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**National Research Council**

**Soybeans**

**by**

**C. A. MacConkey**

**Division of Research Information  
National Research Council**

**Ottawa**

**March, 1935.**

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FOREWORD

The investigation, the results of which are embodied in the present report, was undertaken because of suggestions that had been made that Canada ought to put considerable areas of the prairie provinces under soybeans, and also on account of the wide interest of late in soybeans throughout the Dominion. At first it was hoped that it would be possible to confine it to the Canadian aspect of the problem alone, but it soon became evident that in order to get a clear picture of the Canadian situation, the problem would have to be surveyed from other angles as well.

In 1932 the first two sections of the report were prepared; in 1934 the third section was added in order to bring the report up to date.

The writer wishes to acknowledge his indebtedness to all those that have given him help, and especially to Dr. Kirk, the Dominion Agrostologist at Ottawa, and to Dr. Morse of the U.S. Department of Agriculture in Washington.

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### SUMMARY OF PART I.

The soybean combines the advantages of a legume with those of an annual cash crop and an oil seed bearing plant. It seems to be somewhat hardier than other field crops.

Although of importance in the East since prehistoric times, only in the last twenty or thirty years has it become of any importance amongst the white races. The increase in its popularity over this period, however, has outstripped that of all other oil seeds, and experimental acreages are now being grown all over the world. The best methods of cultivation have been worked out in the United States as well as in Canada and elsewhere, and of the various operations harvesting is the most costly.

It has been found, however, that the selection of the right variety is the most important factor in determining the success of the crop in any district. Thousands of distinct varieties are known in the East, and the points which come in for chief consideration are time of maturity, vigor, erectness of growth, color and oil content of seed, yield and resistance to disease. Of these perhaps the most important is the time of maturity. Some varieties mature in as short a period as 75 days, while others require 130 days and longer. The beans vary in color from pale yellow to black. The dark varieties are suitable only for forage, at any rate at present.

Very energetic efforts have been taken to establish the soybean in the United States, which is the only country outside the Orient where it is being grown on a large scale. The method of development has consisted in obtaining a great number of selections of seed through the services of consular officers, missionaries, agricultural explorers and others in the East. Recently an expert was sent to China and Japan for a two years' visit. As a result they have at present some 7,000 selections of seed under test. When a strain proves to be promising at the experiment station, a sufficient quantity of seed is grown and distributed to farmers for trial. The acreage under the crop has increased from some 700,000 acres in 1917 to over 4,000,000 acres in 1931. Of this some 75% is used for forage purposes. The chief growing district is the corn belt, but the introduction of new varieties from the East has widened the limits of profitable soybean cultivation very considerable. A system of optional federal inspection and standard grades was inaugurated in 1925 and met with considerable success. The remarkably low price of soybeans in the United States in 1931-32 made it possible for some 60,000 tons to be exported. A rise in the home price or a fall in that of the Manchurian product would prevent the resumption of this trade.



The field of usefulness of the soybean is remarkably wide. The plant itself may be used successfully for all the usual forage purposes, while the bean may be converted into oil and cake. Of the methods of separating the oil from the bean, the crushing process is used almost exclusively in the United States, while in Europe extraction by solvents is making more headway. By the first method a short ton of soybeans will give about 250 lb. of oil and 1600 lb. of meal, while by the second the oil is more completely extracted. The chief outlet for the oil is in the food, paint and soap industries but difficulties have been met with in its use. The cake however makes a first class cattle food. It can also be used for human consumption in the form of flour, relishes, vegetable beans, etc. Although it is consumed in the latter way in enormous quantities in the Orient and is very nutritious, it has made little headway in the western countries so far, but nevertheless this is progressing. The cake may also be used for making casein, lecithin and a number of other chemical commodities. In the United States soybeans are turned into about 50 different products, but into 250 in the Orient.

Beans: world production. This is generally estimated at about 7,000,000 tons, nearly 80% coming from Manchuria and the rest from Korea, Japan, the United States and the Dutch East Indies. This figure, however, does not include the rest of China and Russia in which countries it is possible that the production may be as large again. Russia is reported to have had over 1,000,000 acres under soybeans in 1931. If not the largest oil seed crop of the world, it is at least the second largest, yielding place only to cotton seed, of which some 8,000,000 tons are produced yearly.

Beans: world exports. The chief exporting countries for soybeans are Manchuria and Korea, whence two to three million tons are shipped annually. Russia has recently begun to export some 100,000 tons. Taking the £ at par the total world exports of soybeans in 1931 had a value of some \$80,000,000.

Beans: world imports. The chief importing country for soybeans is Germany followed by Japan, Denmark and the United Kingdom. Germany takes about 1,000,000 tons per annum and the other three countries the same amount between them. Thus Germany takes 30-40% of the total world imports of soybeans. Germany is also the largest consumer of soybeans outside the Orient.

Beans: London turnover and price. The turnover in 1928 on the London market alone is said to have been about 1,000,000 tons. The price has fallen from an average of £ 13. 0. 5 per ton in 1925 to £ 6. 8. 0 per ton in 1931. In 1929 the price was £ 11. 7. 11 per ton.

Oil: world exports and imports. Total world exports of soybean oil amount to some 200,000 tons, of which half comes from China, the port of Dairen being one of the largest oil crushing centres in the world. About one-third of these exports goes to Holland and one-sixth to the United Kingdom. The remainder is distributed among a number of countries, the chief of which are Belgium, Germany and France. Taking the £ at par the total world exports of soybean oil had a value of some \$16,000,000 in 1931.

Oil: price. The average price of soybean oil (Manchurian crushed cif London/Hamburg/Rotterdam) fell from £ 39. 5. 0 per ton in 1925 to £ 16. 17. 2 in 1931. In 1929 the price was £ 30. 2. 1 per ton.

Cake: world exports and imports. No figures are available, as for customs purposes soybean cake is included with other oil cakes.

German imports of beans and production and consumption of oil and cake. Imports of soybeans into Germany increased from 370,000 tons in 1926 to 1,015,000 tons in 1931. This represents 22% of the total German imports of oil seeds of all kinds in 1926 and 42% in 1931. The value of the imports in 1931 was 131,000,000 marks. Of the dozen or more different oil seeds imported into Germany the soybean is the cheapest.

All the German imports of soybeans are converted into oil and cake. The production of soybean oil in Germany has increased 800% since 1913. In that year 3% of all vegetable oil produced in Germany was soybean oil; in 1931 this had risen to 20%. The consumption on the other hand of soybean oil in Germany has been showing signs of declining in the last few years.

The production of soybean cake in Germany has similarly increased 800% over the same period or from 9% of the total oil cake production to 53%. While the consumption of soybean oil in Germany has been declining, that of soybean cake on the other hand has risen 50% (1928-31), or from 34% of the total consumption of oil cakes of all kinds to 49%.



SUMMARY OF PART II.

The cultivation of soybeans for the bean (seed) and for forage are two separate industries, as distinct from one another as the linseed and flax fibre industries. This must always be borne in mind when considering the possibilities of growing soybeans in Canada. They might be a success as a forage crop in areas where they could not be grown for the beans.

The climate of Canada is similar to that of Manchuria to which the soybean is indigenous, but the Canadian summers are cooler and the rainfall not monsoonal.

Soybeans for Seed.

The plant is apparently already being grown successfully for beans in the Niagara Peninsula. Some 7,000 acres were under the crop this last year and the yields were good. There are one or two other areas in the Dominion where the climate being specially favorable the cultivation of this crop might be developed, but on the prairies in general there are no immediate commercial possibilities. Only the earliest varieties come into consideration and these as a rule are dwarf and have dark instead of light coloured beans. Although innumerable varieties exist none are as yet known that will give a good yield of seed of the right kind in the short cool and dry prairie summer. Some 150 varieties have been experimented with for several years at a number of points in the Dominion and as a result the variety (O.A.C.211) has been produced that is now being grown in southern Ontario. Varieties suitable for the prairies, however, are not likely to be discovered unless very systematic and energetic steps following the plan adopted in the U.S. (they have tried nearly 3000 varieties) are taken to obtain further introductions of seed. The U.S. Department of Agriculture will supply samples of possibly suitable varieties and trade commissioners, missionaries and others in the Orient might be instructed to try to locate soybean districts where the midsummer temperature is below 70°F. and the climate comparatively dry. The most northerly regions are particularly indicated. Each district in Canada would eventually have to try out many varieties but without assurance of success.

The farmers' need for a supplementary cash crop to reduce their dependence on wheat will likely be the deciding factor in determining whether or not to make such a whole-hearted attempt to establish a soybean industry in the prairie provinces.

The markets in Canada for vegetable oils and oil cake should be capable of absorbing much greater quantities of the soybean products. These might supplant the home



produced linseed oil and cake to some extent. The value of the vegetable oils consumed in Canada amounts to about \$14,000,000 per annum. This consists of 10% home produced linseed oil and nearly 90% of imported oils. The latter includes a very small quantity of soybean oil. While the immediate home market is thus small, the potential market is considerable and is probably largely a matter of price and educating the potential consumer. Oil cakes consumed in Canada amount to about \$1,250,000 p.a. in value. Of this, however, only about 20% is imported, the rest being supplied by home produced linseed cake.

Soybean oil does not compare very favorably with other vegetable oils, but the scientific research which is being prosecuted in the U.S. and elsewhere bids fair to remove this disadvantage. The oil cake is an excellent cattle food. In Germany it represents about 50% of all oil cake consumed, but in Canada only 2.6%.

The largest consumer of soybeans outside the Orient and the U.S. is Germany. Imports have increased phenomenally since the war and now average about 1,000,000 tons a year. This rate of increase can hardly be expected to continue but other countries such as England may follow suit.

#### Soybean for Forage

Practically no soybeans are grown for forage in Canada. In the United States 75% of the crop is cultivated for this purpose. The difficulties encountered are considerably less than in growing for seed (chiefly the fact that a light coloured bean is not a requisite), and it seems probable that varieties could be found that would make a satisfactory growth even on the prairies.

SUMMARY OF PART III.

The greater part of the literature on soybeans, as might be expected, deals with the farming aspects of this industry. Nothing of great novelty was reported as far as the present search of the literature extended.

The differences of opinion as to whether feeding soybeans causes soft pork or not seem to be clearing up. It appears that oil meal cake from which the oil has been extracted is an excellent livestock feed and does not produce soft fat. It also seems that soybeans themselves may be fed to pigs in moderation without causing soft pork in certain cases, depending on the condition of the pigs.

Opinions have differed as to whether soybeans are a soil improver or not, farmers having complained that the subsequent crop was often noticeably poor. It now seems that perhaps the carbonaceous roots stimulate organisms that consume nitrate and that therefore an increase of nitrate cannot be expected unless the green part of the plant is turned under.

Experiments on hybridization have been continued, especially in Germany which has hopes of becoming self-supporting in soybeans. In that country efforts are being directed to developing not only healthy, erect, and high-yielding varieties, but also such as will give beans of desirable chemical constitution, namely, a high oil and protein content.

With regard to oil cake as a general livestock feed, it has been found that, when produced by the expeller process and thus properly cooked, it is more palatable and very much more nutritious.

Some interesting experiments were carried out on the qualities of oil expressed at different temperatures with special reference to the paint industry, oil expressed below a certain critical temperature being a "non-break" oil and therefore considerably more valuable.

The manufacture of soybean flours and emulsions for human consumption continues to develop. Soya meal bread is now being made in Austria on a factory scale, and in the United States efforts are being made to popularize soybeans as a vegetable and to develop special varieties for this purpose.

