed oils. Prices of oil cake and meal appear particularly sensitive to fluctuations in production. Consideration of the relation between the price of cottonseed oil and that of these joint products is taken up later in this report.

Table 152 shows that the production of cottonseed oil was declining from 1917 to 1923, during which years it practically ceased to be used in soap making. Before this period its consumption in foods already had overshadowed its consumption in soaps, and as early in the period as 1914, 1,362,000,000 pounds were used in foods com-

pared with only 119,000,000 in soap. In fact, for a decade or more, demand for food uses had been increasing apace, causing an increased utilization of cottonseed in crushing and a progressive diversion of cottonseed oil from the soap kettle, principally into the manufacture of lard compounds but partly into the production of salad and cooking oils. This tendency probably would have continued even under normal conditions and have led to an increase in the price of cottonseed oil as long as the price of lard was substantially higher. The additional stimulus to demand brought about by war conditions merely made the increase in price much greater than it would have been in a more normal period.

Lard compounds versus lard.—The increasingly greater demand for cottonseed oil in edible uses than in soap making resulted largely from the high price level of the edible products made from cottonseed oil compared with the price level of most soaps and from the fact that cottonseed oil is better fitted by physical characteristics for making lard compounds than for soap making. The processes of making cottonseed oil into lard compound were perfected after long experimentation, and the new product resulting from it was introduced to the public through national advertising. By such means and by its lower price, it won its way in keenest competition with lard.

Since the war period, cottonseed oil has maintained its position as an edible oil and held a higher price level than coconut oil or other oils used mainly in soap making. Its price fluctuations show little connection with those of coconut oil. One of the principal factors, from the side of demand, affecting its price has been the competition of lard with lard compound. This competition distinctly limits the price of lard compound; in turn, the price of American lard, which is exported in large quantities, is limited by the competition in Europe not only of lard from other countries but of margarines, used there largely in cooking, and of other cooking fats. Another factor to be taken into account is the direct competition of other cooking fats with exported domestic lard compounds, and of other edible oils with exported domestic cottonseed oil, in European markets. Because of declining exports this factor has been dwindling in significance. But of increasing importance is the competition which cottonseed oil encounters in the domestic market from domestic corn oil and imported sesame oil in making salad oils and salad dressings. In recent years this use of cottonseed oil has gained greatly in importance.

Table 153 shows prices of cottonseed oil, lard compound, and lard; also the per capita consumption of lard compounds and lard including compounds made primarily of animal oils as well as of cottonseed and other vegetable oils. It shows that lard compounds sell usually from 2 to 3 cents per pound lower than lard and for about the same amount higher than prime summer yellow cottonseed oil. The figures for per capita consumption of lard may be accepted as reasonably accurate, but those of lard compounds for some years are based on estimates of production which may involve a considerable margin of error. They agree roughly, however, with what is known to have been the trend.

TABLE 153.—*Comparison of prices of cottonseed oil, lard, and lard compounds, with the per capita consumption of lard and lard compounds*

Calendar year	Price (in cents per pound)			Approximate per capita consumption (in pounds)	
	Cotton-seed oil [1]	Lard com-pounds [2]	Lard [2]	Lard com-pounds [3]	Lard [4]
1914	6.6	.....	10.2	11.0	12.2
1915	6.8	.....	9.3	.....	12.9
1916	10.6	.....	13.2	9.7	13.6
1917	15.4	17.4	21.7	10.9	11.7
1918	20.1	22.9	25.8	10.8	13.3
1919	24.1	26.2	28.4	11.7	12.3
1920	15.4	18.6	22.2	6.7	13.3
1921	7.9	10.2	13.2	7.0	11.3
1922	10.1	11.9	13.1	6.5	14.2
1923	11.3	12.8	13.9	6.5	15.3
1924	10.8	13.8	14.7	7.0	15.4
1925	10.8	13.2	17.9	9.8	13.2
1926	11.8	13.6	16.9	9.6	13.5
1927	9.7	11.8	13.7	9.9	13.8
1928	9.9	12.0	13.3	9.5	14.7
1929	9.7	11.6	13.0	9.9	14.3
1930	8.1	.....	12.0	9.8	.....

[1] Bureau of Labor Statistics, Wholesale Prices.
[2] Institute of Margarin Manufacturers (Chicago, November, 1930).
[3] From 1914 to 1921, production less exports—Supplement to Bulletin No. 769, Department of Agriculture for production data from 1914 to 1919; 1920 and 1921 estimate based on data obtained from the trade by Tariff Commission; 1922 to 1929 computed by Institute of Margarin Manufacturers Bulletin, November, 1930; production less exports, 1930, Bureau of the Census.
[4] Department of Agriculture, Bureau of Agricultural Economics, Statistics of Meat Production, Consumption, and Foreign Trade of the United States.

Question of replacement of cottonseed oil by coconut oil in soap.

In the early years of the production of cottonseed oil it was probably used mainly in soap making; as long as that continued true the actual domestic production was much smaller than the total potential production based on the quantity of cottonseed produced in excess of the required planting reserve. For 30 years, and probably longer, however, it has been predominantly a food oil, although it was still a considerable factor in soap production in the immediate pre-war and early war years. After 1917, it rapidly disappeared from the soap kettle (except for relatively small quantities, usually of damaged or off grades). This is indicated by the data in Table 154, in large part brought together from tables already presented. The decline from 1917 to 1923 in the use of cottonseed oil in soap is apparently to be attributed largely to the decline in the production of cottonseed oil, due to a succession of short cotton crops; the demand for the oil in food uses being strong, the reduced supply soon came to be used almost entirely for food. Since 1924 the production of cottonseed oil has been much larger but there has been no restoration of its use for soap.

The data in the preceding table may be discussed from several points of view, but first, with reference to what occurred technically in the soap industry as cottonseed oil gradually ceased to be used. From the facts already presented, it appears that the changes were mainly three: (1) a shift from cottonseed to inedible animal oils (tallow and greases) in making yellow laundry soap, (2) a similar shift in making white laundry soap, and (3) a shift from yellow to white laundry soap. All these changes began before the period covered by the table but

were completed in that period. The change in composition of yellow laundry soap did not affect the use of coconut oil, which does not blend well with rosin. Involved, however, in the shift from cottonseed oil to inedible animal oils in white laundry soaps was a small, and in the shift from yellow to white laundry soaps, a considerable increase in the use of coconut oil. The change in composition of white soaps does not materially alter the characetristics of the resulting soap. A white laundry soap, however, differs materially from a yellow laundry soap.

TABLE 154.—*Importance of the soap use of cottonseed oil and the positions of cottonseed and coconut oils in soap making* [1]

[In millions of pounds]

Calendar year [2]	Production of cottonseed oil	Net exports of cottonseed oil	Production less net exports	Consumption of cottonseed oil in soap	Consumption of coconut and palm-kernel oils in soap	Total consumption of oils in soap	Percentage of total consumption consisting of—	
							Cottonseed oil	Coconut and palm-kernel oils
1912	1,512	398	1,114	132	100	741	17.8	13.4
1914	1,450	175	1,275	119	109	819	14.6	13.4
1916	1,253	249	1,004	195	117	1,059	18.4	11.1
1917	1,408	146	1,262	126	174	1,202	10.5	14.4
1919	1,325	165	1,160	56	188	908	6.2	20.6
1921	1,309	252	1,057	48	196	991	4.8	19.7
1922	930	75	855	20	239	1,119	1.8	21.3
1923	1,003	49	954	11	271	1,196	.9	22.7
1924	980	43	937	10	264	1,321	.8	20.0
1925	1,404	62	1,342	8	331	1,415	.6	23.4
1926	1,617	34	1,583	5	354	1,486	.3	23.8
1927	1,888	68	1,820	7	366	1,626	.5	22.5
1928	1,477	52	1,425	20	386	1,635	1.2	23.6
1929	1,604	26	1,578	12	417	1,692	.7	24.6
1930	1,572	28	1,544	8	332	1,560	.5	21.3

[1] Sources: Other sections of the report.
[2] Except exports from 1912 to 1917 which are fiscal years.

The changes in soap discussed above are the technical means of reducing the use of cottonseed oil in soap. The causes of the reduction, on which the question of replacement largely turns, lie in the fundamental factors affecting the consumption and production of the two oils. These causes have been developed at different points in the report and require only brief summary here.

Cottonseed oil practically disappeared from the soap kettle fundamentally as a result of changes in the types of soap consumed, and of the absorption of cottonseed oil into food uses at prices above the level of soap oils. Changes in the types of soap may be due partly to changes in consumers' preferences and partly to advertising undertaken to provide a market for products made from oils obtainable at low prices. The absorption of cottonseed oil into food uses, which is perhaps the more important of the two causes, is accounted for by its special adaptability to the production of lard compounds and of salad oils and salad dressings. To some extent this absorption involved exports to Europe, which, however, Table 154 shows to be declining. It was, moreover, rendered possible by the conditions of supply of cottonseed, which severely restricted any increase of output in response to increase in price and thus kept production within the limits of consumption in the food industries. Under these circumstances, only by

raising the general price level of soap oils to the level of edible oils could any considerable quantity of cottonseed oil have been retained in the soap industry.

The question of replacement may also be approached by considering what might be the effect on the future utilization of cottonseed oil of a drastic reduction or elimination of coconut oil. It is obvious from what has been said that any large increase in the use of cottonseed oil in place of coconut oil in soap making could be accomplished only by material changes in the character of soap produced. Whether the possibility of an increase involving such qualitative changes may be regarded as evidencing replacement is a problem on which the commission expresses no opinion.

Leaving aside the question of changes in the character of soap which might result, the possibility of increasing materially the use of cottonseed oil in soap if the use of coconut oil should be reduced depends largely on the extent to which cottonseed oil might be diverted from lard compounds (through an increase in price of soap oils), any large increase in its production being out of the question. This would involve the diversion of lard from the export trade to use in domestic consumption in place of lard compounds made of cottonseed oil. Strong competition would result between lard and lard compounds for the market for cooking and shortening fats and between the lard compound and soap industries for cottonseed oil. The results of this competition can not be predicted, as the effect of increased prices for soap and for shortening fats upon the volume of demand can not be predicted in advance.

As was pointed out in the general summary statement and developed in detail under the preceding heading, the diversion of cottonseed oil from food uses into the soap kettle would reverse the tendency which has prevailed for three decades. This tendency was strong even when cottonseed oil was yet lower in price than coconut oil. In 1914, for example, although more cottonseed oil than coconut oil was used in soap, the quantity so used amounted to only 119,000,000 pounds as compared with 1,362,000,000 pounds used for food.

The question of the replacement of cottonseed oil by coconut oil in the soap industry leads to the wider question whether under a different tariff policy soft vegetable oils other than cottonseed oil, such as corn, peanut, and soybean oils, could be produced in the United States to take, in a measure, the place once held by cottonseed oil in soap making. This question is considered in a later section dealing with competition among soft vegetable oils.

(F) WITH REFERENCE TO ROSIN

Rosin is produced jointly with turpentine, either by the distillation of the sap or gum of the pine tree, or by the distillation of resinous wood itself. Gum rosin is the more important in value as well as in quantity of production. Table 155 gives the production, net exports, and prices of rosin in specified years 1914 to 1929. It shows that since 1922 the output of both gum and wood rosin has increased, but that the increase in wood rosin has been the larger of the two. The Bureau of the Census in its report of 1922 on the production of turpentine and rosin makes the following statement:

> No great increase in the production of turpentine and rosin by the distillation of crude gum is anticipated, but it is rather expected that the production will

decrease because of the depletion of the available resinous pine timber, * * * The production of turpentine and rosin from wood, however, is likely to increase, as there are vast quantities of resinous logging wastes and tree stumps still available throughout the South.

Whether the utilization of these wastes has yet reached its maximum is problematical.

TABLE 155.—*Production, net exports, and prices of rosin*

Year	Production (in thousands of pounds) [1]			Net exports, (in thousands of pounds), calendar years) [2]	Price of Grade K rosin, Savannah (cents per pound) [3]
	Gum rosin, crop years ended Mar. 31	Wood rosin, years ended Dec. 31	Total		
1914	[4] 807, 822	14, 511	822, 333	074, 284	1. 5
1917	765, 500	50, 000	815, 500	458, 675	2. 1
1918	557, 500	61, 500	610, 000	299, 806	3. 5
1919	[4] 569, 330	65, 528	634, 858	338, 600	5. 8
1920	788, 500	90, 000	878, 500	325, 870	5. 3
1921	830, 812	14, 674	845, 486	280, 403	1. 5
1922	749, 769	76, 128	825, 897	399, 547	1. 7
1923	895, 044	100, 389	995, 433	601, 365	1. 7
1924	860, 382	148, 766	1, 009, 148	725, 541	1. 8
1925	789, 433	[4] 162, 252	951, 685	579, 085	3. 5
1927	1, 035, 906	[4] 226, 094	1, 262, 000	685, 331	3. 2
1929	988, 212	239, 278	1, 227, 490	717, 694	2. 7

[1] Biennial Census of Manufactures, 1927, for 1914-1927; for 1929, Bureau of the Census, press notices.
[2] For 1914-1918 Tariff Information Surveys A-11; Summary of Tariff Information, 1922-1928; Foreign Commerce and Navigation of the United States, 1919-1921 and 1929.
[3] Gamble, naval stores, Yearbook, 1914-1920; Naval Stores Review, 1921-1929.
[4] Calendar year.
[4] Crop year ended Mar. 31 of succeeding year.