A chemical method has been worked out for detecting the presence of soybeans in prepared foods such as



breakfast cereals. It is reported that considerable quantities of soybeans are being used in the manufacture of glue, and that a casein plastic is also being made from them.

The use of refractometers for measuring oil content has been advocated for use by the United States National Grain Inspection Service as a better method of grading.

Manchuria has been suffering from low prices for soybeans and small exports coupled with a large crop, and the government has been encouraging the farmers to grow wheat, cotton and hemp.

A 56 page bibliography on soybeans covering the period 1890-1933 has been prepared by the Seattle Public Library. (101)



PART ICULTIVATION, UTILIZATION AND TRADE.Introduction

Like other beans the soybean is one of those crops known as legumes. It grows two to four feet high and has small white or purplish flowers and seed pods two to three inches in length.

It is a native of south eastern Asia and has been grown and cultivated in Manchuria, where it takes place amongst the sacred beans, since time immemorial.

It combines the advantages of the legumes, which are forage plants and soil improvers but mostly two-year crops, with those of an annual cash crop and an oil seed bearing plant. It is more valuable than other annual hay crops but not necessarily more suitable. The seed contains some 19% of oil, while the residual cake is an exceptionally nutritious food both for man and beast, contains no starch and is the raw material for a number of chemical commodities. The soybean is therefore of special economic interest. Its introduction from the East is of comparatively recent date but since about 1908 trade in it has increased rapidly. Investigation and research with a view to widening its applications and those of its products is being actively pursued in many places as witness the patents that are from time to time appearing. This will no doubt lead to a greater and more general demand.

In Manchuria immense quantities are grown every year so that soybeans form the world's second largest oil seed crop. Lesser quantities are grown in other parts of China, Korea (Chosen) and Japan (Table 10).

Each native village through centuries of cultivation has developed a variety adapted peculiarly to its local soil and climate. There are thus literally thousands of different varieties and ones that grow well in Japan fail in China and vice versa. It has even been found that a variety growing well in one district in Manchuria will fail in a neighbourhood less than 100 miles away. This factor has had a very important bearing on the development of soybeans in Europe, America and other parts of the world, where it has often been necessary to try out in a given neighbourhood a great number of varieties before one was found that would grow successfully.

Soybeans are also of importance agriculturally in India, Indo-China, the East Indies, Java and the Malayan Islands.

The only country in the West where soybeans are as yet grown on a commercial scale is the United States. Here the total acreage in 1931 was about a million and a quarter (Table 4), most of which is used for forage.

The chief consuming country outside the Orient is Germany who imported over a million tons in 1931 (Table 19). This is all crushed, the oil, which is not altogether popular at present being used for a variety of purposes chiefly probably the manufacture of butter substitutes, and the cake which is excellent being fed to cattle. There are indications, however, that other important uses may develop.

Experimental acreages are being grown in Canada, England, France, Italy, Germany, Holland, Hungary, Siberia and southern Russia, Egypt and the Sudan, South Africa, Australia, Hawaii, the Philippines, Brazil and other countries of South America. Extensive experimentation of all kinds on the cultivation of soybeans is also in progress in many parts of the United States, not to mention Manchuria itself and Japan. It can be grown with success in northern India and over a large part of South Africa, while experiments in Victoria and Queensland are reported to have been entirely successful. It will thus be seen that world interest in this plant has been and is still considerable.

### Cultivation

#### Differences in Varieties

The type species is said to be "a slender twining vine with very small dull black seeds". Thousands of years of cultivation and natural cross-breeding in China have resulted in every village having its own distinct varieties. Some lie close to the ground, some are tall and erect, some are bushy, some have thick coarse stems, some fine fragile stems.

"Varieties of soy beans are differentiated largely by the color and size of seed, though they also differ in time of maturity, habit of growth, disposition to shatter their seed, disease resistance, oil and protein content, and in yield of forage and seed. They vary also in their adaptation to climate and soil. Some varieties are especially suitable for fertile land, others for less productive land; some for early planting; others for late planting; some for seed crop; others for forage; some for planting with corn; others for planting with Sudan grass and sorghum. One may find a few varieties or even a single variety adapted to the climate of a certain section which will fill all the local requirements of the crop".



The selection of the variety is the most important factor in determining the success of the crop. The points which come in for chief consideration are time of maturity, vigor, erectness of growth, color of seed, yield and resistance to disease. With dwarf habit the pods are often left in the stubble. In some regions, in the United States for example, many varieties failed before one was discovered that fulfilled all requirements in that particular neighbourhood.

With regard to oil seed, the oil content is said to be the test applied to all varieties by all dealers.

### Maturity

The different varieties of soybeans vary very greatly in the length of time they take to mature and this is the most important differential characteristic for a country like Canada, where only the earliest varieties come into consideration. The early varieties generally give a poorer yield, as might be expected since they have a shorter time to grow.

Wilson and Virginia, two early maturing varieties grown in the United States, show first blossoms in 55 days, nearly full sized pods in 70-75 days and nearly full sized beans within the pods in 95 days. The early varieties mostly give the less desirable dark colored bean but yellow beaned varieties that mature in as short a time as 75 days are among the new selections being tried out this year at the Arlington Experiment Farm in Washington, D.C., where they also have some 150 yellow beaned varieties that mature in less than 100 days.

It is usual to classify the various varieties according to maturity groups, but the maturity of any one variety will vary somewhat with the temperature of the district in which it is grown as would be expected.

Any variety of soybean tends to adapt itself to the length of the growing season. For instance Mammoth Yellow planted 15 April required 6 weeks longer to reach maturity than when planted 17 June. The longer growing period gives a proportionately larger yield.

### Hardiness

Different strains vary considerably in this characteristic. Many are very hardy, growing on poor soil and being comparatively resistant to acidity, disease, cold and extremes of drought and rainfall. They will not however withstand a prolonged drought or frost. According to some authorities no other field crop has a wider climatic adaptation.



They can be sown earlier than other beans and are less fragile to spring frosts. They are not so sensitive to cool weather as are cowpeas. They will endure extremes of drought and wet weather better than corn, cotton or cowpeas. They are more drought and disease resistant than field peas and also freer from insect injury.

Different varieties of soybeans show considerable variation in their ability to withstand low temperatures. However, they do become hardened by repeated mild exposures as do certain vegetable crops and fruit trees.

### Color of Bean

This is the most important characteristic as far as the trade in the beans is concerned. These vary in color according to the variety. They may be pale yellow, pale green, brown or black, or they may be yellow or green with a black or brown seed scar. Practically the whole of the world trade in beans is in the yellow varieties. The black beaned varieties although just as good for hay, pasturage, etc., are not acceptable to the crushing plants. The oil from dark beans is generally of a bad color, although some good oil has been obtained from dark beans grown in Manitoba. Cake from dark beans although just as good for cattle feed is discriminated against by farmers because it does not look as nice as that made from pale beans. For the manufacture of flour and casein it is not suitable.

A black or brown seed scar on a pale colored bean is not considered very objectionable.

### Climate

That part of the world where the most soybeans are grown, namely, Manchuria, is a basin land, whose climate according to the Encyclopaedia Britannica is "Continental in its temperature régime and monsoonal in the seasonal distribution of its rainfall. Midsummer temperatures average 70-75°F., the winters are intensely cold. The rivers are all frozen over in the north until the end of April and even in the south until the beginning of April.

"The story of the opening up of the Manchuria steppe is not unlike that of the Canadian prairie with which it is physically comparable. The cold winters limit cultivation to the summer half year during which only one crop can be grown, apart perhaps from a catch crop after the main harvest. The staple crops are those adapted to a relatively low rainfall, millet, kaoliang, corn, wheat, barley and legumes, especially

beans. Cereals and beans form the essential elements in the rotation system. These features are characteristic of all Manchuria".

Soybeans were found in the United States to grow with ease in any climate suited to corn, but by careful selection of suitable varieties its limits there have been greatly widened.

### Soil

Soybeans can be grown on a great variety of soils but do best on mellow fertile sandy and clay loams, while the most unfavourable is sour clay. In comparison with other crops they thrive fairly well on light sandy soils, even when somewhat acid and poor in nitrogen. On heavy clay soils they succeed better than cowpeas. Like all legumes soybeans require much potash and phosphorus. In general the soil requirements are about the same as for corn. Drainage should be reasonably good although soybeans will stand excessive moisture or drought better than corn. A soil too acid for clover will often produce good crops of soybeans. In Maryland the highest yields of soybean hay were always obtained on soils of high fertility and the best yields of seed on soils of medium fertility.

Since soybeans, being legumes, take their nitrogen not so much from the soil as from the air in the soil by the help of bacteria, the soil must be well cultivated and aerated before sowing, and if it has not already borne a crop of legumes, it or the seed must be inoculated with the necessary bacteria. This presents, however, no difficulty.

As regards acidity of the soil recent (Dobert, 1932) experiments in Germany indicate increasing yields and nodule formation up to a hydrogen ion concentration of 7.1

### Seeding

Soybeans may be sown any time after the danger of severe frost is over, in general about the same time as corn. Nothing is gained by seeding before the soil has become well warmed up, but the longer the growing period the better the yield in general.



It is said that planting should be shallow, one or two inches, in rows if for seed, either broadcast or in rows if for forage. Plants do better when planted thickly, thus ensuring shade to one another.

Experiments on the most satisfactory method of sowing were carried out in a particularly complete manner at Iowa (Agr. Exp. Bull. 228. 1925) and the optimum was found to be double rows 21-30 inches apart, the seeds 1 inch apart.

Purdue University found that soybeans gave higher yields of seed when planted in rows and of hay when planted solid.

The amount of seed required per acre varies with the method of planting and the size of the seed from 30 to 45 lb. For hay 1-1/2 to 2 bushels of seed per acre are needed.

At the Manitoba Agricultural College, according to an article in the Country Guide (May, 1931, p. 13) they use 12 lb. to seed an acre and the yields are 10-15 bushels per acre and 500-1800 lb. of seed. The seed is on sale by seedsmen at 30 cents per lb.

The fundamental principles of growing alfalfa or corn are applicable to soybeans. When grown among corn it reduces the yield of the latter less than do cowpeas, at the same time providing forage and fertilizing the ground.

A small addition of sudan grass to soybeans seeded for hay solves the weed difficulty.

An immense amount of experimentation has been carried out and literature published on this subject and the reader is referred for details to the publications of the United States Department of Agriculture and of the universities and agricultural schools in the United States and Canada.

### Harvesting

If the crop is to be used for hay, soilage or silage, it is cut when in blossom, but if grown for seed the harvest is deferred till September or October by which time the pods have matured and the leaves have all fallen.

Harvesting is one of the most costly operations in soybean production.



In the United States "the development of an efficient method of harvesting the seed crop has been one of the serious problems connected with the production of soy beans. Many types of machines are now on the market, ranging from the single row harvester to broadcast harvesters of the beater type and the combine harvester like those used in harvesting wheat and other small grains".

It is said that there are some slight difficulties in harvesting and curing soybeans either for hay or forage, but these may be readily overcome with a little experience.

This subject is beyond the scope of the present report but much information may be found in publications of the United States Department of Agriculture, of the agricultural colleges in the United States and Canada and of firms such as the International Harvester Company.

#### Production of Oil and Cake

There are two methods of producing oil and cake from oil seeds:-

1. The hydraulic press and expeller process. The oil is pressed out of the beans by subjecting them to high pressure either at normal or elevated temperature.
2. The extraction process. The oil is extracted from the beans by treating them with a fat solvent such as benzol, and is finally recovered by distilling off the solvent.