The principal uses of rosin in the order of their importance are (1) in sized paper, (2) in paints and varnishes, and (3) in soaps. Paper manufacture usually takes the lowest, paints and varnishes the highest, and soap making the medium grades. There is considerable overlapping, however, as the better paper grades and the poorer varnish grades are also used in soaps. Demand has been increasing in the paper industry and, to a less extent, in the paint and varnish industry, but except for an upward trend in 1929, it has been decreasing in the soap industry because of the substitution of white for yellow laundry soaps. The domestic consumption of rosin by these three industries from 1924 to 1929 was as follows:

Year	In paper manufacture	In paints and varnishes	In soaps	In other uses	Year	In paper manufacture	In paints and varnishes	In soaps	In other uses
	Per cent	*Per cent*	*Per cent*	*Per cent*		*Per cent*	*Per cent*	*Per cent*	*Per cent*
1924	31. 8	25. 3	24. 3	18. 6	1927	32. 8	25. 2	22. 1	19. 9
1925	31. 2	22. 7	28. 0	18. 1	1928	36. 1	29. 3	16. 9	17. 7
1926	33. 1	22. 3	24. 0	20. 6	1929	35. 1	25. 7	20. 7	18. 5

The decline in the use of rosin in soap making presents a question of the meaning of the term "replacement." There is no direct competition between coconut oil and rosin; there is, however, competition between two distinct types of soap—between yellow laundry soap made of rosin, low-grade inedible animal oils (or palm, whale, or cottonseed oil), and a small proportion of sodium silicate, on one side, and white

laundry soap made of coconut oil, higher grade inedible animal oils, and a larger proportion of sodium silicate, on the other. As has been pointed out before, rosin is the quick-lathering ingredient of the yellow soaps and coconut oil of the white.

The probability is that taking the two combinations of oils as a whole, sometimes one and sometimes the other has been lower in price. The shift from one to the other, nevertheless, was to some extent a matter of price, for the decline in price of coconut oil made it economically feasible to produce white laundry soap on a large scale in competition with yellow laundry soaps. Many consumers substituted white for yellow laundry soaps. As far as can be determined the price difference between the two soaps is usually small, sometimes one and sometimes the other having a small price advantage.

The quantity of rosin actually used in soaps in each year subsequent to 1914 and the quantity which would have been used if its consumption, instead of decreasing, had increased to the same extent as did the total comsumption of oils, are shown in the following tabulation. In making this estimate, the consumption of rosin in soap making in 1914 is taken as the base. The trend from yellow to white laundry soap began before 1914, however, 290,000,000 pounds of rosin being used in 1909 as compared with 185,000,000 pounds in 1914.

[In thousands of pounds]

Calendar year	Amount of rosin used in soap	Amount of rosin which would have been used in each year specified in soap if its use had increased compared with 1914 to the same extent as the use of oils	Difference
1919	119,529	203,841	84,312
1924	104,956	298,349	193,393
1925	140,615	318,733	178,118
1926	118,257	335,411	217,154
1927	100,227	336,913	206,686
1928	92,777	368,766	275,989
1929	114,300	387,297	272,987

The increased quantity of rosin required to have maintained the same proportionate production of yellow laundry soaps as in 1914 was exceeded several times by the quantity of exports, which in recent years have ranged from 600,000,000 to 700,000,000 pounds annually. There may, however, be some question of the effect on rosin prices of large additional demand from the soap industry.

3. Economic Factors Affecting the Interchangeability of Palm and Whale Oils with Domestic Inedible Animal Oils, Including Tallow, Grease, and Fish Oils

SUMMARY OF TECHNICAL AND STATISTICAL INFORMATION

The information, statistical and technical, presented in Parts III and IV on palm and whale oils may be briefly summarized as follows:

(1) With respect to palm oil—

(*a*) The apparent domestic consumption of palm oil, all of which is imported, may be taken as equal to imports, which declined during

the war period from 62,000,000 pounds in 1914 to 19,000,000 pounds in 1919 but rose to 58,000,000 pounds in 1922, 128,000,000 pounds in 1923, and 287,000,000 in 1930.

(*b*) In recent years three-fourths or more of the palm oil imported into the United States has been used in the soap industry, where it is technically interchangeable with inedible tallow and grease in making certain types of soap. The quantity of palm oil consumed in that industry rose from 17,268,000 pounds in 1919 to 192,331,000 pounds in 1929, or more than eleven fold, and from less than 2 per cent to more than 11 per cent of the total quantity of oils used for soap.

(*c*) The second largest use of palm oil is in the production of tin plate, which takes about 15,000,000 pounds annually. So far, no other material has been used on a commercial scale for this purpose, although tests seem to indicate that hydrogenated cottonseed oil could be so used.

(*d*) So far the other uses of palm oil have been of relatively minor importance. As long as the only palm oil available was the rather low-grade product, high in free fatty acids, which comes from Africa, it was impracticable to use it to any considerable extent for edible purposes. But with the development of a supply of high-grade oil from the Netherland East Indies, some has been used in food products. In particular, it was used in making a yellow margarine in 1929 and 1930 and in 1931 until the passage of the law subjecting margarine of a natural as well as of an artificial yellow color to the excise tax of 10 cents per pound.

(2) With respect to whale oil:

(*a*) The apparent consumption of whale oil in the United States, that is, imports for consumption [9] plus domestic production [9] rose from 4,655,000 pounds in 1914 to 23,702,000 pounds in 1920 and to 71,473,000 pounds in 1929. The proportions supplied by imports and domestic production have varied considerably. In recent years imports have greatly predominated. In 1930, imports supplied 52,702,000 pounds and domestic production only 9,939,000 pounds.

(*b*) The great bulk of the whale oil used in the United States is first hydrogenated and then blended with other oils for use in soap making, in which it is in a measure technically interchangeable with tallow, greases, palm oil, and fish oil. In 1929, 70,664,000 pounds, or about 99 per cent, of the domestic consumption of whale oil was used in soap manufacture, where it formed about 4 per cent of the total consumption of oils. This represents a large increase in comparison with 1921, when whale oil formed only one-half of 1 per cent of the total quantity of oils used in the soap industry.

(*c*) Whale oil has been used in Europe on a large scale in the manufacture of margarine and probably to some extent in making lard compounds.

COMPARISON OF PRICE AND CONSUMPTION TRENDS

Palm oil versus inedible tallow.

The only comparison of price fluctuations among oils of this competitive group which can be made for an extended period is that between palm oil and inedible tallow, shown for 1913 to 1931 in Table 156, which also affords a comparison of changes in the relative

[9] Exports, which are probably negligible, are not separately recorded in Foreign Commerce and Navigation.

importance of those two oils in soapmaking. This table may be used even less than most of the other price tables for determining approximate price differences. Prime packers' tallow is the highest inedible grade, whereas the Niger grade of palm oil is about the lowest grade imported from Africa. The two are not interchangeable. Nevertheless, the quotations given in the table will serve to establish the trend in prices of inedible animal oils and palm oil, respectively, for the differentials between grades remain fairly constant as prices move up and down. Moreover, the fact that tallow prices are for Chicago and palm-oil prices are for New York is a counterbalancing factor, palm oil being higher and tallow lower in Chicago than in New York.

From 1913 through 1919 and in 1921, the annual average price of Niger palm oil in New York was higher than that of packers' prime inedible tallow in Chicago.[10] This indicates the small amount of competition between the two materials in those years. Palm oil was probably bought by soap makers only when as occasionally happened, it was obtainable at a parity in price with competitive grades of tallow or to make soaps, such as certain trade-marked soaps, in which it is a specially desirable ingredient. In 1922 and later years, however, Niger palm oil averaged consistently lower in price than prime packers' tallow. This new price relationship between the two oils was coincident with an increase in the use of palm oil in soap making. It will be noted, however, that from 1921 to 1925, when the change took place, both oils were rising in price, tallow prices having, however, the greater rise. Demand for this group of materials for use in soaps was increasing, and the supply of palm oil proved the more readily expansible of the two. After 1925 the trend of both prices was downward except in 1928, but the price difference between them remained fairly constant until 1931 when it again narrowed. All this is shown in Chart XIII, which follows Table 156.

TABLE 156.—*Comparison of prices and consumption in soap making of tallow and palm oil*

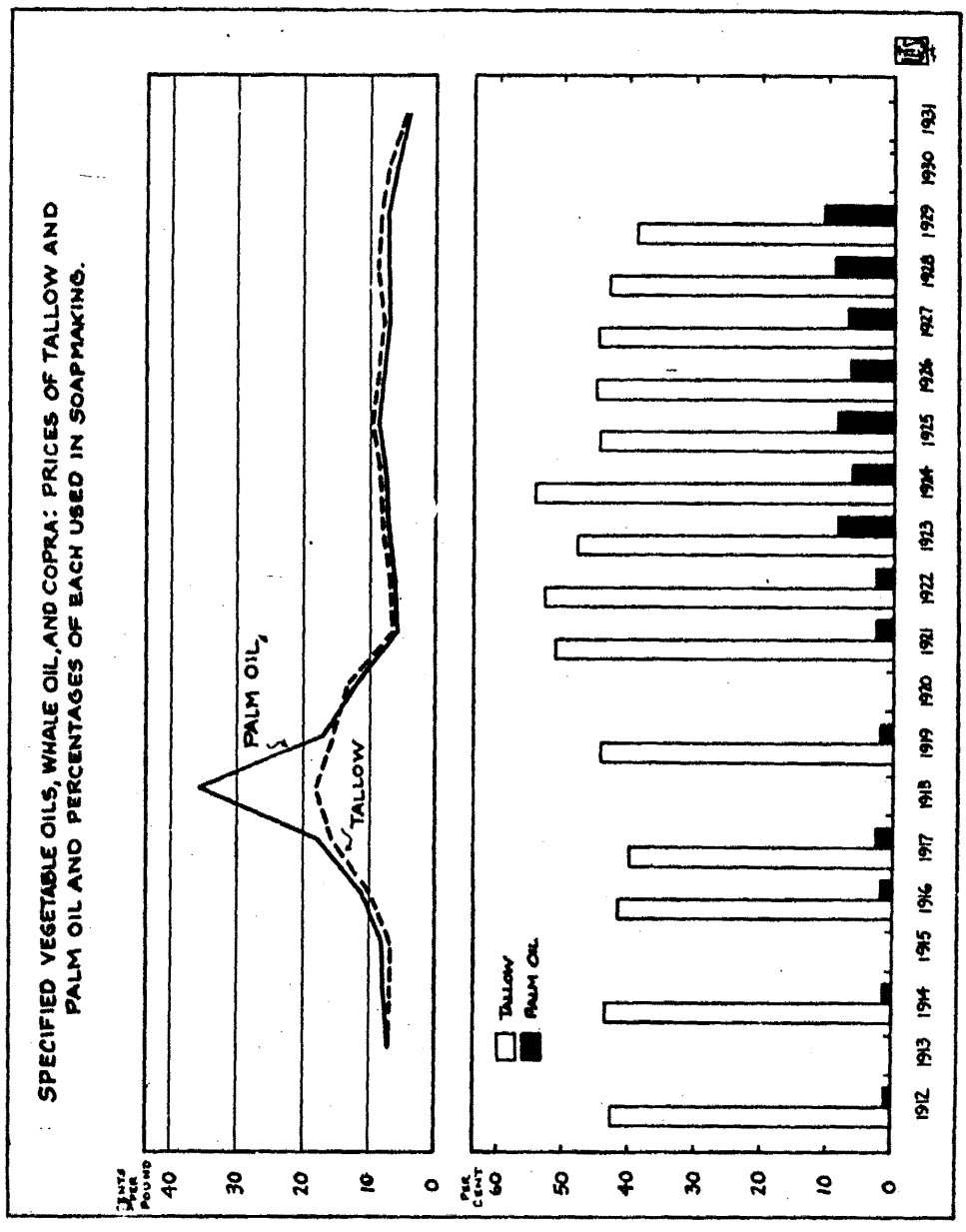
Year	Prices (in cents per pound)		Oils used in soap making consisting of—		Year	Prices (in cents per pound)		Oils used in soap making consisting of—	
	Tallow, packers prime inedible, Chicago [a]	Palm oil, Niger, N. Y. [a]	Tallow and greases [b]	Palm oil [b]		Tallow, packers prime inedible Chicago [a]	Palm oil, Niger, N. Y. [a]	Tallow and greases [b]	Palm oil [b]
			Per cent	*Per cent*				*Per cent*	*Per cent*
1912	----------	----------	42.5	1.0	1922	7.1	6.3	52.9	2.7
1913	7.1	6.9	----------	----------	1923	8.2	7.3	47.9	8.6
1914	6.9	7.6	43.4	1.2	1924	8.5	7.5	54.5	6.2
1915	6.9	8.1	----------	----------	1925	9.7	8.6	44.5	8.4
1916	9.9	11.0	41.6	1.4	1926	8.7	8.0	45.3	6.8
1917	15.6	17.6	39.7	2.3	1927	8.1	7.1	44.7	6.9
1918	17.9	35.8	----------	----------	1928	8.8	7.3	43.0	8.7
1919	15.4	16.8	[c] 44.2	1.0	1929	8.5	7.4	40.2	11.4
1920	13.1	11.6	----------	----------	1930	6.8	5.7	44.0	12.3
1921	6.4	6.1	51.4	2.5	1931 [d]	4.3	4.1	----------	----------

[a] Bureau of Labor Statistics, Wholesale Prices.
[b] Calculated from data in Pt. IV, Tables 117 and 119, pp. 130 and 132.
[c] Includes miscellaneous oils, as greases were not shown separately in this year. The miscellaneous oils probably mostly greases amounted to 4.53 per cent.
[d] Average for first 6 months.