The residue from either process is called oil cake when it is in lump form and oil cake meal when it is in powder form. It may also be referred to simply as soybean cake, for example, or soybean meal. Cake obtained by the expeller process contains 5-9% of oil; by the solvent process only 0.5 to 1.5%.

In the United States the hydraulic crushing process is used almost exclusively, while in Europe the extraction process is more common. Opinion in the United States and Canada seems to be quite against the idea of using oil or cake that has been made by the extraction process for food purposes. This is as it may be, but in Europe extracted cake is apparently fed to cattle satisfactorily provided the right solvent is chosen. In a certain district in Germany an epidemic of disease in cattle (Die ducrerer Krankheit) occurred in 1924 and 1925. This was ultimately traced to the use of soybean cake that had been extracted with trichlorethylene. When cake extracted with benzene was substituted the trouble completely vanished.

For some industrial purposes such as the manufacture of casein extracted cake is preferable on account of its low oil content.

Tests in the United States showed that one ton of beans ( $33\frac{1}{3}$  bushels of 60 lb. with 19% of oil) gave on an average by the expression method 250 lb. of oil and 1600 lb. of meal, 150 lb. being lost in cleaning, milling or as moisture.

Taking the value of the oil at 7 cents a lb. (Canada 1950) and of the cake at \$1.59 a cwt. the ton of soybeans would produce oil worth \$10.50 and cake worth \$22.50. The cake is, therefore, to be regarded as the primary product and the oil as a by-product as is done at the oil mills in Germany. Since the oil, however, has considerably more value per unit of quantity, the oil content is a very important differential characteristic of any variety of soybeans.

### Applications

#### Introduction

In the Far East the soybean is used as a universal food for man and beast and also as a fertilizer for the ground. The native peoples eat very little meat and the soybean fills the place that meat holds in the white man's diet. For food purposes they prepare it in numberless ways and eat it fresh, fermented and dried. Perhaps the best known oriental product is Tofu, a white curd made from soybean milk. The soybean is highly nutritious, containing 19% of fat and 39% of digestible protein. This protein has a higher feeding value than other vegetable proteins but is inferior in this respect to meat protein. The orientals are said to use it to give a meaty flavor to other vegetable dishes. The soybean also contains vitamins and phosphorus but only a trace of starch. This last property has made it of special interest in the west as a food for diabetics.

Soybeans are now turned into about 50 products in America, while in the Orient 250 products are made from them. The soybean is truly a versatile commodity as evidenced by the multitudinous possibilities for its use given in Table 1.

The industrial and agricultural applications of soybeans have been dealt with at some length in "Soy Bean Utilization", a 27-page Farmers' Bulletin (No. 1617) issued by the U.S. Department of Agriculture in 1928 and revised in 1932, to which the reader is referred. The sections therein on soybeans for hay, pasturage, silage, soilage, etc., are illustrated with numerous tables of analyses of the various forms of soybean products in comparison with other crops. The different feeding problems such as the value of soybean silage, hay, grain, pasture and oil meal have been extensively



investigated in the United States by the experiment stations of the various States, in whose publications a mass of data may be found. The reader is also referred to "The Versatile Soy Bean", published in May 1930 by the Allis-Chalmers Manufacturing Co. (Bull. 1246).

TABLE 1

Uses of SoyBeans

Stalks and leaves	(Green manure	(Hay
	(Forage	(Silage
	(Pasture	(Soiling
		(Straw
Bean cake and meal	(Celluloid	(Breakfast Foods
	( substitute	(Diabetic Foods
	(Stock feed	(Flour.....(Cakes
	(Fertilizer	(Macaroni (Breads
	(Human food.....	(Crackers (Pastry
	(Glue	(Wafers
	(Vegetable	(Infant Foods
	( casein	(Soy Milk
	(Water paints	(Bean curd
		(Soy sauce
		(Bean powder
Bean Oil	(Glycerin .....	(Explosives
	(Enamels	
	(Food products.....	(Margarine & cooking fats
	(Varnish	(Salad oil
	(Waterproof goods	
	(Linoleum	
	(Paints	
	(Soap stock.....	(Hard soaps
	(Celluloid	(Soft soaps
	(Rubber substitutes	
	(Printing inks	
	(Lighting	
	(Lubricating	
	(Core binder	
Green Beans	(Candies	
	(Lecithin	
	(Green vegetable	
	(Canned vegetable	
	(Salads	

TABLE 1 (continued)Uses of Soy Beans

Dried Beans	(Stock feed .....	(Sheep
	(Soy Sauce	(Hogs
	(Boiled beans	(Cattle
	(Baked beans	(Poultry
	(Soups	
	(Coffee substitute	
	(Vegetable milk	(Fresh
	(Breakfast foods	(Dried
	(Bean curd.....	(Smoked
	(Condensed soy milk	(Fermented
	(Fresh soy milk	
	(Soy casein .....	(Sizing & glazing
	(Soy milk powder	( paper
	(Paper size	(Cement for wood
	(Paints	( veneer
	(Textile dressing	
	(Waterproofing for textiles	
	(Patented yeasts for bakeries	
	(Confections	

The PlantForage

In the United States three-quarters of the soy-beans planted are grown for forage purposes.

(a) Hay

Soybean hay is relished by all kinds of livestock, including young cattle, sheep and lambs, steers, work horses, mules, dairy cattle, draft fillies, hogs, gilts and poultry.

Very considerable experimentation has been carried out in the United States in the feeding of soybean hay and it has been found to compare favorably with other hays, such as alfalfa and red clover. It also compares favorably with cowpeas and is satisfactory as a substitute for oats. Difficulties have arisen, but it would appear these may be overcome by care and experience, and the acreage for hay has increased rapidly during the last five years. The feeding of soybeans alone is not recommended. The hay is inclined to be coarse, but varieties vary greatly in this respect.



(b) Pasturage

The soybean can be used as pasturage for all kinds of live stock and especially for hogs when supplemented with corn.

Table 2 shows the digestible nutrient value per 100 lb. of soybean hay and some other feeds as taken from the International Harvester Company's pamphlet "Soy Beans" and Henry and Morrison's "Feeds and Feeding".

TABLE 2

Nutrient Value per cent of Various Feeds

---

	Protein	Carbohydrates	Fat	Total
SoyBean Hay	11.7	39.2	1.2	53.6
Alfalfa	10.6	39.0	0.9	51.6
White Sweet Clover	10.9	38.2	0.7	50.7
Red Clover	7.6	39.3	1.8	50.9
CowPeas	13.1	33.7	1.0	49.0
Timothy	3.0	42.8	1.2	48.5
Corn Fodder	1.0	12.8	0.4	14.7

---

(c) Silage

For this purpose, soybeans are said to be unsatisfactory alone, but valuable when supplemented with corn.

(d) Soilage

Soybeans being high in protein may be fed with low protein crops such as corn, Sudan grass and millet.

(e) Soil Improvement and Fertilizer

The printed word invariably mentions soil improvement and ground building as one of the virtues of soybeans. The value of the ground is supposed to be increased by \$3 to \$5 worth of fertility per acre. Agriculturalists will not always agree with this. Several farmers from different parts of the States told the writer that they thought soybeans took more out of the soil than other legumes. The explanation of this may be that the soybeans add nitrogen, but take away potash and phosphorus. The improvement in the soil is therefore of a one-sided nature.

At the Virginia Station, the yield of wheat was 3.5 bushels per acre greater where soybeans had been previously grown and cut for hay, and 10.1 bushels per acre greater where the entire crop had been turned under for green manure.

Charles E. Chambliss, writing in the Agriculture Yearbook, says:

"Plowing under the soy bean plants, after the beans are harvested, adds to the soil a large quantity of organic matter which decomposes rapidly when drainage is good. The upturned soil under these conditions readily responds to tillage in preparing a suitable seed bed for rice. Good seed-bed preparation insures a more thorough destruction of weeds, better germination, a better stand, a stronger root growth and larger yield. When the soil is deficient in organic matter, such a seed-bed is not easily obtained, even with extra tillage. Soil fertility also is greatly increased by the decomposed vegetable matter. On the typical rice soil of Louisiana the soy bean rotation is giving an average acre increase of 10 bushels of a better grade of rice, which is a greater return than is being obtained by the use of commercial fertilizers".

### The Bean

#### Grain for Cattle Feed

Soybeans may be fed to cattle in the form of grain and when minerals are added to the ration, the results compare favorably with those from a ration of tankage and meat scrap. Soybeans are rich in protein and, mixed with corn, form a well balanced feed. Three pounds of soybeans will substitute 1 lb. of tankage. Its feeding value is a little higher than that of alfalfa.

The high oil content of the bean, however, tends to produce soft pork and butter. The use of soybean cake is therefore to be preferred.

#### Flour for Human Consumption

Soybean flour can substitute wheat flour to a certain extent. It is said to be more nutritious than whole wheat bread, and is eaten in great quantities by the Chinese. It contains more vitamins and phosphorus compounds. As its content of starch and sugar is very low, it is a valuable article of diet for diabetics. The protein which it contains in large proportion ranks in value between the protein of meat and other beans. It has been marketed in Europe under the name of Berczeller's Soyolk Flour and in the United States there are a



number of companies manufacturing it, one of which is said to be producing a ton a day. The United States Department of Agriculture have published a long compendium of recipes in order to try and popularize its use. In the East it is made into all kinds of cakes, biscuits and the like.

Information is not available as to the extent to which the whole bean or the extracted cake is used in the manufacture of flour. It is likely that most of this material is made from cake in western countries at any rate. Flour can be made from the whole bean, but it is difficult to prevent it turning rancid.

#### Soy Sauce

Soy sauce is made by fermenting the soybeans and is an important commodity in the East besides being well known in the West. It is said to be the basis of the well known Worcestershire Sauce. In its preparation the whole bean is used but recent investigations have shown that the extracted cake can be used equally well. The manufacture of soy sauce is said to have been found to be most profitable in some parts of the Corn Belt.

#### Bean Curd

This is another product of the Orient that has been manufactured in the Corn Belt.

#### Vegetable Beans

The United States Department of Agriculture has tried to introduce the use of soybeans in the manner of field and navy beans but without great success as yet.

#### Other Uses

In the Orient soybeans are prepared for human consumption in a multitude of other ways.

#### The Cake

#### Cattle Feed

The most important use for soybean cake is the manufacture of dairy and other cattle feeds. Its protein content which runs from 42-56% is higher than almost any other product available. The protein has a higher nutritive value than other vegetable proteins although not as high as that of meat, and is present in a readily assimilable form. It can be fed to all kinds of livestock including poultry and has "the widest usefulness".

A great number of experiments have been carried out in the United States and Europe to determine the relative value of soybean cake and cottonseed, peanut, sunflower, corn, wheat, kafir, tankage, linseed, barley, velvet bean, etc. The results are somewhat ambiguous but show that soybean is of high nutritive value and is perfectly satisfactory if used in admixture with other feed.

It is popular in the United States and Canada, where the opinion seems to be that it is as good as, if not better than, cottonseed or linseed cake.

Complaints have been made that it causes some animals, especially hogs, to become fat and soft, that it has an undesirable laxative effect and that with prolonged feeding it becomes unpalatable. It must, therefore, be used with the same precautions observed with other highly concentrated feeds and appears to require a little experience. W.J. Morse, writing in United States Farmers Bulletin No. 1617 says, "alleged injurious effects from feeding it have been reported in the United States and in Europe, but after careful investigation no proof is to be had substantiating these reports".