[10] The extremely high prices of palm oil in 1917, 1918, and perhaps 1919, were due to the difficulty, under war conditions, of obtaining the quantity of palm oil in the tin-plate industry.

Table 157 gives a comparison of annual average prices of the Lagos and Niger grades of palm oil with those of inedible tallow of the extra grade in New York and of the packers' prime and No. 1 grades in Chicago. Chicago prices of palm oil were obtained by adding to New York prices the freight from New York to Chicago. Data are given for different grades of tallow in New York and Chicago, because the

CHART XIII



same grades are not handled in both markets. Comparatively little middle western tallow goes to the Atlantic seaboard, most of it being consumed by middle western soap makers. Most of the tallow used by eastern soap makers is produced in the East, largely by recovery from wastes, but this production is supplemented, to a small extent, by imports and by receipts from the Middle West.

TABLE 157.—*Comparison of prices of palm oil and inedible tallow in New York and Chicago*

[In cents per pound]

Year	New York markets—			Chicago markets—			
	Palm oil (in casks)		Inedible tallow, extra (loose) grade [1]	Palm oil		Inedible tallow	
	Lagos grade [1]	Niger grade [2]		Lagos grade [1]	Niger grade [2]	Packers' No. 1 grade [3]	Prime packers' grade [4]
1926	8.5	8.0	8.6	8.0	8.4	8.1	8.7
1927	7.6	7.1	7.9	8.0	7.5	7.3	8.1
1928	7.9	7.3	8.6	8.3	7.7	8.2	8.8
1929	8.2	7.4	8.2	8.6	7.8	7.9	8.5
1930	6.1	5.7	5.7	6.5	6.1	5.6	6.8
Average, 1926-1930	7.7	7.1	7.8	8.1	7.5	7.4	8.2
1931 [5]	4.6	4.1	4.0	5.0	4.5	3.8	4.3

[1] Oil, Paint and Drug Reporter; New York price plus 0.38 cent per pound for Chicago price.
[2] Bureau of Labor Statistics, Wholesale Prices, New York price plus 0.38 cent per pound for Chicago price.
[3] The National Provisioner.
[4] Bureau of Labor Statistics, Wholesale Prices.
[5] Average for first 6 months.

The extra grade of tallow quoted for the New York market may be regarded as roughly comparable with the packers' No. 1 grade quoted for Chicago; if anything, the extra grade is probably the better of the two. Both grades are more closely competitive in price with Lagos than with Niger palm oil. With these facts in mind the data in Table 157 will be seen to be consistent with information obtained from the trade to the effect that palm oil is in a stronger competitive position in New York than in Chicago. For the five years 1926 to 1930, extra grade tallow in New York averaged one-tenth of a cent per pound higher than the Lagos grade of palm oil and seven-tenths of a cent higher than the Niger grade. On the other hand, the packers' No. 1 tallow in Chicago averaged seven-tenths of a cent lower than the Lagos and one-tenth of a cent a pound lower than the Niger. Although higher in quality, prime packers' tallow in Chicago had the same average price differential over Lagos palm oil as did the extra grade of tallow in New York.

In the East, at least, there is a strong tendency for palm oil and tallow to sell at a parity taking into consideration refining costs, which are usually higher for palm oil, and glycerin yields, which are usually higher for tallow. The higher prices shown for palm oil as compared with tallow in 1930 and 1931 probably are not representative of actual purchases, at least not of those made by large soap makers. Until the last few years palm oil was shipped in casks and a comparison of tallow in bulk with palm oil in casks was valid. Recently, however, the practice of shipping palm oil in tanks has become more important, and practically all purchases by large soap makers in 1930 and the first half of 1931 were for delivery in tanks. In such a situation, prices in barrels apply largely to small spot transactions, which are usually at higher prices than large orders for future delivery. Then, too, these 18 months were a period of falling prices when nominal prices, which are more frequent in trade journal quotations of palm oil than of tallow, tend to be high compared with actual sales prices.

Table 158 gives data obtained from trade sources showing average prices for actual transactions in palm oil in each month of 1929, 1930, and 1931. These data are for three grades of African oil—soft, medium, and hard. The soft grade is comparable with the Lagos grade in the preceding table and the medium and hard grades, which are close together in price, are comparable with the Niger grade. It will be noted that the prices in this table give for both 1929 and 1930 an annual average lower than that shown in Table 157, partly because of differences between bulk and cask prices. The difference is particularly striking for the soft, or Lagos grade.

TABLE 158.—*Average monthly prices of palm oil*

[In cents per pound]

Month	1929			1930			1931		
	Soft	Medium	Hard	Soft	Medium	Hard	Soft	Medium	Hard
January	8.3	8.1	7.9	7.3	7.1	6.8	4.2	4.1	4.2
February	8.3	8.1	7.9	6.9	6.7	6.5	3.9	4.0	3.9
March	8.3	8.1	7.6	6.5	6.5	6.5	4.2	4.1	3.9
April	7.8	7.9	7.3	6.2	6.3	6.2	4.2	4.1	4.2
May	7.1	7.2	6.9	5.9	5.7	5.8	3.8	3.7	3.6
June	7.5	6.8	6.8	5.3	5.2	5.2	4.0	3.1	3.1
July	7.2	6.5	7.3	5.3	5.4	5.2	3.8	3.2	4.1
August	7.2	7.1	7.2	5.0	5.0	5.1	3.8	3.4	3.4
September	7.2	7.1	7.1	4.8	4.7	4.7	3.5	3.4	3.2
October	7.3	7.0	7.1	4.7	4.6	4.6	3.4	3.4	3.0
November	7.3	7.0	6.8	4.7	4.5	4.6	3.7	3.6	3.0
December	7.3	6.9	7.0	4.6	4.5	4.5	.....	.....	.....
Average	7.5	7.3	7.2	5.6	5.5	5.5	[1] 3.9	[1] 3.6	[1] 3.6

Source: Supplied by the trade.

[1] Average for 11 months.

Palm oil, inedible tallow, and greases.

Table 159 gives a comparison of average prices of inedible tallow, No. 1 packers, with prices of brown grease, and Niger palm oil. All of these are materials much used in yellow laundry soaps. Among them, brown grease is always the cheapest.

TABLE 159.—*Comparison of prices of palm oil, inedible tallow, and brown grease, Chicago*

[In cents per pound]

Year	Palm oil, Niger grade, New York price plus freight to Chicago [1]	Inedible tallow, packers No. 1 grade [2]	Brown grease [2]	Year	Palm oil, Niger grade, New York price plus freight to Chicago [1]	Inedible tallow, packers No. 1 grade [2]	Brown grease [2]
1926	8.4	8.1	7.0	1929	7.8	7.9	7.1
1927	7.5	7.4	6.0	1930	6.1	5.7	4.6
1928	7.7	8.2	7.0	1931 [3]	4.5	3.8	3.0

[1] Bureau of Labor Statistics, Wholesale Prices, plus freight rate of 0.38 cent per pound.

[2] The National provisioner.

[3] Average for first six months.

Prices of whale oil and fish oils.

Representative price data which may be published were not obtainable on whale oil or fish oils. When used in soap making, these oils compete with inedible tallow, at a price sufficiently lower, however,

than that of tallow to offset the cost of hydrogenation. Evidently there has been no large or general price advantage in the use of these oils, or they would have been used in larger quantities and by a larger number of manufacturers, even though their use requires the installation of hydrogenating equipment. Most of the whale oil used in the United States is purchased by one soap maker, who usually contracts for his supply at a definite price in advance of the season's catch. His costs laid down at plant have been submitted to the commission but may not be published without revealing confidential information. The percentages which whale oil and fish oils have supplied of the total oils used in soap making since 1912 follow:

Year	Whale oil	Fish oils	Year	Whale oil	Fish oils
	Per cent	*Per cent*		*Per cent*	*Per cent*
1912	1.4		1924	2.8	2.3
1914	.6	1.4	1925	3.9	3.1
1916	1.0	.3	1926	4.2	3.3
1917	.6	.5	1927	3.7	4.7
1919	1.5		1928	4.0	4.7
1921	.5	3.4	1929	4.1	3.8
1922	5.4	2.6	1930	3.9	3.4
1923	3.5	2.6			

CONDITIONS OF DEMAND

All the oils under consideration are affected by the same general conditions of demand. The type of soap which has greatly predominated in domestic production in recent years is made principally of coconut or palm-kernel oils blended in various proportions with tallow or grease and/or palm oil or hydrogenated whale or fish oil. In 1919 the oils named taken together formed approximately 85 per cent of the consumption of oils in soap making. Until 1921 the increasing demand for the second group of oils in this combination was supplied almost entirely by the increased production of domestic inedible tallow and greases. After 1921, however, further increase in demand was supplied mainly by imported palm oil but to a considerable extent also by hydrogenated whale and fish oils of both domestic and foreign origin.

There are, however, conditions of demand affecting specific oils. These operate to give palm oil and hydrogenated whale and fish oils a more restricted market than tallow. Tallow is generally preferred by soap makers to hydrogenated whale and fish oils, which are used mainly in blend with tallow in the production of general household and laundry soaps. As a rule, these hydrogenated oils are not used in soaps intended exclusively for toilet use.

Opinions in the trade differ as to the relative merits of palm oil and tallow in soap making. The use of palm oil, however, is confined largely to colored soaps. This is because it is expensive to bleach and is usually not obtainable at a price sufficiently lower than tallow to warrant the added cost. On the other hand, palm oil has a considerable market in which it is preferred. This market is created by demand from the following sources:

(1) From manufacturers of certain textile soaps, in which it is used because of the special characteristics which it imparts.

(2) From producers of certain trade-marked brands, carrying a brand name or advertising description indicating the use of palm

oil. The substitution of tallow for palm oil would necessitate the abandonment of the trade name and the good will associated with it.

(3) From manufacturers of certain brands of soap to which palm oil gives a distinctive red color, difficult to obtain without its use.

These three cases, which to a considerable extent overlap, account for a large part of the palm oil used in soap making. There are, however, certain important manufactures, as that of yellow laundry soaps, in which it is freely interchangeable with tallow, the cheaper of the two being used. As a result of these uses, there is a distinct tendency for palm oil and tallow to sell at a parity in price.

CONDITIONS OF SUPPLY

A discussion of conditions of supply of the several oils under consideration is necessary to an understanding not only of price changes but also of the problems involved in the question whether imports of palm and whale oils have replaced inedible tallow and grease in soap making. If there has been any substantial replacement of domestic oils as a result of these imports, it occurred in this industry. Whale oil goes almost entirely into the soap kettle. Palm oil goes into other industries, but in relatively small quantities compared to its use in soaps. So far no other oil has been successfully used on a commercial scale in the production of a bright glossy tin plate. The relatively small amount of palm oil used in margarine in the last few years, however, affected, although slightly, the use of oleo oil, neutral lard, and coconut oil.

Palm oil.