In 1924 and 1925 a serious outbreak of disease in cattle (the Dürerkrankheit) which occurred on the continent of Europe was traced to the use of soybean cake that had been extracted with trichlorethylene. When cake extracted with benzene was substituted the trouble disappeared. In Canada and the United States there seems to be an assumption that only cake made by the expresser method can be used for feeding purposes.

Meal made from dark beans is discriminated against by farmers because of its appearance, but not because of lower nutritional value or palatability.

### Flour

Soybean cake is manufactured to some extent into flour for making bread and other special flour products (see page 22). For this purpose presumably only yellow or light green beans would come into consideration. The flour must be specially treated or it has an oily "beany" flavor objectionable to the white man's palate.

### Fertilizer

As a fertilizer soybean meal may possibly be used in Asiatic countries. It contains phosphates, potash and nitrogen. In America and Europe where synthetic fertilizers are so readily available, it is not profitable to use it for this purpose.



### Other Uses

As indicated in Table 1 there are many other possible uses for soybean cake. "Research chemists have been studying the value of soy bean meal for industrial uses for many years... Results indicate that the extent of possible commercial uses is limited principally by the supply of the raw product" (J.E. Barr, Yearbook of Agriculture. 1926). For example, casein, a product of milk, is one material that can now be manufactured commercially from soybeans. It is used for glazing and sizing paper, as an adhesive in woodwork and for making plastics. Active investigations, some on a large scale, towards the development of this industry are in progress in different parts of the world.

### The Oil

Among the many uses for which soybean oil has been suggested, its three principal outlets are the soap, the paint and varnish and the edible oil industry.

Many authoritative statements have been made to the effect that soybean oil does not compare favorably with other fatty oils, that it is neither "fish, flesh, fowl nor good red herring", being neither a hard oil nor a soft oil, neither a drying oil nor a semi-drying oil. One paint works in Ontario does not use soybean oil at present because it is "too expensive, too slow drying and offers no advantages", while at an oil mill in Manitoba they believe that it is "very much over-rated industrially and that its usefulness will be limited very largely to soap manufacture". From the point of view of the food industry the complaint has been made that it has an unpleasant "beany" flavor and easily goes rancid.

Manufacturers have often been afraid of soybean oil, partly because of its cheapness and partly because it was at first of very poor quality. In the United States, however, some 10,000 tons have been used annually since the war. In 1931 there was a considerable increase in consumption, both in crude soybean oil and especially in the refined oil, while in 1932 it is stated on good authority that mills were 30 days behind with orders. From Table 8 an indication may be obtained of the relative importance of soybean oil in the different industries in the United States. It will be noticed that there the chief market for soybean oil is in the food industry and in this connection it may be noted that practically all the soybean oil exported from Germany goes to the Netherlands, which are one of the largest producers of butter substitutes. The next most important outlet in the United States is the paint and varnish industry; soap ranks third and linoleum and oilcloth fourth.

### Soap Industry

Soy bean oil cannot be used for making hard soap unless it has been hydrogenated. For the manufacture of soft and liquid soaps, however, it is said to have displaced linseed oil to a great extent. Soap is probably its cheapest market because almost any oil will do for making soap.

### Paint and Varnish Industry

This is the highest priced market for soybean oil. Only a few oils, principally linseed are suitable. Technical development so far will only permit of its replacing linseed to a very limited extent (15-20%) on account of its slow drying properties. It is half way between the drying linseed and the semi-drying cottonseed. All the demand from the trade today is towards quick drying products. For some very special purposes, for example, in the manufacture of dressing for automobile tops a high percentage of soybean oil is necessary to give a fine glossy finish without cracks.

The difficulty experienced in the use of soybean oil in the manufacture of paints may be due to the fact that it requires a different type of drier, those which work well with other oils not functioning satisfactorily with soybean oil.

Research is in progress at the University of Illinois on the production of soybean oil paints and the results seem promising. Paints incorporating 50% and even 100% of soybean oil have been developed. A number of paint manufacturers are co-operating in this development work and some soybean paint has been put on the market. For more detailed information on the subject of the use of soybean oil in paints, the reader is referred to the publications of the American Paint and Varnish Manufacturers Association.

According to newspaper reports Henry Ford is painting the 1933 model of his car with soybean oil paint. It is not known whether this means that he is only painting the tops in this way, which would be no innovation, or whether he is going to use it to substitute cellulose lacquer, which is hardly likely.

### Food Industry

No information was available about the success of soybean oil in the food industry. It seems, however, that the unpleasant flavor and tendency to turn rancid is removed when the oil is properly refined, and it without doubt has a definite place in the edible oil industry.



## The Soybean Industry in the United States

### Importance of the Crop

The United States is the only western country where soybeans are as yet grown on a large scale. The United States Department of Agriculture have summed up the situation thus:- "The soy bean is used in the United States primarily for forage purposes", but "as a forage crop alone it is not likely" to "become a major field crop in the United States. The reasons for this are twofold:

"First:- The high yielding capacity of the soy bean and the cheapness of harvesting the seed, in both which respects soy beans excel other legumes. The seeds and the numerous manufactured products thereof furnish very valuable human foods, which are certain to be used extensively if for no other reason than their cheapness. Of more immediate importance are soy bean oil and soy bean cake. Extensive data show that the United States can successfully compete with the Orient in raising soy beans because the use of machinery counterbalances the cheaper Oriental labor. The market demands for vegetable oils and oil meals are far greater than the supply and there is no reason to expect that the supply will exceed the demand.

"Second.- In general the soy bean proves to be a more profitable crop than oats, the crop which it will mainly replace in Corn Belt rotations. This in itself would seem to assure a very rapid and large increase in soy bean acreage. Incidentally the fact of the soy bean being a legume will probably make its effect on the succeeding crop more favorable than is the case with oats".

In a letter to the writer (Nov. 2, 1932) W. F. Callander, Chairman of the Crop Reporting Board says: "The cultural and marketing practices differ markedly in the north and the south. In the north soy beans are grown mainly for production of oil and seed and for hay with a rather limited acreage for grazing. When intended for the latter purpose soy beans are ordinarily planted thinly in the corn rows, usually at the rate of about one-tenth of the quantity per acre that is ordinarily planted for production of the seed or for hay. Their use in this manner is rather incidental and of little significance in the northern states. Practically all of the oil seeds are produced in the north central states, especially in Illinois, Indiana, Ohio, Missouri and Iowa. In these states we have ceased to estimate the acreage of soy beans for grazing and show only the acreage for hay or for seed.

"In the south the production of soy beans is mainly for hay and grazing and only incidentally for oil and seed except in the eastern sections of Virginia and North Carolina which in past years have produced considerable quantities of seed of the forage types of soy beans for sale for planting. We understand that considerable oil seed is now being produced in those two States, some of which has gone into export channels during the past year. For the southern states estimates are still made of the acreage for grazing as well as of that for seed and for hay.

"Soy beans for hay are ordinarily grown alone, although they are sometimes planted in a mixture with sorghum, millet, etc. When intended to be harvested for the seed, soy beans are planted alone in the north but in the south they may be planted alone or in with corn or other crops. When beans are harvested from such interplanted fields they are usually gathered by hand. In estimating soy bean acreage in the south mixed plantings are usually reduced to their equivalent solid acreages on a half and half basis. In that section corn is not planted as thickly as in the north and the interplanted beans are sown more thickly. In some sections an acre of soy beans in corn is considered equivalent to 0.6 of an acre of soy beans grown alone. Soy beans to be grazed by livestock are generally planted with other crops, usually, corn; sometimes there will be a mixture of three crops, such as soy beans, peanuts and corn".

#### History and Development

Previous to 1898 there were not more than eight varieties of soybeans being grown in the United States. From then onwards the United States Department of Agriculture made a number of introductions and "vigorous efforts were inaugurated about 1907 to obtain additional varieties through consuls, agricultural explorers, foreign seedsmen and extensive correspondence with missionaries and others until in 1909 the department had in its trials about 200 distinct varieties, by 1913 400 varieties, by 1919 600 varieties, by 1925 1,200 varieties, while in 1932 they have had growing at the Arlington Experiment Farm at Washington, D. C., some 7,000 selections representing about 2,500 distinct varieties". This great increase in the last few years is due to introductions made by W. J. Morse, who is in charge of the division of soybeans and made a visit extending over a period of two years to Manchuria and Japan. He told the writer that he had covered pretty well every part of the soybean growing district.

"When new introductions are received they are thoroughly tested at Arlington Experiment Farm the first year, and if mixed, single plant selections are made for the second year's test. After three years' work with these selected strains,



those giving the best results in comparison with standard varieties are disseminated among the state experiment stations, where they are grown again under careful observation and test conditions. Finally seed is distributed among the farmer co-operators who assist the department in its practical field investigations. Varieties that appear promising in these field trials ultimately are assigned suitable varietal names and made available for general use and distribution in the localities to which they are adapted". (U.S. Yearbook of Agriculture, 1926).

In 1926 already over half the soybean hay and seed produced was obtained from varieties introduced by the department. Today the proportion will no doubt be very much greater.

The varieties introduced come not only from Manchuria but also from Japan, China, India, Korea, Siberia and the East Indies. It is stated to be "universally appreciated and acknowledged by all soy bean authorities that the annual introductions of soy beans into the United States have been of fundamental importance in the rapid rise of the crop in public favor.

"The results that have been obtained by this wholesale search have justified the work and expense many times over. When the department work began, the soy bean was a very minor crop and of importance only in limited areas, owing primarily to the lack of suitable varieties. Today its culture, due to a wide range of excellent varieties, is widespread and lends substance to the belief that the soy bean will become one of our major crops.

"The Department of Agriculture .... has developed varieties which have extended the range of profitable soy bean culture far beyond what were at first considered its limits".

The adaptability of the soy bean to new conditions is well illustrated by the Virginia variety. In the Ozark region of Missouri extensive tests failed to show any promising sorts till the Virginia was tried and found to succeed admirably on the less fertile Ozark soils. The range of local adaptability is extensive and the study of varieties must be carried on over a wide territory.

Only about 25 varieties are widely grown in the United States at present and perhaps not more than 25 additional varieties are grown to a lesser degree.

Henry Ford has been interesting himself considerably in soybean cultivation and is said to have 10,000 acres under the crop.

As shown in Table 3a the total acreage in the United States on which soybeans are grown either alone or interplanted with corn has increased from about 700,000 acres in 1917 to 4,000,000 acres or more in 1931. A large proportion of this, perhaps 40%, represents acres of soybeans interplanted with corn. The figures in this table are taken from the Yearbooks of Agriculture as well as from data supplied from the Department of Agriculture at Washington and other sources. The Department of Agriculture, however, states that the figures up to 1928 are not comparable with those that follow being apparently too high and subject to revision. The table is, therefore, given for what it may be worth and is to be taken as an indication rather than a statement of fact.

For statistical calculations it is the custom to reckon 2 acres of soybeans interplanted as equivalent to 1 acre solid. In Table 3b an attempt has been made to show the proportions of the soybeans grown for different purposes. It would appear that of all soybeans grown reckoned as solid acres about 50% is used for hay, 25% for interplanting with corn for pasturage, grazing, hogging, etc., 20% for beans and 5% for other purposes. As these proportions are calculated from the figures in Table 3a which are themselves subject to revision, it is not known to what extent they are accurate.