The supply of palm oil increased greatly during the decade of 1920–1930 and gives promise of further increase. Exports from the principal producing regions rose from about 335,000,000 pounds in 1923 to 595,000,000 pounds in 1930.[11] This increase of approximately 55 per cent was coincident with an increase of about 120 per cent in palm-oil imports and of about 90 per cent in its use in soap making. After 1925 it occurred in the face of a tendency to declining prices. This may not be of much significance, however, since palm trees do not come into bearing until the fifth year after planting and do not attain the maximum yield of fruit until, at least, the eighth year. Moreover, they remain in bearing for many years.

Of the increase of 260,000,000 pounds in the total world export of palm oil from 1923 to 1930, only 136,000,000 pounds came from West Africa, until recent years practically the only source of palm oil. Notwithstanding this increase, well-informed observers doubt whether there has been any large expansion in total African production. There have been increases in some sections and decreases in others. In some sections, particularly on the Gold Coast and in Lagos, there is severe competition between palm trees and cocoa beans for use of the land and labor. For this and other reasons it is problematic whether much further increase in the exportation of palm oil from West Africa may be expected in the near future. A much larger production of oil could be obtained, however, without increasing the number of palm trees, if the natives could be induced to

[11] But exports from principal producing regions in 1923 were not much larger than before the World War. This is evidenced by statistics given in the International Yearbook of Agricultural Statistics, 1929–30, pp. 422–423. These show an average annual export of about 270,000,000 pounds in the five years 1909 to 1913 and of 536,000,000 pounds in 1929. The 1929 figure includes a few relatively small sources not included in the figures above and also includes whatever exports of palm-kernel oil may have occurred.

gather and crush a larger proportion of the fruit and to use more efficient and scientific methods.[12] But so far little progress has been made in this direction, and little is anticipated in the near future. One reason is that there is a general agreement among the West African governments not to permit the use of indentured labor, particularly in making products for export. Another is the prevalent system of communal land ownership which prevents sudden changes in methods of production and renders difficult the development of large plantations.

Of the increase in the world export of palm oil from 1923 to 1930, about 100,000,000 pounds came from the Netherland East Indies, principally from Sumatra, and about 7,000,000 pounds from British Malaya. Considerable further expansion of exports may be expected from both these regions. The industry in both regions is new, having developed largely since the World War. Production, unlike that in Africa, is carried on in large plantation units by modern methods of production, and a 98 per cent recovery of the oil content of the palm fruit is said to be realized.[13] Moreover, the resulting oil is high in grade and low in free fatty acids.

The acreage planted to palms in the principal palm-growing region of Sumatra rose from 10,860 in 1918 to 61,123 in 1929. In the island as a whole, 93,409 acres were planted to palms in 1929. On only 41,174 acres, however, had the trees reached the bearing stage, and on not all of these had they yet reached full bearing. The palm acreage in British Malaya increased from 2,640 in 1922 to 24,000 in 1928, with further acreage reserved for future plantings.

Whale oil.

The world production of whale oil increased from 160,000,000 pounds in the whaling season 1919–20 to 1,500,000,000 pounds in that of 1930–31. This tenfold increase resulted from the wholesale exploitation, largely by Norwegian and British whalers, of the Antarctic waters, which afford the only known undepleted supply of whales. Modern whaling is conducted by much more efficient methods than those by which the whales in northern waters have been almost exterminated. It is carried on by fleets, consisting of a large mother ship, equipped for rendering the oil, and several small steamers which capture the whales and tow them to the mother ship. Capture is facilitated by a dynamite-charged harpoon fired by a small cannon.

Notwithstanding the use of these methods an abundant supply of whales is reported still existing in Antarctic waters. For a limited but indeterminate number of years the catch may continue to increase, although perhaps at a slackened rate; nevertheless, in a comparatively short time, a rapid decline may be expected to set in. Apparently the only thing that can prevent rapid depletion is an international agreement severely limiting each year's catch. The evidence is that "the present rate of killing is far in excess of the normal rate of production." [14] Owing to the current depression and oversupply of oil, the principal Norwegian whalers have agreed not to operate in the 1931–

[12] It has been estimated that not more than 10 per cent of the available fruit in the densest palm areas is being crushed and that not more than 50 per cent of the oil content is being recovered from the crushed fruit.

See Nigeria Palm Oil and Palm-kernel Industry, American Trade Commissioner, L. J. Schwarz, Department of Commerce.

[13] Department of Commerce, Palm Oil Industry of Sumatra and West Africa, 1927.

[14] Statement of Dr. Remington Kellogg, assistant curator, Division of Mammals, U. S. National Museum, in hearings before a special committee on wild life resources, U. S. Senate, 72 Cong., 1st sess., Mar. 20, 1931., p. 29.

32 season, but in all probablity they will resume operations in the following season.

The supply of whales in the North Atlantic and North Pacific region in which domestic whaling operations are conducted is approaching exhaustion. "The domestic whaling industry is now confined almost entirely to Pacific waters from Lower California, an important calving ground for whales, to northern Alaska, the northern limit of the annual migration of the same whales. Thus they are subject to practically 12 months of slaughter,[15] and "depletion * * * has been carried so far that normal pairing is no longer possible."[16] As a result of this intensive slaughter, however, production has shown some increase in recent years. But the fact that the average size of whale caught is small and declining [17] is further evidence of depletion. In 1929 the domestic industry was responsible for 2.6 per cent of the world slaughter but for only 1.7 per cent of the world production of whale oil.

Domestic fish oils.

Under favorable conditions of price the production of fish oil in the United States might be somewhat increased, but the maximum increase would leave fish oils as a minor source of domestic supply of oils. In the 5-year period 1926 to 1930, average domestic production of fish oils amounted to 96,763,000 pounds compared with an average total consumption of animal and vegetable oils amounting to about 6,000,000,000 pounds and with an average import of 202,000,000 pounds of palm oil. The situation with respect to expansion of the supply of fish oils may be outlined as follows:

(1) Any large expansion of the production of menhaden oil seems improbable, as all existing fishing areas have been systematically exploited in recent years. During the 17-year period 1912 to 1928, the annual production of menhaden oil varied from 21,000,000 to 57,000,000 pounds and has decreased since 1922. Because of the sporadic appearance of the fish, production fluctuates greatly from year to year.

(2) Production of sardine oil, from the pilchard taken off the coast of California, has fluctuated greatly, being 15,800,000 pounds in 1926 and 28,700,000 pounds in 1928. Canned sardines are a joint product. The laws of California limit the production of sardine oil by providing that only a certain percentage of the catch may be used for oil extraction.

(3) Herring oil, the production of which amounted to 21,000,000 pounds in 1925, is manufactured from several species of herring caught in large quantities off the shores of Alaska and of Maine. The oil is made either from the whole fish or from the offals of sardine canneries and herring salteries. In Maine the oil is a by-product of the sardine industry; in Alaska it is partly that and partly an independent production from small fish. The supply of herring is limited by restrictions enforced by the United States Bureau of Fisheries.

(4) Salmon oil is a by-product of salmon canning and is, therefore, limited in output by the quantity of the fish caught for canning. But heretofore only a part of the salmon offal and other waste has been converted into oil, in 1928 only 15 per cent of it. This 15 per cent made 1,287,000 pounds of salmon oil.[18] Utilization of a full 100 per cent for oil recovery would have yielded only 8,580,000 pounds of oil.

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[15] Ibid, p. 8-9.
[16] Ibid, p. 8.
[17] Ibid, p. 7.
[18] United States Bureau of Fisheries, Fishery Industries of the United States.

Domestic inedible tallow and greases.

Inedible tallow is derived principally from such fat of cattle and sheep as can not be utilized for food purposes; grease, from the fat of hogs not suitable for lard; and from house and garbage wastes containing mixed fats of all kinds. Since 1914 the recovery of both products has increased more than the total production of meat, evidencing a greater utilization of waste animal fats. This is shown by Table 160, which indicates an increase in production, 1914 to 1929, of 97 per cent for edible tallow, 65 per cent for animal greases, 81 per cent for inedible tallow and grease taken together, and only 23 per cent for meat. Table 161 shows that the increase in inedible tallow was greater than in beef, veal, lamb, and mutton combined, and the increase in greases greater than in pork.

TABLE 160.—*Course of production of inedible tallow, greases, and meat in the United States, 1914 to 1930*

Year	In millions of pounds				Percentage of production in 1914			
	Animal greases [1]	Inedible tallow [1]	Total greases and inedible tallow	Meat [2]	Animal greases	Inedible tallow	Total greases and inedible tallow	Meat
1914	220	227	447	13,299	100.0	100.0	100.0	100.0
1916	224	276	500	14,626	101.8	121.6	111.9	110.0
1917	210	269	479	13,932	95.5	118.5	107.2	104.8
1918	244	305	549	16,405	110.9	134.4	122.8	123.4
1919	258	252	510	16,006	117.3	111.0	114.1	120.4
1920	326	264	590	15,511	148.2	116.3	132.0	116.6
1921	323	327	650	15,182	146.8	144.1	145.4	114.2
1922	360	363	723	16,295	163.6	159.9	161.7	122.5
1923	387	384	771	17,912	175.9	169.2	172.5	134.7
1924	376	388	764	17,867	170.9	170.9	170.9	134.3
1925	341	378	719	17,005	155.0	166.5	160.9	127.9
1926	347	425	772	17,245	157.7	187.2	172.7	129.7
1927	369	404	773	16,872	167.7	178.0	172.9	126.9
1928	374	392	766	16,955	170.0	172.7	171.4	127.5
1929	390	426	816	16,803	177.3	187.7	182.6	126.3
1930	363	448	811	16,394	165.0	197.4	181.4	123.3

[1] Source, 1914-1918, L. B. Zapoleon (Stanford University, Food Research Institute, Fats and Oil Studies, No. 3), Inedible Animal Fats in the United States, p. 93; 1929 and 1930, Bureau of the Census.
[2] Bureau of Agricultural Economics, Department of Agriculture.

TABLE 161.—*Production of inedible tallow, greases, beef, veal, mutton, lamb, and pork*

Year	Production of—		Ratio of grease to pork	Production of—		Ratio of inedible tallow to beef, veal, lamb, and mutton
	Grease [1]	Pork [2]		Inedible tallow	Beef, veal, lamb, and mutton [3]	
	Pounds	*Pounds*	*Per cent*	*Pounds*	*Pounds*	*Per cent*
1914	220,000,000	6,530,000,000	3.4	227,000,000	6,769,000,000	3.4
1916	224,000,000	7,386,000,000	3.0	276,000,000	7,240,000,000	3.8
1917	210,000,000	6,139,000,000	3.4	269,000,000	7,793,000,000	3.5
1918	244,000,000	7,854,000,000	3.1	305,000,000	8,551,000,000	3.6
1919	258,000,000	7,832,000,000	3.3	252,000,000	8,174,000,000	3.1
1920	326,000,000	7,455,000,000	4.4	264,000,000	8,056,000,000	3.3
1921	323,000,000	7,645,000,000	4.2	327,000,000	7,537,000,000	4.3
1922	360,000,000	8,260,000,000	4.4	363,000,000	8,035,000,000	4.5
1923	387,000,000	9,595,000,000	4.0	384,000,000	8,317,000,000	4.6
1924	376,000,000	9,279,000,000	4.1	388,000,000	8,588,000,000	4.5
1925	341,000,000	8,255,000,000	4.1	378,000,000	8,750,000,000	4.3
1926	347,000,000	8,181,000,000	4.2	425,000,000	9,064,000,000	4.7
1927	369,000,000	8,533,000,000	4.3	404,000,000	8,339,000,000	4.8
1928	374,000,000	9,387,000,000	4.0	392,000,000	7,568,000,000	5.2
1929	390,000,000	9,223,000,000	4.2	426,000,000	7,580,000,000	5.6
1930	363,000,000	8,665,000,000	4.2	448,000,000	7,729,000,000	5.8

[1] See preceding table.
[2] Bureau of Agricultural Economics, Department of Agriculture.
[3] Total dressed meat less pork. This figure may include negligible quantities of goat, horse, and other meat.

As shown by Table 162, the increase in production of inedible tallow and greases was mainly by producers other than the packers. These are of two classes—local rendering plants distributed in urban centers throughout the country, and municipal reduction plants erected for the recovery of grease from city garbage. The bulk of the increase has come from the local renderers. The following are their principal sources of supply of raw materials: [19]

(1) *Waste in the distribution and consumption of meats, collected mainly from butchers, hotels, restaurants, and clubs.*—The growth of urban population with the increased patronage of public eating places has increased the material obtainable from those sources; moreover, the motor truck has immensely increased the radius of collection.

(2) *Slaughterhouse offal.*—Renderers collect the offal from small local slaughterhouses. In recent years collections have increased greatly.

(3) *Fallen animals.*—With good roads and the motor truck the collection of fallen animals has become increasingly important. It is estimated that millions of farm animals perish otherwise than by slaughter every year and from only a portion of them is the fat now recovered.

TABLE 162.—*Production of inedible tallow and greases from packers and other producers in specified years* [1]

Year	Inedible tallow			Animal greases		
	Packers	Other	Total	Packers	Other	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1914	163, 616, 000	33, 723, 000	197, 339, 000	120, 004, 000	100, 143, 000	220, 147, 000
1919	174, 682, 000	77, 172, 000	251, 854, 000	147, 244, 000	110, 912, 000	258, 156, 000
1921	152, 400, 000	174, 505, 000	320, 905, 000	136, 534, 000	186, 803, 000	323, 337, 000
1923	177, 471, 000	206, 575, 000	384, 046, 000	178, 061, 000	208, 757, 000	386, 818, 000
1925	164, 731, 000	213, 741, 000	378, 472, 000	179, 780, 000	160, 857, 000	340, 637, 000
1927	170, 519, 000	233, 645, 000	404, 164, 000	182, 283, 000	186, 800, 000	369, 083, 000
1928			391, 662, 000			373, 579, 000

[1] L. B. Zapoleon, Inedible Animal Fats in the United States (Fats and Oils Studies, No. 3), p. 107.

Indications are that the upward trend of the production of inedible tallow and animal greases will continue for a time at a rate faster than the similar trend in the production of meat, which has failed to keep pace with the growth of population in the United States. A recent survey on the subject suggests that if a larger proportion of the losses on the farm and the wastes of consumption and distribution were utilized, the present production of inedible fats "would be increased, perhaps to a maximum three times as large." [20] No such increase is in prospect, however, and only a gradual increase may be expected. On this point the authority quoted above states: [21]

The supply of raw material (for inedible fat production) is essentially an incident of meat production and consumption, and correspondingly limited. The demand for animal by-products is increasing much more rapidly than the demand for the production of meats. There is little question that such a situation will lead to a further development of the salvaging industries apart from the

[19] L. B. Zapoleon, Inedible Animal Fats in the United States (Fats and Oils Studies, No. 3 Research Institute, Stanford University), pp. 178-180.
[20] L. B. Zapoleon, Inedible Animal Fats in the United States (Fat and Oil Studies No. 3), pp. 92-93.
[21] *Ibid.*, pp. 262-263.

fact that the long-run trend of meat production is upward. The output of inedible animal fats and their joint products seems likely to continue to increase for some time to come, although such expansion can come only slowly, chiefly through the installation of new plants in many areas not now served.

The two principal divisions of the industry stand on a different footing as far as expansion of production is concerned. Speaking broadly, the packers recover now about the maximum amount of inedible fats and will probably continue to do so irrespective of price so long as it covers the cost of recovery. Production by renderers, however, must be affected largely by price, for they are not in the position of utilizing a by-product of their principal manufacture but of purchasing fatty wastes and converting them into tallow and grease as major products, along with their joint products, tankage and crackling. Manifestly, the price of tallow and grease will influence the volume of production, in particular the rate of erection of new rendering plants. So also, of course, will the price of tankage and crackling.

The question may also be raised whether an increase in the production of tallow and grease is possible other than through a more nearly complete utilization of fatty wastes. It is not likely that an increased demand for tallow and grease would be met by increasing the production of cattle, sheep, and hogs, carrying with it a corresponding increase in meat production. The price of meats, the major product, would be a more important consideration than that of oils. Increased demand for animal oils might, however, cause such changes in the method of feeding animals as would result in a greater proportion of fat. To what extent this would prove profitable or would actually take place in case of a marked reduction in imports of foreign oils, it is entirely impossible to judge; it should be noted that such a change would affect the character of the meat sold as such, not merely add to the quantity of tallow and greases available.

QUESTION OF REPLACEMENT

Table 163 shows for the years 1926 to 1930, general imports of palm oil, whale oil, fish oil, inedible tallow, and animal greases, separately and in total.

TABLE 163.—*General imports of palm oil, whale oil, fish oil, inedible tallow, and animal greases*

[In thousands of pounds]

Year	Palm oil [1]	Whale oil [1]	Fish oil [1 2]	Inedible tallow and greases [3]	Total	Year	Palm oil [1]	Whale oil [1]	Fish oil [1 2]	Inedible tallow and greases [3]	Total
1926	130,746	63,434	31,090	15,617	240,887	1929	261,816	54,532	77,919	18,957	413,224
1927	159,912	39,750	85,721	15,969	301,352	1930	287,492	74,663	84,277	5,175	451,607
1928	169,228	68,386	72,497	16,493	326,604						

[1] Foreign Commerce and Navigation of the United States.
[2] Includes herring, sardine and "other" fish oils, including salmon.
[3] Bureau of the Census, Animal and Vegetable Fats and Oils.

With the exception of some 15,000,000 pounds of palm oil used annually in the tin-plate industry, practically all of these imports may be taken as technically interchangeable with inedible tallow and grease. Since this is true, the question how far imports may be con-

sidered as in replacement of domestic oil and how far as supplementary to them may be said to turn entirely on the extent to which the domestic supply of inedible animal fats and fish and whale oils would have been expanded had the imported materials not been available. Any increase which would have occurred in the domestic production of whale and fish oils would have been small compared with these imports. At higher prices, however, a somewhat greater expansion of the production of inedible tallow and grease might have occurred. How great this expansion would have been depends upon such unknown factors as the effect of higher prices on the demand for and supply of tallow and grease and their joint products, tankage and crackling.

The foregoing discussion leaves out of consideration the possibility of using cottonseed oil, or other soft vegetable oils, in place of tallow and grease in soap making. The situation with respect to cottonseed oil has already been analyzed. The possibility of expanding the production of other vegetable oils will be discussed later.

4. Economic Factors Affecting the Interchangeability of Certain Soft Vegetable Oils, Including Sesame Oil

INTRODUCTORY

Consideration must now be given to the competitive position of sesame oil, which is technically interchangeable with cottonseed oil in most of its uses. The facts so far developed with respect to sesame oil may be summarized as follows:

(1) Exports of sesame seed from India and China, the principal countries of production, have shown no tendency to increase in recent years. They amounted to 338,468,000 pounds in 1923 and to 280,603,000 in 1930. In all the intervening years they were smaller than in either 1923 or 1930. During the same period exports of sesame oil from the Netherlands, which is the principal oil exporting country, ranged from 11,994,000 pounds to 21,202,000 pounds annually. Estimated production in the United States, ranging from 1,326,000 to 8,437,000 pounds a year before 1929, rose in 1930 to 25,607,000 pounds. As sesame seed remained on the free list in the tariff act of 1930 while sesame oil, unless denatured, was dutiable, it became advantageous to import the seed and crush them here instead of importing sesame oil as such.

(2) Sesame oil has been used in this country principally as a salad oil and as a constitutent of salad dressing, in which use it is interchangeable with cottonseed oil and corn oil. It has also been used to some extent in lard compounds and margarine, in making which they are regarded by some producers as the equal of cottonseed oil. The remainder has been used largely in soaps.

Consideration must also be given here to questions raised at various points with respect to the possiblity of increasing the domestic production of certain soft vegetable oils, such as corn, peanut, and soybean oils and of using them in place of imported coconut, palm kernel, palm, sesame, and whale oils in soaps. These questions were raised on the assumption that corn, peanut, and soybean oils have the same technical position in soap making as cottonseed oil. This is probably approximately true of corn and peanut oils, but soybean oil is more limited in use and is less easily refined.

PRICE COMPARISONS

Table 164 gives annual average prices, 1926 to 1931, of refined cottonseed, sesame, corn, and peanut oils. Prices of soybean oil are not included because none are available for the refined edible grade. The prices of cottonseed oil are for the Chicago market; the other prices for the New York market. It is not certain that the quotations are for oils of exactly the same degree of refinement. Morever, a close inspection of the monthly data on which the annual averages are based suggests that many of them represent only nominal quotations. Nevertheless, the following three general conclusions may be drawn from the table.

(1) Cottonseed oil is usually lower in price than the vegetable oils which might be substituted for it. This largely accounts for its predominance in the domestic production of lard compounds and salad oils and salad dressings.

(2) Peanut oil is usually higher in price than other oils of this group, which accounts for the fact that it is used to so small a degree in lard compounds and salad oils and salad dressing. It is used more in margarine because some producers prefer it to other oils, and because of the ruling of the Department of Agriculture excluding both cottonseed and corn oil from "nut" margarines.

(3) Sesame oil is usually higher in price than cottonseed or corn oil. It has been used in salad oils and salad dressings, largely because a certain trade in large cities prefers it. Moreover, at times there may be a slight price advantage in buying it. In 1930 and 1931 sesame oil, crushed in domestic mills from imported seed, may have had some price advantage on the Pacific coast, where the crushing was done.

TABLE 164.—*Comparison of prices of cottonseed oil, sesame oil, corn oil, and peanut oil*

[In cents per pound]

Year	Cottonseed oil, white deodorized, Chicago [1]	Sesame oil, refined (drums), New York [2]	Corn oil, refined (barrels), New York [2]	Peanut oil, refined (barrels), New York [2]
1926	13.6	13.8	13.5	15.8
1927	11.2	13.0	11.6	14.4
1928	10.6	13.8	12.0	13.3
1929	10.6	12.5	11.3	13.3
1930	9.7	11.5	10.4	12.1
Average	11.1	12.9	12.0	13.8
1931 [3]	9.2	10.8	9.9	11.7

[1] The National Provisioner.
[2] Oil, Paint and Drug Reporter.
[3] Average for first 6 months.

Table 165 shows a comparison of annual average prices of crude cottonseed, corn, and soybean oils from 1913 to 1931. The prices of cottonseed oil are for shipments in tanks f. o. b. southeastern mills; the prices of corn and soybean oils for shipments in barrels delivered in New York. In the case of corn oil, however, for the years 1926 to 1931 prices are also given for shipments in tanks f. o. b. mill. These average about 2 cents per pound lower than prices in barrels delivered New York.

The fact that prices of soybean oil are for imported oil delivered in barrels at New York,[22] in itself makes them higher than prices of cottonseed oil in bulk. Another factor working in the same direction is that soybean oil quotations, taken from trade journals, are frequently nominal and, when not, may be slightly in excess of those prevailing in actual transactions. A factor working in the opposite direction is that soybean oil is more difficult to refine than cottonseed or corn oil. This is taken into consideration by food and soap manufacturers in comparing prices of soybean oil with those of the other oils. It should be noted in this connection that in the United States soybean oil in most years has been used mainly in paints and varnishes in competition with linseed oil instead of with the oils under discussion.

TABLE 165.—*Comparison of annual average prices of crude cottonseed, corn, and soybean oils*

[In cents per pound]

Year	Cottonseed oil in tanks, f. o. b. southeastern mill [1]	Corn oil, crude		Soybean oil in barrels delivered, New York [2]	Year	Cottonseed oil in tanks, f. o. b. southeastern mill [1]	Corn oil, crude		Soybean oil in barrels delivered, New York [2]
		Barrels, New York [2]	Tanks, mill [3]				Barrels, New York [2]	Tanks, mill [3]	
1913	5.9	6.1	----------	6.1	1923	9.6	11.6	----------	11.7
1914	5.7	6.2	----------	6.3	1924	9.1	11.9	----------	12.4
1915	5.7	6.3	----------	6.3	1925	9.2	12.1	----------	13.2
1916	9.3	9.6	----------	8.9	1926	9.8	12.0	10.3	12.6
1917	14.0	14.5	----------	14.2	1927	8.2	10.8	8.3	12.0
1918	17.5	18.0	----------	18.3	1928	8.4	10.5	8.9	12.2
1919	18.1	17.5	----------	16.7	1929	8.2	10.3	8.3	12.0
1920	13.2	15.0	----------	15.2	1930	6.9	9.4	7.3	10.1
1921	6.2	8.4	----------	7.9	1931 [4]	6.4	8.4	6.8	7.2
1922	8.5	10.1	----------	10.9					

[1] War Industries Board, 1913-1919; New York Produce Exchange, 1920-1924; Oil, Paint and Drug Reporter, 1925-1931.
[2] Bureau of Labor Statistics, Wholesale Prices.
[3] Oil, Paint and Drug Reporter.
[4] Average for first 6 months.