TABLE 3a

Approximate Division of Soybean Crops in United States  
by Purposes: in acres 1917 and 1923-31.xx

Year	Soybeans interplanted with corn.	Soybeans alone	Hay	Beans	Other purposes
100,000 acres					
1917	3	4			
1923			8		
1924	15	17	12		
1925	15	16	12		
1926	15	20	15		
1927	18	23	17	6.2	5.4
1928	15	24	17	6.6	4.9
1929	6 <sup>x</sup>	21	15	8.9	5.4
1930	7 <sup>x</sup>	25	17	8.6	3.0
1931	8 <sup>x</sup>	31	22	9.6	3.2

xxCompiled from figures supplied by the Department of Agriculture as well as from those published in the Yearbook of Agriculture.

<sup>x</sup> Southern States only.



TABLE 3b

Approximate Division of **Soybean** Crops by purposes  
in per cent 1924-28.

Crop grown primarily for			
Year	Hay%	Beans%	Other purposes%
of total solid acreage			
1924	49	20	31
1925	50	19	31
1926	53	19	28
1927	52	19	29
1928	52	19	29

Table 4 gives for 1927 to 1931 the acreage grown for beans, the yield per bushel and the farm price for the whole of the United States as well as for the four chief growing states, viz., Illinois, where 35% of all the beans were grown in 1931, Indiana 18%, N. Carolina 11% and Montana 9%. It will be noticed that the acreage for beans has increased materially over this period but that the average yield per acre is not very high, 17.8 bushels in Indiana in 1931 being the maximum recorded. In 1921-22 the production of beans was 84,000 tons and 1931-32 450,000 tons. (Table 10).

Further details of production, exports, imports and consumption of soybeans and their products in the United States will be found under section entitled Trade and Statistics.

#### Standards

A system of optional federal inspection and standard grades and classes for soybeans was inaugurated in the United States in 1925. Particulars are given in Handbook of United States Standards for Soybeans, effective 1926,- a 20-page booklet issued by the U.S. Government Printing Office in Washington, D.C.

"In the U.S. Standards for soy beans there are five classes, designated according to color. Each class may be made up of a single variety or of several varieties

TABLE 4

Acreage of Beans Gathered in the United States, Yield and Farm  
Price in the 4 Chief growing States

Year	Illinois	N. Carolina	Montana	Indiana	All States
	ac. yield 1000 bu.	ac. yield 1000 per ac. bu.	ac. yield 1000 bu.	ac. yield 1000 bu.	ac. yield 1000 bu.
	Farm price Dec. 1 \$/bu.	Farm price Dec. 1 \$/bu.	Farm price Dec. 1 \$/bu.	Farm price Dec. 1 \$/bu.	Farm price Dec. 1 \$/bu.
1927	184 13.0 1.40	94 15.0 1.50	68 13.0 1.65	621 12.0 1.80	
1928	186 16.5 1.40	120 11.5 1.65	69 14.5 1.60	656 13.4 1.80	
1929	240 16.5 1.50	162 12.0 1.70	100 10.0 1.95	893 12.8 1.90	
1930	336 17.0 1.20	97 13.0 1.55	129 9.5 1.65	864 13.9 1.56	
1931	346 17.5 0.35	107 14.0 0.70	172 12.0 0.60	956 15.6 0.63	
1931% of total	36	11	9	18	



of the same or a similar color. Variation in size and shape have no bearing on the class designation. This classification by colors simplifies the application of the standards and at the same time gives a more accurate basis for evaluating various lots of soy beans, especially for crushing or industrial purposes. Each class of soy beans in the U.S. Standards is divided into six grades".

Specially designed triers are recommended for sampling the lots of soybeans.

#### Classes of Soybeans

"Soy beans shall be divided into five classes, as follows:

"Yellow Soy Beans.- This class shall include all yellow soy beans of the Mammoth Yellow, Midwest, Manchu, Ito San, A.K., Hollybrook, Haberlandt, and all other varieties of a similar color and may contain not more than 5 per cent of soy beans of other colors. A slight tinge of green or olive green on the beans shall not affect their classification as Yellow Soy Beans.

"Green Soy Beans.- This class shall include all green colored soy beans of the Morse, Medium Green, or Guelph, and all other varieties of a distinct green color, and may contain not more than 5 per cent of soy beans of other colors and may be slightly yellow tinged.

"Brown Soy Beans.- This class shall include all light brown and dark brown soy beans of the Virginia, Mammoth Brown, Early Brown, Biloxi, and all other varieties of a solid brown color and may contain not more than 10 per cent of soy beans of other colors.

"Black Soy Beans.- This class shall include all black soy beans of the Wilson, Peking, Wisconsin Black, Tarheel Black, Laredo and all other varieties of a solid black color and may not contain more than 10 per cent of soy beans of other colors.

"Mixed Soy Beans.- This class shall include the "Black Eyebrow" variety and any mixtures of soy beans not provided for in classes Yellow Soy Beans, Green Soy Beans, Brown Soy Beans, and Black Soy Beans".

TABLE 5

Grade requirements for Yellow Soybeans, Green Soybeans, Brown Soybeans,  
Black Soybeans and Mixed Soybeans.

U.S. grade	Condition and general appearance	Minimum test weight per bushel	Maximum limits of (per cent)		
			Moisture	Splits	Damaged beans Foreign Material
Extra No.1	Shall be cool and of natural odor, plump, well screened, and of good color.	56	15	0.5	1.0 0.2
No.1	Shall be cool and of natural odor and good color.	56	15	1.0	2.0 0.5
No.2	Shall be cool and of natural odor and may be slightly stained or mottled.	54	16	10.0	3.0 2.0
No.3	Shall be cool and of natural odor and may be stained or mottled.	52	17	20.0	5.0 5.0
No.4	Shall be cool and may be badly stained or mottled and may be slightly frosted or immature.	50	18	30.0	8.0 10.0

Sample shall be soybeans which do not comply with the requirements of any of the above  
Grade grades or which have any commercially objectionable foreign odor or are sour,  
heating, hot, moldy, infested with live weevils or other insects injurious to  
stored soybeans, or are of otherwise distinctly low quality.

The grade U.S.Extra No.1 shall apply only to soybeans of the classes: Yellow Soybeans,  
Green Soybeans, Brown Soybeans, and Black Soybeans containing not more than 1 per cent  
of soybeans of other classes, either singly or in any combination, and shall not apply  
to the class Mixed Soybeans, except when such "Mixed Soybeans" are composed of 98  
per cent or more of the Black Eyebrow variety.



In the United States there are also standards for soybean hay.

In the United States, according to the Oil, Paint and Drug Reporter, May 9, 1932, p.34, sixteen mills were operating during the first quarter of 1932. The production figures for the first quarters of each of the last four years is given in Table 6.

TABLE 6.

Soybeans Crushed and Oil and Cake Produced in the United States

(N.B. These figures refer to the first quarter of each year only)

Year	Mills Operating	Beans Crushed (tons)	Oil Produced (tons)	Cake Produced (tons)
1928	-	5,139	595	-
1929	-	10,595	1523	-
1930	-	12,644	1672	-
1931	-	32,412	4554	-
1932	16	50,917	7314	40,971

Consumption of Soybean Oil in the United States

Some 10,000 tons have been used annually in the United States since 1922. In 1931, the amount consumed rose to over 25,000 tons as shown in Table 7, while in the summer of 1932, it is stated on good authority mills were 30 days behind with orders. Table 8 shows the factory consumption of soybean oil in the United States by industries in 1931 and gives an indication of the relative importance of soybean oil for different purposes. The figure in this table for the total consumption is lower than that in the preceding table, having been arrived at "by deducting from the total of both crude and refined consumed the quantity of refined produced".

It will be noticed that the chief market for soybean oil in the United States is in the food industry; the next most important outlet is paint and varnish, while soap ranks third, and linoleum and oilcloth fourth.

TABLE 7

Factory Consumption of Soybean Oil in the United States, 1922-1931, (tons)					
<u>Year</u>	<u>Crude</u>	<u>Refined</u>	<u>Year</u>	<u>Crude</u>	<u>Refined</u>
1922	8,800	2,300	1927	-	-
1923	9,700	3,400	1928	7,700	2,000
1924	5,400	3,000	1929	10,400	2,500
1925	5,700	2,800	1930	8,800	4,500
1926	8,500	5,100	1931	17,800	8,200

TABLE 8

Consumption of Soybean Oil in the United States by Industries in 1931 (tons)									
	Compounds & Vegetable Shortenings	Oleo Mar- garine	Paints & Varnish	Soap	Linoleum & Oil- cloth	Print- ing Ink	Miscell- aneous	Loss in Refining	Total
Soybean Oil	5,500	310	3,100	1,910	1,310	17	1,030	810	140,000
All mineral and Vegetable Oils and Fats	610,000	95,000	164,000	700,000	37,000	6,700	192,000	86,000	1,890,000



### U.S. Export Trade in Soybeans

The United States began exporting soybeans in November 1931. By the end of the following May, 50,000 short tons had been exported. Nearly half went to Germany, 20% to the United Kingdom and the remainder to Canada, France and the Netherlands. Resumption of the trade in the fall of 1932 would be problematical, according to the Dept. of Commerce. An advance in price in the United States would stop it.

The United States soybean has a preference with the European crusher because it is subjected to Federal grading and is more uniform than the Manchurian offerings. Its yellow color is also a point in its favor.

In the following table, figures are given showing the number of bushels inspected for export, first by months, second by ports, and third by grade and class.

TABLE 9

#### Soybeans Inspected in the United States for Export

(Figures in bushels)

<u>By Months</u>	<u>By Ports</u>	<u>By Grade &amp; Class</u>
<u>1931</u>	New Orleans, La.	984,461 U.S.#2 Yellow 1,891,964
November 132,980	Mobile, Ala.	339,626 2 Mixed 131,347
<u>1932</u>	<sup>x</sup> Norfolk, Va.	318,729 2 Black 3,733
February 138,132	Chicago, Ill.	423,238 1 Yellow 24,140
March 635,929		
April 573,308		1 Mixed 14,870
May 232,394		
June 140,734		
July 212,577		
Total 2,066,054	2,066,054	2,066,054

<sup>x</sup>All exports of soybeans from Norfolk, Va., are made up of soy beans grown in eastern North Carolina and adjacent territory and all those from other ports originated in Illinois and other mid-western States.

The total figure of 2,066,054 bushels is equal to 61,982 tons. It is interesting to note that over 90% of this total is represented by U.S. Standard Grade No. 2 Yellow. The specifications for this grade are given elsewhere.

Statistics of World Trade(a) BeansProduction

Among plants bearing oil seeds, soybeans constitute the world's second largest crop, cottonseed coming first with some 8,000,000 tons. China is the largest producer. According to the U.S. Yearbook of Agriculture, the production in Manchuria, viz. about 6,000,000 tons, represents 97% of the total production of China, but, according to the Empire Marketing Board, only 39%. The latter estimate the total normal crop of China at 13,000,000 tons. Soybeans have also been grown in Russia since the war and over 1,100,000 acres are said to have been under the crop in 1931.

TABLE 10

Production of Soybeans by Countries<sup>1</sup>  
(1,000 tons)

Year	Man- churia	Korea (Chosen)	Japan	United States	Dutch East Indies (Java)	Total for these countries	Russia
1921-22	2,000	720	640	84	109	3,600	
1922-23	3,300	690	560	130	116	4,800	Produc-
1923-24	2,700	710	530	196	107	4,300	tion
1924-25	2,800	560	410	170	106	4,100	not known
1925-26	3,500	710	550	153	118	5,000	(see ex-
1926-27	4,100	670	380	196	110	5,500	ports).
1927-28	4,900	730	500	220	119	6,500	
1928-29	5,400	590	460	260	129	6,900	
1929-30	5,400	610	410	260	118	6,800	
1930-31	3,800	690		360	134		
1931-32	6,400			450			

<sup>1</sup>U.S. Yearbook of Agriculture, p.747, 1932. 33-1/3 bushels taken as equivalent to 1 ton.