The following comments on Table 165 seem pertinent:

1. *With respect to soybean and cottonseed oils.*—In the years 1920 to 1930 prices of soybean oil as shown in Table 165 usually exceeded those for cottonseed oil by more than the difference in the cost of shipping in barrels and in tanks, both of which methods are now possible from Manchuria, the principal source of imports. Before 1920 the price position of the two oils with relation to each other fluctuated and in 1916 and 1919 those of soybean oil packed in barrels averaged the lower. Because of this price advantage, caused by the shortage of oils at that time, soybean oil temporarily increased in use in domestic industries, particularly in the soap industry. As has already been noted, part of the decline during the period in the use of cottonseed oil in soaps was offset by an increased use of soybean oil. This is substantiated by the following figures, which show the proportions of the total consumption of oils in soapmaking consisting, in each year 1914 to 1930, of cottonseed and soybean oils.

[22] Soybean oil shipped to the United States from the Orient in the war and immediate postwar period was usually packed in cases containing two 5-gallon cans each. These cans were usually second or third hand, having previously been used as containers for illuminating oils. Shipment in barrels was restricted by their high cost, by the high additional freight rate on them, and by the necessity of returning them empty to the Orient. In recent years shipments have probably been in tanks. See Tariff Information Surveys, A-11, p. 262. Domestic soybean oil, now being produced in the Middle West, is probably shipped chiefly in tanks. Probably little of it gets to the Atlantic seaboard.

Year	Per cent of oils used in soap-making consisting of [1]—		Year	Per cent of oils used in soap making consisting of [1]—	
	Cotton-seed oil	Soybean oil		Cotton-seed oil	Soybean oil
1914	14.6	0.5	1924	.8	.2
1916	18.4	5.4	1925	.6	.2
1917	10.5	10.3	1926	.3	.2
1919	6.2	6.4	1927	.5	.1
1921	4.8	1.1	1928	1.2	.1
1922	1.8	.2	1929	.7	.4
1923	.9	.3	1930	.5	.3

[1] For source see section on soap making.

Except from 1916 to 1920, soybean oil has been a negligible factor in soap making; since the imposition of a duty on soybean oil in the emergency tariff act of 1921, it has never formed more than four-tenths of 1 per cent of the oils used in soap. Even before the passage of that act its use had declined compared with war years.

2. *With respect to crude cottonseed and corn oils.*—To a large extent corn oil is refined in the plant in which the crude oil is produced, but shipments of crude corn oil, like crude cottonseed oil, are really in tanks. Comparing prices of crude corn oil in barrels with crude cottonseed oil in bulk, it will be be noted that corn oil has averaged consistently the higher in price. For shipments of both in bulk, prices in the five years 1926 to 1930 were close to a parity, taking into consideration the higher freight to principal oil-consuming centers from mills producing cottonseed oil than from those producing corn oil.

CONDITIONS OF SUPPLY AND DEMAND

An analysis of the conditions of supply and demand underlying the present organization of prices is required in order to determine the probability of its persistence and to throw light on the question of replacement, which in one important aspect is a question of how far domestic production of the group of oils under consideration may be expanded. The domestic oils, animal and vegetable, dealt with in the preceding sections of Part V, are oils made from by-products. Of the six oils specifically discussed here, two, cottonseed and corn oils, are also by-products oils, and one other, peanut oil, is a by-product oil as produced in the United States, but a principal-product oil as produced in Europe. The three remaining oils—sesame, soybean, and sunflower—are principal-product oils, and with respect to the possibility of expanding domestic production present a different set of problems.

It will be unnecessary further to discuss conditions of supply of cottonseed oil, but conditions of supply of each of the other five oils will be discussed separately below, followed by a general discussion of the problem of oil cake and oil meal, on which, to a considerable extent, the possibility of expanding the domestic production of vegetable oils turns.

Sesame oil.

Sesame oil is obtained from the seed of the sesame plant, an annual plant, grown mainly in the Orient. As has been noted, most of the sesame oil consumed in Europe and America is crushed from seed

exported from China and India. These exports have tended to decline in recent years. The seed exports in 1930 would yield only about 150,000,000 pounds of oil. Even if all of these came to the United States, the resulting oil production would form only about 2½ per cent of the total domestic oil and fat consumption in 1930. As a matter of fact, exports of sesame seed have always gone mainly to Europe, although the proportion coming to the United States has increased since 1927. The consumption of sesame oil in the United States, including both oil imported and expressed here from imported seed, amounted to about 11,000,000 pounds in 1928, 30,000,000 pounds in 1929, and 36,000,000 pounds in 1930. Before that its consumption in no year had exceeded about 15,000,000 pounds.

Corn oil.

Corn oil is derived, along with about an equal weight of corn-oil cake, from the corn germ, which forms 6 to 13 per cent of the total weight of the corn grain. So far it has been produced in the United States in order to utilize the germs removed in two of the alternative uses of corn. The great bulk of the corn produced is fed entire to animals, and another considerable quantity is ground entire for use as food. A limited quantity of corn is processed for the primary purpose of producing cornstarch, glucose, and related products. For this purpose it is necessary to remove the germs, and from the germ, as a by-product, corn oil is expressed, leaving a residue of cake. Corn oil is also expressed from germs removed in the production of degerminated corn meal, grits, and hominy.

An increased demand for domestic oils under these circumstances would not be expected to result in a greater production of corn. Nor would it probably have much effect on the proportion of corn which is treated for starch and sugar, with corn oil as an incidental product. Considerably higher prices might, however, cause some increase in oil production through a larger utilization of the germ separated in producing corn meal and hominy, but in all probability the increase would be small. Any large increase in production would have to come from some other direction. It might be technically possible to devise an economical method of separating the corn germ for oil purposes, leaving the remainder of the kernel for animal feed. To what extent such a process could be applied would depend both on its cost and on the relative demand for degerminated corn, as against whole corn, for animal feed.

It is thus impossible to estimate, even in the roughest fashion, the effect of a reduction of imports of oils upon the domestic output of corn oil. The course of production and exports of corn oil in each year from 1919 to 1930 is shown in Table 166. It also shows statistics of production of corn-oil cake and meal and the amount of corn consumed each year in the corn-products industry—that is, in making cornstarch, glucose, and related products. The production statistics for corn-oil meal are obviously incomplete. They probably represent only the quantity sold as such and not the considerable quantity sold as an ingredient of mixed feeds.

TABLE 166.—*Production of corn oil and corn-oil cake and meal, exports of corn oil, and consumption of corn in corn-products industry*

Year	Production of crude corn oil [1]	Corn-oil cake and meal	Exports of corn oil [1]	Consumption of corn in corn-products industry [2]
	Pounds	*Pounds*	*Pounds*	*Bushels*
1919	97,400,000	61,662,000	6,415,000	64,934,000
1920	98,619,000	----------	12,059,000	60,663,000
1921	87,481,000	33,316,000	4,400,000	58,441,000
1922	111,508,000	----------	5,733,000	66,854,000
1923	111,343,000	64,600,000	4,361,000	66,213,000
1924	117,064,000	----------	3,679,000	73,349,000
1925	104,153,000	66,642,000	3,847,000	70,265,000
1926	120,041,000	----------	1,324,000	82,219,000
1927	117,441,000	47,116,000	310,000	85,553,000
1928	124,327,000	----------	337,000	----------
1929	133,680,000	38,130,000	315,000	86,620,000
1930	120,747,000	----------	613,000	75,662,000

[1] Bureau of the Census, Animal and Vegetable Oils and Fats.
[2] Corn sugars, sirups, dextrines, starches, and corn oil. Associated Corn Products Manufacturers, 1919-1926; Tariff Commission Report to the President on Corn; 1927, 1929, and 1930, Department of Commerce.

Peanut oil.

Peanut oil is produced under entirely different conditions in Europe and the United States. In Europe it is produced from peanuts imported from subtropical, tropical, and oriental countries in quantities which have been increased from an annual average of 565,000,000 pounds in the five years 1909–1913 to 1,525,000,000 pounds in 1929. Usually the straight run of peanuts is crushed, although the choice nuts are sometimes sorted out and used for direct human consumption.

In the United States peanut oil is at present obtained exclusively from domestic nuts. Production, however, is subsidiary to the shelling and grading of peanuts for direct consumption as food and for use in the manufacture of candy and peanut butter. Most peanuts grown in the United States are of the Virginia or Spanish types. Virginia peanuts are sold to peanut mills which grade them into several unshelled grades and into four shelled grades—extra large Virginias, No. 1s, No. 2s, and No. 3s. Only number 3s, or culls, which are in the nature of by-products unfit for direct human consumption, are pressed for oil. Spanish peanuts are also usually sold to peanut mills which shell and grade them as No. 1s, No. 2s, and No. 3s, No. 3s being culls used only for oil crushing. Spanish No. 1s and No. 2s are used more often for oil than are the corresponding Virginia grades, but in a normal year practically all of them go into other uses.

The practice outlined above is the usual one. But farmers growing Spanish peanuts, under abnormal conditions of price, occasionally may sell some or all of their crop to crushers. In almost all years some damaged or off-grade peanuts may be sold in this way. In the World War period, when because of conditions of scarcity, prices of oil were abnormally high, an appreciable proportion of the crop was disposed of directly to crushers. The same thing may be expected to happen whenever peanuts are worth about as much for oil and cake as they are for direct consumption. In 1930 this may have happened in some parts of the peanut growing region through a fall in the value of peanuts for direct consumption compared with their value for oil. An increased utilization of peanuts for oil resulted. The prices received by farmers in that year, however, were generally regarded as

below their cost of production. It is generally accepted that American farmers can not profitably produce peanuts at their value for oil on the basis of the oil prices which have prevailed since or which prevailed before the World War. Moreover, costs obtained in the commission's investigation of peanuts substantiate this.[23]

Table 167 shows the quantities of peanuts harvested and crushed, the amounts of oil produced, and the average prices of crude oil and of farm-run peanuts. From what has been said above, it appears that the production of peanut oil can be increased in three ways:

(1) By increasing the peanut crop, which would give a larger volume of culls for crushing but would tend to lower the price for the major products, graded peanuts for food.

(2) By crushing not only culls but some of the shelled nuts now ordinarily used for direct consumption, candy, and peanut butter. To make this possible either prices of oil must rise or prices of graded peanuts for direct consumption must decline.

(3) By the peanut farmers selling a substantial proportion of their crop directly to the oil crusher. The conditions under which this might happen have already been discussed.

TABLE 167.—*Production and prices of peanuts and peanut oil*

Year	Peanuts gathered [1]	Peanuts crushed (on "in the hull" basis) [2]	Crude and virgin oil produced [3]	Price of crude oil [4]	Average United States farm price of peanuts, Dec. 1 [5]
	Pounds	*Pounds*	*Pounds*	*Cts. per lb.*	*Cts. per lb.*
1919	783,273,000	[6] 429,632,000	87,607,000	18.7	9.33
1920	841,474,000	35,215,000	13,085,000	13.5	5.26
1921	829,307,000	111,779,000	33,234,000	6.9	3.99
1922	633,114,000	115,157,000	22,644,000	9.6	4.68
1923	647,762,000	31,627,000	5,359,000	13.1	6.78
1924	745,059,000	18,239,000	6,691,000	11.8	4.60
1925	698,476,000	68,335,000	15,156,000	10.6	3.64
1926	631,825,000	50,071,000	10,644,000	11.3	[6] 4.54
1927	864,549,000	35,009,000	10,590,000	11.3	[6] 3.98
1928	855,096,000	60,816,000	12,439,000	9.6	[6] 4.44
1929	928,975,000	56,048,000	10,131,000	9.0	[6] 3.62
1930	[7] 740,710,000	126,936,000	25,495,000	7.2	[6] 3.24

[1] U. S. Department of Agriculture, Yearbook of Agriculture, 1931, p. 815.
[2] Yearbook of Agriculture, 1931, p. 817, fiscal year beginning Oct. 1 (i. e., 1920 is from Oct. 1, 1919, to Sept. 30, 1920).
[3] Bureau of the Census, Animal and Vegetable Fats and Oils (published annually).
[4] Bureau of Labor Statistics, Wholesale Prices.
[5] Yearbook of Agriculture, 1931, p. 815. Prices, 1919–1923 are for Nov. 15.
[6] U. S. Tariff Commission, Report to the President on Peanuts, 1929, p. 8. (Changed to "in the shell" basis.)
[7] Preliminary.
[8] Average price weighted on total production.

Soybean oil.

There is an abundance of land in the United States suited to soybean culture. The beans are grown widely as a cover crop and for feeding purposes. Their use in the production of oil, although still small, has been increasing in recent years. The conditions surrounding this production are different from those surrrounding the production of the other vegetable oils which have been considered. Unlike them, soybean oil is a principal product, not a subsidiary product made in order to utilize a by-product. But the price at which the farmer sells the beans to the crusher is not all that he gets

[23] Tariff Commission, Report to the President on Peanuts 1929, pp. 39–41.

out of that part of the soybean crop used for oil. The roots, which contain the bulk of the nitrogen absorbed from the air by the soybean plant, are left in the ground, and the vines still retain their feed and fertilizer value, which, however, is small compared with that contained in the beans.

The increased production of soybean oil in the United States is indicated by Table 168, which shows, for each year 1924 to 1930, the quantity of beans gathered and crushed, the amount of soybean oil produced, and the average price of the oil.

TABLE 168.—*Production of soybeans and soybean oil and price of soybean oil*

Year	Soybeans gathered [1]	Soybeans crushed [2]	Soybean oil produced [2]	Price of soybean oil, crude, in barrels, New York [3]
	Pounds	*Pounds*	*Pounds*	*Cts. per lb.*
1924	311,400,000	18,402,000	2,269,000	12.4
1925	307,860,000	21,040,000	2,638,000	13.2
1926	363,780,000	20,072,000	2,659,000	12.6
1927	447,540,000	33,512,000	4,374,000	12.0
1928	520,140,000	52,986,000	7,285,000	12.2
1929	685,920,000	95,676,000	12,591,000	12.0
1930	726,360,000	103,874,000	39,129,000	10.1

[1] Calendar years. Data from Department of Agriculture, Division of Crops and Livestock Estimates.
[2] Department of Agriculture, Yearbook of Agriculture, 1931, p. 798, except for 1930, Bureau of the Census.
[3] Bureau of Labor Statistics, Wholesale Prices.

NOTE: The year is the 12 months beginning Oct. 1 of the year specified. For example, the beans harvested in the fall of 1924 would be crushed in the fiscal year beginning Oct. 1, 1924.

Through 1930 domestic production of soybean oil seems to have been kept largely within the limits of the ability of the drying industries, particularly the paint and varnish industries, to absorb it at prices above those prevailing for the oils, like cottonseed oil, most widely used in the food industries. At such prices the production of soybean oil seems to have been higher than the average cost of producing soybeans, as ascertained by the commission for the years 1925 and 1926,[24] plus the average cost of crushing, as ascertained by the commission for the first half of 1924.[25]

If soybean oil production in the United States is extended much beyond the quantity which the drying industries will absorb, it will come into competition with cottonseed and other edible oils and may be expected to fall below cottonseed oil in price.[26] Cottonseed oil is less difficult to refine than soybean oil and after refining is preferred in almost all edible uses. Moreover, if it were used in soap making its price would drop still lower, unless soap oils should rise to the price level of edible oils.

Whether soybean oil could be produced at cottonseed oil prices, or lower, and leave a profit for the farmer can not be definitely determined. A number of unpredictable factors are involved. If the price of cottonseed oil were at its level in the last decade is one thing; if it were at a substantially higher level it is another thing. Then,

[24] From unpublished preliminary report of the U. S. Tariff Commission. They include net cash rental of land, 6 per cent interest on other capital plus elevator costs plus transportation costs.
[25] U. S. Tariff Commission, Certain Vegetable Oils, Pt. I, 1926, p. 60.
[26] According to reports in the trade the production of soybeans increased in 1931 compared with 1930, but farmers realized extremely low prices for their seed. Moreover, the price of soybean oil seems to have fallen to about the cottonseed oil level.

too, the price received for oil cake might be the determining factor. The oil recovery from soybeans is low, about 15 per cent, and the production of oil cake and oil meal is correspondingly high.

The problem of conditions of supply and demand for oil cake and oil meal will be discussed later.

Sunflower oil.

There are large areas in the United States adapted to the production of sunflowers, and several million pounds a year of sunflower seed have been produced. The present important producing areas are southeastern Missouri, southern Illinois, and the San Joaquin Valley in California. The seed has been used chiefly in the preparation of poultry feeds; as far as is known, none has been used in making oil. The development of a sunflower oil industry involves the cake and meal problem a little less acutely than does the development of a soybean-oil industry, as sunflower seed yields 20 to 25 per cent, usually about 22 per cent of oil. The cake is said to have proved a satisfactory feed for all kinds of stock in Europe.[27]

QUESTION OF REPLACEMENT

Sesame oil is the only oil covered by this section which is specifically mentioned in the Senate resolution in response to which this report is made. It is the only one, therefore, with respect to which the question of replacement need be discussed.

The whole quantity of sesame oil consumed in the United States may be taken as technically interchangeable with domestic cottonseed and corn oils. From 1923 to 1928 imports of sesame oil ranged from 1,700,000 to 8,700,000 pounds annually; domestic production, entirely from imported seed, from 1,300,000 to 6,400,000 pounds; total apparent domestic consumption from 3,000,000 to 15,000,000 pounds. Imports in this period were consumed largely by a special trade, in eastern cities, in which sesame oil commands a price premium. But part of the import and the bulk of domestic production were used in salad oils and dressings and in lard compounds in direct competition with domestic cottonseed and corn oils. Some was also used in soap and a little may have gone into margarine.

In 1929 imports of sesame oil amounted to 21,585,000 pounds and domestic coast production to 8,436,000 pounds, in 1930 to 10,700,000 and 25,600,000 pounds, respectively. Since the tariff act of 1930 went into effect consumption has been confined largely to oil produced on the Pacific coast from imported seed. Practically the entire increase in 1929 and 1930, except that going into the soap kettle, went into salad oil and dressings, lard compounds, and margarine.

Other factors which may affect judgment on the question of the replacement, past and future, of domestic oils by sesame oils are as follows:

(1) In eastern markets sesame oil has usually sold higher in price than either cottonseed or corn oil. No data are available on prices of sesame oil on the Pacific coast; it may be that in some years, particularly in 1929, 1930, and 1931, it undersold competitive domestic oils in that region.

(2) In 1928 and preceding years, exports of cottonseed oil regularly exceeded domestic consumption of sesame oil; since then the reverse has been true.

[27] W. A. Henry and F. B. Morrison, Feeds and Feeding (1915), p. 179.

(3) Further increase in the use of sesame oil is limited by the relatively small available supply of seed, exports of which from China and India have tended to decline in recent years.

OIL CAKE AND OIL MEAL

As has been noted, the possibility of an expansion of domestic production of soft vegetable oils, such as corn, soybean, and sunflower oil, depends to a considerable extent upon the market for oil meal and oil cake. Its importance, however, is greater for some oils than for others, according to the ratio of the production of oil cake and oil meal to the production of oil. Some of the more important materials when expressed yield on the average approximately the following percentages of oil cake:

	Per cent		Per cent
Cottonseed	85	Sesame seed	55
Soybean	85	Palm kernels	55
Sunflower seed	78	Corn germs	50
Peanuts	72	Copra	35
Flaxseed	67		

The yield of cake is high for all the oils specifically covered by this section, except sesame and corn oils. Cottonseed and soybeans yield five and one-half times as much cake and meal as oil; sunflower seed, three and one-half times as much; peanuts, two and one-half times as much; flaxseed, twice as much. From palm kernels are obtained about equal quantities of cake and oil. The same is true of the germ of the corn grain, but from the whole corn grain twelve to twenty-six times more cake than oil is obtained.

Table 169 gives pertinent data with respect to the feeding value of the various oil meals. Oil cake and oil meal usually are fed mainly because of their protein content, and, other things being equal, the higher the protein content the higher the price which will be paid for it. Table 170 gives the fertilizer constituents of the various oil meals. Only cottonseed meal is used to any appreciable extent for this purpose.

TABLE 169.—*Digestible nutrient constituents of specified oil cakes and oil-cake meal* [1]

Kind of cake or meal	Total dry matter in 100 pounds	Digestible nutrients in 100 pounds				Nutrition ratio [2]
		Crude protein	Carbohydrates	Fat	Total	
Coconut meal or cake:						
New process [3] [4]	90.0	19.9	44.2	3.0	70.8	2.6
Old process [5]	89.8	18.6	41.3	8.4	78.8	3.2
Old process, high in fat [5]	92.3	18.4	37.6	17.1	94.5	4.1
Corn germ meal	91.1	16.5	42.6	10.4	82.5	4.0
Cottonseed meal:						
Cold pressed	92.1	21.1	33.2	7.4	70.9	2.4
Choice	92.5	37.0	21.8	8.6	78.2	1.1
Prime	92.2	33.4	24.3	7.9	75.5	1.3
Good [3]	92.1	31.6	25.6	7.8	74.8	1.4
Linseed meal:						
New process [4]	90.4	31.7	37.9	2.8	75.9	1.4
Old process [5]	90.9	30.2	32.6	6.7	77.9	1.6
Peanut oil cake or meal from shelled nuts	93.4	40.3	22.5	9.2	83.5	1.1
Soybean oil meal	89.5	39.7	34.7	4.5	84.5	1.1
Sesame oil cake	90.2	34.5	20.0	13.2	84.2	1.4
Sunflower oil cake	90.0	32.0	18.3	16.5	87.4	1.7

[1] W. A. Henry, and F. B. Morrison, Feeds and Feeding (Madison, Wis., 1922), pp. 730-732.
[2] Ratio between digestible crude protein and the combined digestible carbohydrates and fat. One part digestible crude protein to number of parts stated of combined digestible carbohydrates and fats.
[3] Digestion coefficients not available, but digestion coefficients for a similar feed used.
[4] "New process" is extraction by naphtha.
[5] "Old process" is extraction by pressure.

TABLE 170.—*Fertilizing constituents in 1,000 pounds of specified oil cake and oil-cake meal* [1]

Kind of cake or meal	Nitrogen	Phosphoric acid	Potash
Coconut meal or cake:			
New process [2]	35.4		
Old process [3]	33.1	12.4	23.6
Old process, high in fat [3]	32.6	7.8	24.2
Corn germ meal	36.2	13.2	2.5
Cottonseed meal:			
Cold pressed	41.8		
Choice	70.6	26.7	18.1
Prime	63.7	26.6	18.0
Good [3]	60.2	26.6	18.0
Linseed meal:			
New process [2]	59.0	17.7	13.0
Old process [3]	54.2	17.0	12.7
Peanut oil cake or meal, from shelled nuts	71.7	12.1	10.5
Soybean oil meal	69.1		
Sesame oil cake	60.0	33.2	14.7
Sunflower oil cake	55.7	21.6	11.7

[1] W. A. Henry and F. B. Morrison, Feeds and Feeding (Madison, Wis., 1922), pp. 730–732.
[2] "New process" is extraction by naphtha.
[3] "Old process" is extraction by pressure.

Table 171 shows domestic production of different types of oil cake and meal in specified years 1921 to 1930. Table 172 shows domestic production plus imports minus exports (apparent consumption) of oil cake and meal (from both domestic and imported materials) in the United States in 1923, 1925, 1927, and 1929. In addition, there is a production of tankage and crackling probably exceeding 2,000,000,000 pounds annually, and of fish meal and scrap, amounting usually from 200,000,000 to 250,000,000 pounds annually. These compete to some extent with oil cake and oil meal as a feed and a fertilizer. Tankage is fed, however, mainly to poultry and hogs; oil cake and oil meal, mainly to cattle.

TABLE 171.—*United States production of principal kinds of oil cake and oil meal for specified years* [1]

[In thousands of pounds]

Oil cake and meal	1921	1923	1925	1927	1929	1930
Cottonseed	2,709,208	3,035,718	5,193,430	5,680,168	4,563,152	4,463,984
Linseed	[2] 900,000	1,226,000	1,487,124	1,431,710	1,506,370	[2] 1,080,000
Corn oil	23,316	64,600	66,642	47,116	38,130	[2] 35,000
Copra	61,644	129,760	113,140	154,852	193,656	193,504
Soybean	[3]	6,664	14,974	17,470	59,694	76,482
Peanut	56,076	10,884	29,608	20,240	31,878	49,100
	[2] 3,750,244	4,473,626	6,904,918	7,351,556	6,392,880	[2] 5,898,070

[1] Bureau of the Census, Census of Manufactures, except as noted under footnote 2.
[2] Estimated.
[3] Data not available but output probably small.

TABLE 172.—*Production, imports, exports, and apparent consumption of oil cake and oil meal*

Year	Domestic production [1]	Exports [2]	Imports for consumption [2]	Apparent consumption (production plus imports minus exports)
	Pounds	*Pounds*	*Pounds*	*Pounds*
1923	4, 473, 626, 000	917, 394, 000	124, 124, 000	3, 680, 356, 000
1925	6, 904, 918, 000	1, 487, 756, 000	88, 535, 000	5, 505, 697, 000
1927	7, 351, 556, 000	1, 569, 969, 000	188, 884, 000	5, 970, 471, 000
1929	6, 392, 880, 000	1, 277, 525, 000	334, 172, 000	5, 449, 527, 000

[1] Bureau of the Census.
[2] Department of Commerce, Foreign Commerce and Navigation of the United States.