Exports

China and Korea are the chief exporting countries for soybeans. It will be noticed (Table 11) that the proportion of the crop exported is small (Empire Marketing Board), contrary to the statement of Encyclopaedia Britannica that half the production of Manchuria is available for export. The exports from Korea go in toto to Japan. Japan exports a small quantity to



Formosa. Russia is estimated to have shipped some 80,000 tons from Leningrad in 1930 and Russian trade returns indicate large exports in 1932, the first time such exports have been recorded.

TABLE 11

Exports of Soybeans from Chief Exporting Countries  
(1,000 tons)

Country	Average 1909-13	1926	1927	1928	1929	1930	Average 1926-30	1931	Proportion of crop percent
China	697	1342	1732	2373	2689	1928	2013	2206	15
Korea		182	189	183	178	184	183	-	33

Manchurian soybeans are exported through Dairen and Vladivostok.

The turn-over on the London market in 1928 was 1,000,000 tons.

In the winter of 1931-32, the United States exported 62,000 tons of soybeans (Table 9). The extremely low price on the home market made competition with Manchuria possible, and it may be that these exports will not continue.

Imports

The country which imports the largest quantity of soybeans is Germany (Table 12). In recent years, she has taken 30 to 40% of the total world exports.

TABLE 12

Imports of Soybeans into the Principal Importing Countries  
(1,000 tons)

	Pre-war Average	1926	1927	1928	1929	1930	(Provisional) 1931	
Germany	--	370	570	840	1020	880	1000	
Japan (1)	220	600	590	650	740	610	-	(1) Including im-
Denmark	35	170	160	210	240	175	240	ports from
U.K. & Empire countries	230	46	84	194	210	99	110	Korea.
Dutch East Indies	54	87	88	94	106	97	---	
Sweden	1	62	68	90	100	49	31	
Italy	-	-	58	64	88	8	40	
Formosa (2)	6	29	27	35	42	34	---	(2) Including im-
Holland	33	19	10	18	49	19	31	ports from
Total			1660	2200	2600	1970		Japan.

It will be noticed that the imports of soybeans into Germany have increased from year to year since 1926 (1930 excepted) amounting to over a million tons in 1929 and again in 1931. In 1926, the imports of soybeans represented 22% of the total imports of oil seeds of all kinds, but by 1931 this figure had risen to 42%, a maximum so far. For this reason, a special section has been appended dealing with German statistics relating to soybeans and their products.

### Consumption of Beans

The greatest quantities of soybeans are consumed, as might be expected, in China, Japan, and the Orient generally. Outside this area the chief consuming country is Germany. Exports and German native production of soybeans being negligible, the import figures represent the internal consumption which amounts, as has been seen, to about one million tons a year. This is apparently all converted into oil and oil cake, of which some 20% is then exported.

The excess of imports over exports for the principal countries is given in Table 13.

TABLE 13

### Net Imports of Soybeans by Countries (1,000 tons)

	Average 1909-13	1927	1928	1929	1930
Germany,1	-	576	848	1024	889
Japan,2	218	585	651	745	613
Denmark,1	-	158	214	235	176
U.K.,3	-	83	195	206	107
Dutch East Indies,4	53	89	94	107	98
Sweden,1	0	68	91	100	49
Italy,5	-	59	64	88	8
Formosa,6	5	27	35	42	34
Holland,4	18	10	18	49	19
British Malay	-	-	-	2	6
Total Europe	-	954	1437	1705	1249
Total Asia	-	701	780	896	751
Total World	-	1655	2217	2601	1990

1. No exports; 2. exports 1000 tons to Formosa & 300 tons to other countries; 3. small exports to Empire countries; 4. small exports; 5. small exports; 6. exports 1000 tons mainly to Japan.



The United States does not figure in Table 13, as she is not an importer of soybeans. From the tables of production elsewhere, it may be seen that she consumed 400,000 tons or more per year.

#### Price of Soybeans

Table 14 gives the average price of soybeans in sterling:

TABLE 14

#### Average Price of Soybeans per ton for Shipment During Current or Following Month

<u>Year</u>	<u>Price in Sterling</u>		
1925	£13	0	5
1926	11	16	6
1927	11	6	3
1928	11	11	9
1929	11	7	11
1930	8	9	2
1931	6	8	0

#### (b) Oil

#### Production of Soybean Oil

The largest quantities of soybean oil are probably produced in the Orient, but figures are not available. Of western countries, the chief producer is Germany. Here the production was 20,000 tons in 1913 or 3% of all the vegetable oils and fats produced, but in 1931 this had risen to 160,000 tons and 20% of all oils and fats, which is a remarkable achievement for soybean oil over the other oils. Further details are given in the section on Germany's internal trade in soybeans and products. Production in the United States has also increased from 5,000 tons in 1928 to 51,000 tons in 1932 (Table 6).

Figures for the production of oil in other countries are not so readily available. Crushing mills have been erected in China in recent years, and this country is now the largest exporter of soybean oil (Table 11). At the port of Dairen, 67 mills for crushing soybeans from Manchuria, are said to be in operation, making this the largest oil milling centre in the world.

In the United States, soybean mills, with a capacity for crushing 300,000 tons of beans a year are in operation. So far as European countries go, the production of the oil probably corresponds to the imports of soybeans.

#### Exports of Soybean Oil

Total world exports of soybean oil in 1930 amounted to some 197,000 tons (Table 15) with net exports (surplus exports over imports) amounting to 150,000 tons. China is the chief exporter averaging about 100,000 tons per annum, although the actual figure fluctuates very widely.

TABLE 15

#### Exports of Soybean oil by Countries (1,000 tons)

	Pre-war	1927	1928	1929	1930
China	35	149	57	68	114
Germany	1	16	33	47	23
U.K.	16	29	22	18	16
Denmark	2	16	21	20	13
Holland	-	34	16	11	11
Japan	4	5	5	7	15
Sweden	-	7	8	7	2
U.S.	-	3	3	4	2
Austria, Belgium)					
France, Italy )					
Norway, Tcheco- )	-	0	1	1	1
slovakia, Algeria)					
Total		259	166	183	197

#### Imports of Soybean Oil

Total world imports of soybean oil amounted in 1930 to about 152,000 tons (Table 16) with net imports 106,000 tons. This goes chiefly to Holland who took 57,000 tons, while 26,000 tons went to the United Kingdom.



TABLE 16

Imports of Soybean Oil by Countries  
(1,000 tons)

	Average 1909-1913	1927	1928	1929	1930
Holland	5	75	41	43	57
United Kingdom	-	54	25	15	26
Belgium	-	6	7	12	21
Germany	10	11	1	2	13
France	1	9	9	8	12
United States	9	7	6	9	4
World total in- cluding Asia, Africa and U.S.S.R.	36	207	123	111	152

Consumption of Soybean Oil

For the Orient where no doubt the greatest consumption of soybean oil takes place, no figures are available. However, net imports (surplus imports over exports) of soybean oil for the various countries of the world are given in Table 17. Holland and the United Kingdom import appreciable quantities of soybeans also; but France and Belgium do not (see Table 12).

TABLE 17

Net Imports of Soybean Oil by Countries  
(1,000 tons)

	Pre-war Average	1927	1928	1929	1930
Holland	4	41	25	32	46
Belgium	-	7	8	12	20
France	1	9	9	8	12
United Kingdom	-	25	3	1 <sup>x</sup>	10
United States	9	4	2	5	1
Austria, Italy, )					
Norway, Sweden, )					
Tchecoslovakia, )					
U.S.S.R., Korea, )					
Formosa, Algeria )					
& Egypt )		38	27	24	17
Total		124	74	73	106

<sup>x</sup> Excess of exports

The consumption of soybean oil in Germany has averaged 139,000 tons over the last five years without showing any decided tendency to increase (Table 23). In the United States, the consumption amounted to about 14,000 tons in 1931 (Table 7).

### Price of Soybean Oil

The price of soybean oil is governed in the edible field by the price of cottonseed oil and in the industrial field by that of coconut and linseed. The price has fallen steadily on the international market since 1925 (Table 18).

TABLE 18

#### Average Yearly Price of Soybean Oil Per Ton, 1925-1931

(Basis: Manchurian crushed in bulk cif. London/Hamburg/Rotterdam)

<u>Year</u>					<u>Year</u>				
1925	£	39	5	0	1929	£	30	2	1
1926		33	10	1	1930		23	1	10
1927		32	2	10	1931		16	17	2
1928		31	19	7					

The price should be about the same cif. Seattle. To arrive at a price cif. New York, 1/4¢ per lb. should be added.

The value per ton of the different oils and fats produced in Germany in 1928 is given in Table 22, from which it would appear that soybean oil, although a cheap oil is more valuable than linseed there.

### (c) Oil Cake

#### Production of Oil Cake

Figures for the production of oil cake in various countries are not so readily available as are those for beans and oil. A very considerable quantity must be produced in the Orient itself, in view of the oil mills that have now been erected in China. As far as European countries go, the production of cake, like that of oil, presumably corresponds to the imports of oil seed. The United States, in the first quarter of 1932, is reported to have produced 41,000 tons of soybean cake from 51,000 tons of beans (Table 6). In Germany, the production of soybean meal was 102,000 tons in 1913 or 9% of all cake produced. These figures had risen respectively to 830,000 tons and 53% by 1931 (Table 24) - a phenomenal gain.



### Exports and Imports of Oil Cake

Figures for trade in oil cakes are not generally segregated into the various kinds. Further, oil cake is mostly consumed in the country of manufacture and does not enter to so great an extent into international trade. Figures for Germany are given in Table 25.

### Statistics of the German Oil Seed Industry

#### Oil Seeds in Germany

Germany is by far the largest importing country, having taken in recent years from 30 to 40% of the total world exports. For this reason, a statistical survey has been made of the German trade in soybeans and their products. From Table 19 may be seen that the imports of soybeans into Germany have increased since 1926 from year to year (1930 excepted) amounting to over a million tons in 1929 and again in 1931. The oil seed of next importance in Germany is the peanut, of which little more than half this quantity is imported. While the imports of soybeans have increased from 370,000 tons in 1926 to 1,015,000 tons in 1931, the imports of peanuts have only increased from 444,000 to 584,000 tons. In 1926, the imports of soybeans represented 22% of the total imports of oil seeds of all kinds, whereas in 1931 they had risen to 42%, a maximum.

Table 20 shows the value of the imports of oil seeds into Germany in Reichsmarks per metric ton from 1926 to 1931. Soybeans have been quite the cheapest of all oil seeds imported, linseed being the next cheapest (with the exception of sunflower) and copra the most expensive.

The value of soybeans being comparatively so low, the total value of soybean imports in 1931, viz., 131 million RM., did not quite reach the corresponding value for peanuts, viz., 134 million RM., although the imports were nearly twice as great. The value of soybeans imported into Germany in 1926 represented only 14% of the total value of imported oil seeds, but in 1931 it had increased to 31%. Soybeans are, therefore, quite outstanding in the way they have increased in importance in Germany during the last six years.