Table 173 indicates that the United States produces more vegetable-oil cake and oil meal than it consumes, and thus has an excess of exports over imports. In the last decade, however, the export surplus has shown some tendency to decline. More than half of the export usually consists of linseed-oil cake made from imported flaxseed and exported with benefit of the drawback. The remainder is mainly cottonseed-oil cake, which Southern crushers export in large quantities. In 1929 exports were composed as follows:

	Pounds
Linseed-oil cake	734, 404, 000
Cottonseed-oil cake	473, 982, 000
Other	69, 919, 000
Total	1, 278, 305, 000

Imports for consumption in the same year were composed as follows:

	Pounds
Soybean	171, 855, 000
Coconut or copra	30, 292, 000
Cottonseed	43, 770, 000
Linseed	69, 295, 000
Cottonseed and linseed (Bibby's)	1, 373, 000
Peanut	10, 560, 000
Other	7, 037, 000
Total	334, 182, 000

TABLE 173.—*United States balance of trade in oil cake and oil meal*

Year	Imports		Exports		Excess of exports over imports	
	Quantity	Value	Quantity	Value	Quantity	Value
	Pounds		*Pounds*		*Pounds*	
1921	88, 430, 000	$1, 756, 000	1, 193, 058, 000	$24, 312, 000	1, 104, 628, 000	$22, 556, 000
1922	93, 485, 000	1, 885, 000	926, 301, 000	19, 898, 000	832, 816, 000	18, 013, 000
1923	124, 124, 000	1, 764, 000	917, 394, 000	19, 831, 000	793, 270, 000	18, 067, 000
1924	154, 572, 000	2, 482, 000	1, 289, 948, 000	27, 590, 000	1, 135, 376, 000	25, 108, 000
1925	88, 535, 000	1, 580, 000	1, 487, 756, 000	31, 666, 000	1, 399, 221, 000	30, 086, 000
1926	120, 555, 000	2, 125, 000	1, 449, 758, 000	26, 458, 000	1, 329, 203, 000	24, 333, 000
1927	188, 884, 000	3, 124, 000	1, 569, 969, 000	30, 186, 000	1, 381, 085, 000	27, 062, 000
1928	250, 786, 000	4, 695, 000	1, 186, 934, 000	27, 198, 000	936, 148, 000	22, 503, 000
1929	334, 172, 000	6, 715, 000	1, 277, 525, 000	28, 414, 000	943, 353, 000	21, 699, 000
Jan. 1–June 17, 1930	179, 094, 000	3, 266, 000	511, 392, 000	9, 706, 000	263, 726, 000	5, 519, 000
June 18–Dec. 31, 1930	68, 572, 000	921, 000				
Jan. 1–June 30, 1931	45, 154, 000	490, 000	287, 116, 000	4, 145, 000	241, 962, 000	3, 655, 000

Source: Summary of Tariff Information, 1929; Foreign Commerce and Navigation of the United States, 1929 and 1930; Monthly Summary of Foreign Commerce, June, 1931; import data furnished by the Bureau of Foreign and Domestic Commerce.

The existence at the same time of considerable exports and imports of oil cake and meal is due largely to transportation costs and the concentration of the bulk of domestic production in the Southern States, which export cottonseed cake and meal, and the Northeastern States, which export linseed cake and meal under the benefit of the drawback. The Middle Western States, in which is produced less oil meal than is consumed, use large quantities of cottonseed-oil meal from the South. The Rocky Mountain and Pacific Coast States, however, supplement their supply largely by imports from China, Mexico, Japan, the Philippines, and other Pacific countries. On a bulky commodity of relatively low value, like oil meal, ocean freight is usually cheaper than rail freight, which tends to become prohibitive for very long distances. Taking this factor into consideration, crushers on the east coast and in the South usually find a more advantageous market in Europe than in the far Western States, while the far Western States find it more advantageous to buy in various far eastern countries and in near-by Mexico, from which come most imports of cottonseed-oil meal. This situation may have been affected by the imposition of a duty of three-tenths of 1 cent per pound on oil cake and meal in the tariff act of 1930. A specific duty is most effective in checking imports in a period of low prices, such as 1930–31. This may largely account for the small export of cake and meal under the present tariff.

Table 174 shows for 1929 the balance of trade of the United States in oil cake and oil meal by groups of customs districts. In the northern districts are included, in general, customs districts bordering on Canada, or near the Canadian line, including practically all middle western ports of entry. Most of these obtain the bulk of their imports from Canada. The eastern districts include all districts in the Northeastern States, except those along the Canadian border and not on the coast. The western districts include Arizona, California, Oregon, Washington, and Alaska.

The effect of an increased production of oil cake and meal incident to an increased production of oil expressed from domestic materials would depend on the following factors:

(1) On the section in which the increase in production occurred: If it occurred in the Rocky Mountain and Pacific Coast States it might replace imports. If it occurred in the East or the South it might increase exports.

(2) On whether or not accompanied by a decrease in the production of oil cake and meal from imported material: The principal examples of such production are coconut-oil cake on the Pacific coast and linseed-oil cake on the Atlantic.

(3) On the feeding value of oil meal in which the increase occurred: Linseed, cottonseed, and soybean oil meals have high feeding value and have a ready market. Coconut-oil meal does not contain as much protein, but makes a good feed. Corn-oil meal contains less protein than coconut oil. (See Table 169.)

(4) On the possibility of expanding domestic consumption of oil meal, which depends upon many factors, including the competition of alternative feeding materials.

TABLE 174.—*Balance of trade in oil cake and oil-cake meal by regions, 1929* [1]

Kind of cake	Imports (general)	Exports	Surplus of exports (+), of imports (−)
Eastern districts:	*Pounds*	*Pounds*	*Pounds*
Cottonseed		4,836,160	+4,836,160
Linseed	700	727,829,760	+727,829,060
Coconut	80,286		−80,286
Soy and other beans	16,595,535	14,638,400	−1,957,135
All other	191,334		−191,334
Total	16,967,855	747,304,320	730,436,465
Southern districts:			
Cottonseed	3,103,388	433,184,640	+430,081,252
Linseed	88,800	2,080,960	+2,012,160
Coconut			
Soy and other beans	30,118,640	2,728,320	−27,390,320
All other	1,605,802		−1,605,802
Total	34,896,630	437,993,920	+403,097,290
Western districts:			
Cottonseed	40,666,620	13,018,880	−27,647,740
Linseed	30,934,730	2,511,040	−28,423,690
Coconut	30,167,122		−114,673,087
Soy and other beans	120,594,285	51,587,200	
All other	15,528,880		
Total	237,861,637	67,117,120	−170,744,517
Northern districts:			
Cottonseed		22,942,080	+22,942,080
Linseed	38,381,486	1,982,400	−36,399,086
Coconut			−964,040
Soy and other beans	1,400	965,440	
All other	1,623,031		
Total	40,005,917	25,889,920	−14,421,046

[1] Department of Commerce, Foreign Commerce and Navigation of the United States, 1929.

Farmers, when considering whether it would be advantageous to increase their production of any oil-bearing plant would, of course, take into consideration both the prices of oil and prices of oil cake and meal, and likewise the relation of the production of these forms of animal feed to the demand for corn and other feed grains, both in this country and in export markets. The uncertainty as to the actual reaction of domestic producers to these considerations renders more or less insoluble the question how much the output of vegetable oils in the United States might increase as the result of any reduction in the imports of such oils.

5. Economic Factors Affecting the Interchangeability of Perilla Oil with Linseed Oil

Perilla oil is derived from the seed of an annual plant grown principally in China but crushed principally in Japan. The supply of the seed is limited, and it does not seem probable that it will be increased to any appreciable extent in the future.[27] Perilla-oil cake is unfit for cattle feed, but it is used in Japan as a fertilizer for mulberry trees.[27]

Demand for perilla oil in the Orient and in Europe has decreased, and the United States is now the largest market for it. International trade consists mainly of shipments from Dairen, China, and from Japan to this country. Imports into the United States in the last 11 years have

[27] See, *supra*, Pt. III, p. 109.

ranged from a low of 652,840 pounds in 1921 to a high of 8,838,000 pounds in 1930. Next to 1930, the largest imports were 7,582,000 pounds in 1920 and 7,401,000 pounds in 1926.

Perilla oil is used in the United States exclusively in the drying industries, principally in making certain high-gloss enamels and baking varnishes having an exceptionally hard film. Varnish manufacturers state that it would be difficult to manufacture these without perilla oil. Perilla supplies less than 1 per cent of the factory consumption of oils in the paint and varnish industry compared with 75 per cent supplied by linseed oil. This is partly due to custom, to the limited and uncertain supply of perilla oil, to the fact that untreated it tends to sweat and streak in the process of drying, and to the further fact that even after treatment linseed oil usually is preferred for general use in paints and varnishes.

Table 175 compares prices of linseed and perilla oils. The other paint oils are so markedly different from perilla oil as to render price comparison unnecessary. It will be noted that perilla oil was higher in price than linseed oil except in 1930 and 1931, when perilla seems to have had a slight price advantage. This advantage, however, has led to no large increase in consumption. It may have been substituted to a minor extent for linseed oil in some uses, particularly in border-line uses, where there is not much preference between the two oils. Only to the extent of such substitution could perilla oil be said to have replaced linseed oil, except in the sense that if perilla oil had not been available consumers might have been forced to use somewhat different enamels and varnishes made of linseed instead of perilla oil. About half the domestic consumption of linseed oil is produced in the United States from domestic flaxseed; the other half is either imported or made from imported flaxseed.

TABLE 175.—*Comparison of prices of perilla and linseed oils*

[In cents per pound]

Year	Perilla oil, crude, New York [1]	Linseed oil, raw, New York [2]	Year	Perilla oil, crude, New York [1]	Linseed oil, raw, New York [2]
	Barrels	*Barrels*		*Barrels*	*Barrels*
1926	13.7	11.2	1929	15.2	12.3
1927	14.8	10.5	1930	12.2	12.5
1928	14.3	10.0	1931 [3]	8.9	9.0

[1] Oil, Paint and Drug Reporter.
[2] Bureau of Labor Statistics, Wholesale Prices.
[3] Average for first 6 months.

6. ECONOMIC FACTORS AFFECTING THE INTERCHANGEABILITY OF RAPESEED OIL WITH DOMESTIC CORN AND SOYBEAN OILS

Rapeseed oil is derived from the seed of an annual plant grown principally in India, China, and Japan, and to a less extent in European countries. The only important seed-exporting countries are British India and China, but their exports have declined from 630,000,000 pounds in 1923 to 208,000,000 pounds in 1930. The principal countries exporting rapeseed oil have been the United Kingdom and Japan; the exports from the latter country rose from 2,000,000 pounds

in 1923 to 32,000,000 pounds in 1930. No marked change may be expected in the near future in the supply of rapeseed oil, either in the way of an increase or a decrease.

Imports of rapeseed oil into the United States increased from 12,908,000 pounds in 1920 to 19,224,000 pounds in 1927 but declined to 14,959,000 pounds in 1930. In this country its principal use is in blend with mineral oils as a lubricant for marine-reciprocating engines. No satisfactory substitute for rapeseed oil in this use has yet been discovered, although experiments have been made with various oils.

The second largest use of rapeseed oil in the United States is in making rubber substitutes. Corn oil is also used for this purpose, but the rubber substitutes made from two oils differ materially and are interchangeable only to a limited degree. Corn-oil substitute is preferred for erasers and rapeseed-oil substitute for compounding with rubber to which it gives certain desirable properties.

Table 176 compares prices of refined rapeseed and corn oils in barrels in New York. The comparison indicates that rapeseed oil has sold consistently lower in price than corn oil. The continued use of corn oil has been due to the preference for it for certain types of rubber substitutes, particularly, as stated, for art erasers.

TABLE 176.—*Comparison of prices of rapeseed oil and corn oil*

[In cents per pound]

Year	Rapeseed oil, refined (barrels), New York [1]	Corn oil, refined (barrels), New York [1]	Year	Rapeseed oil, refined (barrels), New York [1]	Corn oil, refined (barrels), New York [1]
1926	11.5	13.5	1929	10.8	11.3
1927	10.7	11.6	1930	8.4	10.4
1928	11.4	12.0	1931 [2]	6.9	9.9

[1] Oil, Paint and Drug Reporter.
[2] Average for first 6 months.

It is apparent that as far as there has been replacement of domestic oils by rapeseed oil it has occurred in rubber substitutes. There is interchangeability between rapeseed and corn-oil substitutes in what might be called border-line uses; that is, in cases where there is not much preference as between substitutes made of rapeseed oil and corn oil. In such uses the rapeseed variety would probably be used because of price, and replacement may be said to have occurred. How far corn-oil substitute would be substituted in other uses were the rapeseed not available can not be determined.

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