TABLE 19

## Retained Imports of Oil Seeds in Germany

Year	Soy- beans	Soy- beans (about 15% unshelled)	Lin- seed	Palm Kernel	Copra	Rape Seed	Sun- flower seed	Se- same	Hemp Seed	Cotton Seed	Other Oil Seeds	Total Imports	Total Soy-	
													exports	beans
1926	370	584	317	239	198	13	26	8	6	27	23	1669	4	22
1927	576	643	398	294	187	19	5	5	8	33	19	1946	7	30
1928	848	644	441	297	201	32	6	9	4	6	9	2462	7	34
1929	1024	595	312	305	244	15	3	14	3	8	5	2584	8	40
1930	889	422	234	307	151	17	5	36	2	0	6	2300	4	39
1931	1015	444	340	267	145	13	11	8	1	-	8	2401	5	42
1926	86	180	60	96	110	5	6	4	0	5	11	603	2	14
1927	130	171	77	109	101	8	1	3	1	7	9	667	2	20
1928	199	252	104	122	107	12	2	4	1	1	4	843	3	24
1929	239	250	136	119	121	6	1	6	1	2	2	854	3	28
1930	167	216	125	92	65	5	1	13	2	-	2	639	1	26
1931	131	134	99	55	41	2	2	2	1	-	2	431	1	31



TABLE 20  
Relative Value of Various Imported Oil Seeds (Germany)  
(RM. per Metric Ton)

Year	Soy- beans	Peanuts (about 15% unshelled)	Linseed	Palm Kernel	Copra	Rape Seed	Sun- flower	Se- same	Hemp Seed	Cotton Seed	Other Oil Seeds
1926	232	405	311	403	553	399	220	493	268	193	462
1927	226	405	315	398	540	387	278	519	268	206	495
1928	234	423	308	411	531	371	322	474	341	206	440
1929	234	388	333	392	494	397	290	436	347	198	399
1930	188	335	327	249	429	274	201	363	208	214	396
1931	129	229	176	204	285	196	149	256	199	-	264

### Vegetable Oils In Germany

Outside the Orient, Germany is the chief producer of soybean oil. The amount of soybean oil produced in Germany has risen from 20,000 tons, or 3% of the total oils and fats produced, in 1913 to 160,000 tons in 1931 or 20% of the total oils and fats, coming second in importance to peanut oil of which 245,000 tons were produced (Table 21). The production of soybean oil has increased in Germany over this period more rapidly than that of any other vegetable oil or fat.

TABLE 21

Production of Vegetable Oils & Fats in Germany in 1913  
and 1925-31.

(1,000 tons)

Year	Total oil seeds crushed	Total	Rape Seed	Lin- seed	Pea- nut	Soy- bean		Cotton- seed, Sesame & Other Oils	Palm Kernel	Coconut & other Fats
1913	1784	653	71	180	41	20	% 3	108	109	124
1925	1539	560	22	80	136	53	9	52	104	113
1926	1692	626	9	102	187	58	9	26	110	134
1927	1961	676	11	127	178	91	13	15	126	128
1928	2472	824	16	141	251	134	16	13	137	132
1929	2599	853	10	100	271	162	19	14	140	156
1930	2325	759	10	75	269	140	18	26	141	98
1931	2401	790	-	-	245	160	20	-	123	-

The value per ton of the various oils in Germany in 1928 is given in Table 22. It will be noticed that linseed is the lowest in value and soybean oil comes next, while rapeseed has the highest value.

The German consumption of soybean oil from 1926-1931 is shown in Table 23. In the last four years, the excess of exports over imports has averaged 15% of the production, which indicates that the internal market is now saturated for soybean oil also.

TABLE 22.Value of Various Oils and Fats in Germany in 1928

RM. per Metric Ton		RM. per Metric Ton	
Rapeseed	815	Soybean	625
Peanut	762	Linseed	598
Palm Kernel	752	Other oils	882
Copra and other fatty seeds	804		

TABLE 23.Consumption of Soybean Oil in Germany.  
(1,000 metric tons)

Year	Production <sup>1</sup>	Imports <sup>2</sup>	Exports <sup>2</sup>	Consumption	Exports as Percentage of Production
1926	58	200	5	253	--
1927	91	115	16	190	--
1928	134	11	33	112	16
1929	162	2	47	117	28
1930	140	13	22	131	6
1931	160	9	25	144	10

1. Soybean oil.

2. "Soya or other bean oil"

Oil Cake and Meal in Germany

The production of soybean cake has increased from 102,000 tons in 1913 to 830,000 tons in 1931 (Table 24). In 1913, the soybean cake represented 9% of all the oil cake produced and in 1931 53%! The cake and not the oil is considered the primary product at the mills and it has evidently increased very considerably in popularity.



TABLE 24.

Production of Oil Cake and Meal in Germany, 1913 and  
1925-31. (1,000 tons)

Year	Total Oil Seeds Crushed	Oil Cake Produced		
		Total	Soybean Meal	Per Cent
1913	1,790	1,120	102	9
1925	1,540	960	280	29
1926	1,690	1,050	300	29
1927	1,960	1,260	470	37
1928	2,800	1,610	690	43
1929	2,600	1,700	840	49
1930	2,300	1,530	730	48
1931*	2,400	1,580	830	53

\* Estimated

Figures for exports of soybean cake are not so readily available, figures for trade in oil cakes generally being not segregated into the various kinds. Further, oil cake is probably mostly consumed in the country of manufacture. Table 25 shows imports and exports of oil cakes in Germany. Soybean cake is the only one for which there is a surplus of exports over imports (excepting a small quantity of peanut in 1930).

The net export of soybean cake is about equivalent to 20% of the total production of soybean cake, but fell in 1931 to 7%. The figures for imports and exports of oil cakes do not show any particular trends.

TABLE 25.

German Exports and Imports of Oil Cakes  
(1,000 tons)

	Soybean Cake		Other Oil Cakes*		Total		Net Exports of Soybean Cake as of Production
	Imports	Exports	Imports	Exports	Imports	Exports	
1928	27	162	520	375	547	537	20
1929	27	186	528	281	555	467	19
1930	11	187	444	270	455	457	24
1931	33	87	513	200	546	287	7

\* Includes largely peanut, linseed, copra, but also cotton-seed, palm kernel, sunflower, rapeseed, hempseed and others.

Table 26 shows the consumption of all oil cakes in Germany, as well as the consumption of soybean oil cakes. It will be seen that the consumption of soybean oil cakes rose from 34% of the total consumption of oil cakes of all kinds in 1928 to 49% in 1931. At the same time the excess of exports over imports has averaged 18% of the total production for these four years, so that the internal market is no doubt saturated for soybean cake at present.

TABLE 26.

Consumption of Oil Cakes in Germany (1928-31)  
(1,000 tons)

	Oil Cakes of all kinds Consumption	Soybean Oil Cakes	
		Consumption	Per Cent of Total Consumption
1928	1,620	555	34
1929	1,788	676	38
1930	1,528	549	36
1931	1,834	776	49

Table 27 shows the consumption of oil cakes in Germany by kind in 1928. As Germany is one of the most highly industrialized countries on scientific principles these figures may indicate to some extent the order of future consumption in other industrialized countries, and shows how remarkably outstanding is the consumption of soybean cake in Germany.

TABLE 27

Consumption of Oil Cake by Kinds in Germany in 1928  
(1,000 tons)

	Production	Imports	Exports	Consumption
Rapeseed	25.6	8.6	3.0	30.2
Linseed	300.6	84.9	89.6	295.9
Peanut	323.7	175.5	107.3	391.9
Soybean	699.1	26.9	162.2	563.8
Other oil seeds		230.7	154.5	
Palm kernel	156.5	19.9	20.6	157.2
Copra and other fatty seeds	89.2			165.5
Total	1,594.7	546.5	537.1	1,604.1

Table 28 shows the value per ton of various oil cakes produced in Germany in 1928. It will be noticed that soybean cake is considerably cheaper than linseed apparently, although from the point of view of a cattle feed it is just as good.

TABLE 28.

Relative Value of Various Oil Cakes (Germany 1928)

	RM. per metric ton		RM. per metric ton
Linseed cake	222	Soybean cake	203
Copra and other		Rapeseed cake	184
fatty seed cakes	220	Palm kernel cake	178
Peanut cake	217		

Soybean Experiment Stations in Germany

Experiments on the growing of soybeans are being carried out at the Kaiser-Wilhelm-Institut für Züchtungsfor-  
schung, Müncheberg (Mark) and the Institut für Pflanzenzüch-  
tung der Landes-Universität in Glessen (Prof. Dr. G. Sessous,  
Glessen, Sud-Anlage 9).



PART II.DEVELOPMENT IN CANADAThe Difference Between Growing Soybeans for Forage and for Seed

In considering the growing of soybeans in Canada we must first be clear in our minds as to whether we are referring to their cultivation for forage purposes or for the production of seed. These are two entirely separate undertakings comparable with the growing of flax for fibre or for seed. The reasons for this are threefold. Firstly, the varieties that produce most forage are not generally those that produce most seed, although occasionally this does occur. Secondly, the plant arrives at its best stage for forage some time before the seeds are matured. In fact when the seeds are mature the leaves have all fallen. Thirdly, if the plant is being grown for forage the color of the bean is not of great importance, but if oil seed is the object a yellow or light colored bean is essential. The mills at present demand this, although it is within the bounds of possibility that methods will be developed of producing satisfactory oil and cake from dark beans.

Present Status of Soybean Cultivation in Canada

Soybeans are at present being grown for seed on a commercial scale in southern Ontario, chiefly in Kent and Essex Counties. Prior to 1931 the acreage under soybeans was about 1000 or 1500. The efforts of persons interested in establishing oil mills increased this to about 5000 in 1931 and to 6000 or 7000 in 1932. The variety chiefly grown is known as O.A.C. 211. The average yield of seed has been about 23 bushels per acre, which is quite equal to yields in the U.S., while another variety, the A.K., has yielded at the rate of nearly 40 bushels per acre during a six-year test at Harrow, Ontario.

For forage soybeans are not being grown in Canada to any extent, although this is a much easier problem than growing them for seed and is the purpose for which 75% of the soybeans in the United States are grown. Where soybeans can be profitably grown for seed they can be successfully grown for forage also.

In the limited part of Canada that lies south of a line drawn from Montreal to the southern end of Georgian Bay it should be quite possible to develop a soybean oil seed industry, and probably also in one or two other comparatively favorable parts of the Dominion, such as the interior valleys of British Columbia and the small areas in the prairie provinces referred to by the Dominion Agrostologist (p.6).

In the prairie provinces in general, however, the coolness and dryness of the summers presents great difficulties.

Except in the warmest districts in Canada soybeans have not matured seed, but if the crop is to be grown for forage purposes this is not a sine qua non, for the necessary seed could be obtained from special plantings elsewhere, a practice followed in certain cases in the United States.

### The Future for Soybeans on the Prairies

Opinions differ as to the possibility of ever growing soybeans successfully on the Canadian prairie, and therefore as to the value of carrying out experiments and the extent to which this should be done.

The Dominion Agrostologist is not very sanguine on this point. In a letter to the writer he says: "The chief limiting factor in the soybean production in the west appears to be the low mean temperatures and especially the cool nights. Equally important is the limited supply of moisture. Early maturing varieties must always be grown and these are invariably dwarf as compared with the later maturing varieties. Because of this and also the limited moisture supply this crop is restricted in yield of hay as well as seed."

"In my opinion the most favored locality of the prairie provinces for the growing of soybeans is southern Manitoba in the vicinity of Morden. Here the moisture supply and the temperature are favourable. The Maple Creek district in Saskatchewan can mature the earlier varieties but lack of precipitation and high evaporation are against the success of this crop. In southern Alberta, on the irrigated land from Lothbridge to Taber and at Brooks, it is probable that early maturing varieties of soybeans could be grown successfully. In all other parts of the three western provinces the growing of soybeans is a very doubtful proposition."

"It is probable that early dwarf sorts can be obtained which will mature over a large part of the West, but it is doubtful if the growing of such would prove profitable."

The early maturing characteristics, which the shortness and coolness of the prairie summers demand, do generally go hand-in-hand with dwarfness, but this is the same with other forage plants such as corn, although not with all. Further, it is always possible that some sport variety may exist which is early without being dwarf. As regards seed there are indications that earliness and poor yield are not invariable concomitants.



W.J. Morse, the United States government soybean expert, in a letter to the writer, of November 9, 1932 says: "It would seem to be that if sufficiently early varieties could be obtained, the soybean might be grown profitably in the provinces referred to (Manitoba, Alberta and Saskatchewan). Of course it would take more or less experimental work with the varieties that are grown in North Manchuria."

T.B. Macaulay, President of the Sun Life Assurance Company of Canada has been experimenting for a number of years on the growing of soybeans in the hopes of being able to make the western farmer more free from his dependence on wheat, and believes that he is near to discovering suitable varieties.

Here again the difference in the problems of growing soybeans for forage or for oil seed must be clearly kept in mind.

A statement appearing in the Montreal Financial Times (Nov. 18, 1932) reports that a number of varieties introduced from Urbana and tried in various parts of Alberta made an excellent growth of forage.

An economic study that showed the estimated cost to the farmer of growing an acre of soybeans and what the return would have to be to make the crop profitable for oil seed would be of much interest. In this connection the results of the commercial venture this year in western Ontario will be particularly interesting.

#### Extent of Canadian Experimentation

The chief points in Canada where soybeans are being experimentally grown are given in Table 1.

Besides the places mentioned in this table a few rows of soybeans have been grown at practically all the Dominion Experimental Farms, and small lots of soybean seed have been distributed by the Department of Agriculture to interested individuals in various parts of the Dominion.

A considerable amount of time has also been spent on experimenting with various methods of planting, analysis of seed, inoculation of the soil and the action of fertilizers etc., but these questions are all subsidiary to the prime problem of finding the right varieties.

A little work is being carried out on cross breeding, but the soybean is a difficult plant to cross breed, and when thousands of different varieties are obtainable, it would seem an indirect and probably lengthy method of attaining the end in view.



The only result of this work that has so far been of commercial interest is the development of the variety known as O.A.C. 211, which is being grown in western Ontario. It is perhaps significant that this one success originated from the station that has tried the greatest number of varieties. A few other varieties have been found that will mature in the warmer parts of most of the provinces, but these have not been taken up to any extent by the farmers.

The work being carried out at T.B. Macaulay's experiment farm at Hudson Heights, Que., is particularly worthy of mention. Here the testing of varieties has been in progress for 8 years. Mr. Maccaulay's method of approaching the problem consists in obtaining samples of hitherto untried varieties from the most northerly regions where soybeans grow and the earliest varieties from Asia and elsewhere. The samples consisting of more or less mixed seed are sown and seeds gathered from the most promising plants. This selection method is the one adopted in the United States also and is without doubt the likeliest to lead to quick success. Mr. Macaulay has a new variety which he calls Toyanaga. It matures 5 days to a week earlier than the variety called Manchu, which is being grown to a small extent in southern Ontario and he thinks it will prove of interest for cultivation there. He also has strains which he thinks may be successful in the west.

In the United States over 7,000 selections of seed have been obtained and planted and from these some 2,500 distinct varieties are being grown experimentally. As only the very earliest varieties come into consideration for Canada, the number available is of course much less, which accounts to some extent for the fact that only some 125 varieties (apart from those tried by Mr. Macaulay) have been tried in Canada. The Experimental Farm in Ottawa, however, is in touch with the soybean section of the United States Department of Agriculture and is obtaining samples of further early varieties from them.

#### Varieties Suitable for Canada

Besides O.A.C. 211 which is the one outstanding variety that has shown itself suitable for cultivation in Canada albeit only in southern Ontario, a number of other varieties have been tried and experimented with such as Mandarin, Manchu, Wisconsin Black, Quebec 92, Quebec 537, Early Yellow, Early Brown, and Manitoba Brown, but none of these have been very satisfactory.

TABLE 29.Summary of Canadian Experiments with Soybeans

Experimental Station	Period over which soybeans have been grown. Years	Approximate number of different varieties tried.
Ontario Agricultural College, Guelph	39	125
Dominion Experimental Farms, Ottawa and Harrow	9	100
Macdonald College, Quebec.	20	16
Manitoba Agricultural College, Winnipeg	10	12
University of Alberta, Edmonton	3	7
Brooks, C.P.R. Irrigation Experimental Station	?	?
Pointe Platin, Que. J. deLothinière	?	?
Hudson Heights, Que. T.B. Macaulay	8	110
University of Saskatchewan	10	25

The Climates of Manchuria and Canada

As has been described in another section the climates of Manchuria and Canada are in some respects alike. In Manchuria the winters are intensely cold. The rivers are all frozen over until the end of April in the north and even until the beginning of April in the south. Midsummer temperatures average 70-75°F. In Canada the mean midsummer temperatures however, are lower. Even in the Niagara Peninsula the mean monthly temperatures only rise to 70 or 71°F. The mean maximum and minimum July temperatures from places recording in the different provinces in 1931 were as follows: Alberta 57-68°F., British Columbia 54-72°F., Saskatchewan 60-66°F., Manitoba 53-67°F., Ontario 59-72°F. (Peleé Isl. 74°F.), Quebec 54-70°F., Nova Scotia 59-66°F., and New Brunswick 60-66°F. In the distribution of its



rainfall Manchuria is monsoonal. Canada is not.

The latitude of the prairies ranges from approximately 49 to 54°; Manchuria lies between 38 and 53°, Korea between 34 and 43°, while Vladivostok in Siberia is about 43°. Harbin, a great soybean centre lies approximately on latitude 46. Hokkaido the home of Mr. T.B. Macaulay's new strain Toyonaga is at about 43°. Tsitsihar is 47°. It would be interesting to know the area covered by Mr. Morse during his two years of soybean exploration in Manchuria and Japan. The prairies are thus more northerly than the main soybean growing areas of Manchuria. It is of some interest to note here that as you go north the oil content of the bean increases, which is an advantage.

#### Planning the Development of Soybeans in Canada

The history of the development of the soybean industry in the United States shows that little or nothing can be expected without thoroughly systematic and planned experimentation. The method indicated is to obtain samples of seed of as many different strains as possible.

The areas over which soybeans grow in Manchuria, Siberia and Japan are very wide and it is possible that districts could be found which as regards the dryness and coolness of their summers approached the climate of the Canadian prairies. From these districts strains of soybeans should be available that might do well in Canada. Some samples are already being obtained from the United States Department of Agriculture; others could be got by co-operation with agricultural research stations in different parts of the world, e.g., Germany, England, South Africa, but especially through the offices of agents, trade commissioners, missionaries and friends in Manchuria, Japan, Siberia and other parts of Asia.

In a letter to the writer (July 27, 1932), Mr. Macaulay says: "The only section of Manchuria that holds hope for us in Canada is the far northerly district, north of the Sungari River, Harbin and Tsitsihar, the further north the better .....where the bandits rule supreme".

The seeds would be planted in a favorable locality such as Harrow, Ontario. From the first year's planting selections would be made of the most promising varieties and a larger quantity of seed obtained by a second and if necessary further plantings. These selected strains of seed would then be distributed for trial in the various districts where it is desired to establish a soybean industry.

Since each variety of soybean seems best adaptable to a particular combination of soil and climatic conditions,



it is reasonable to expect that a variety that has been found especially successful in some part of the United States may not succeed in any part of Canada and vice versa. W. J. Morse, writing in the United States Yearbook of Agriculture for 1926, says: "No single factor has greater influence upon the success of the crop than the selection of the right variety to meet the needs and the conditions of the section where it is to be grown".

The short duration of the Canadian summer eliminates from consideration all but the most early maturing varieties. In the United States on the other hand this was not so great a desideratum, because their summers are longer and later maturing varieties give generally a better yield.

The greater the number of different varieties tried in a given district, the sooner is a suitable variety for that district likely to be found. The work therefore is of a comparatively inexpensive nature but the larger the scale on which the operation is carried out, the sooner may results be expected.

In view of the great number of different varieties that could be obtained and tried, it would seem advisable to concentrate all available effort along the lines indicated above, and to leave experiments on special methods of fertilization, inoculation, cultivation, etc., to a later stage. Experiments on cross breeding, however, are more indicated in Canada than in the United States, because of the fewer number of suitable varieties available. They are, however, a less direct method than that of exploration and introduction.

The millions of tons of soybeans produced annually in Manchuria are made up from literally thousands of varieties, and cases are known where a variety that is the pride of its district has been a failure when planted only 90 miles away. With the wide areas involved in Canada and this extremely localized adaptation of the soybean it is not likely that any one variety would be suitable for the whole of Canada. Every district might turn out to be a problem in itself and require a specific variety.

#### Consumption of Vegetable Oils in Canada

Figures for the amounts of soybean and other fatty oils used in Canada over the period 1926 to 1930 are given in Table 30. It will be seen that these oils are used mainly in the soap, paint, food, and slaughtering and meat packing industries. In 1930 these four industries consumed a total

Consumption of Fatty Oils in the Soap, Paint  
and Food Industries of Canada.\*

[illegible]

Cost at Works in 1000 Dollars

SOAP

1926	1224	25	28	537	41	268	Olive oil	18	2141	13%
1927	1383	14	30	564	45	167		3	2205	8
1928	1519	15	28	506	42	190		5	2305	8
1929	1707	10	19	474	50	476		6	2742	17
1930	1507	12	20	416	94	432		6	2487	17

PAINT (5)

1926	1549	20	475	2321			Tung oil			0.9%
1927	1585	12	531	2554						0.5
1928	1741	7	577	3286						0.2
1929	1757	50	652	3956						1.3
1930	1585	49	589	3358						1.5

FOOD (1)

1926	120	1486	79	460	2299		Cooking oil	154		3.4%
1927	121	1520	113	296	2221			172		5.0
1928	(2)	1488	95	542(3)	2335			209		4.1
1929	137	1638	21	502	2486			187		0.8
1930	114	1080	1	695	2096			205		0.0

TOTAL

1926	1511	1577	537	501	647					5.4%
1927	1344	1615	564	341	706					4.2
1928	1504	1769	506	584	791					3.7
1929	1519	1776	474	552	845					6.5
1930	1844	1648	416	789	800					6.1
	1624	1092								

- (1) Chiefly shortening but incl. bread, biscuits, chocolate, confectionery etc.  
 (2) No record but probably in vegetable oils or peanut.  
 (3) Returned chiefly as "vegetable oils, crude".  
 (4) Incl. corn oil, palm, palm kernel etc.  
 (5) Gallons have been converted into lb. taking 1 gal. = 9 lb.



Slaughtering and Meat Packing

	Short Tons			1000 Dollars			Total
	Cotton- seed oil	Other Oils not specified Vegetable	Animal	Cotton- seed oil	Other Oils not specified Vegetable	Animal	
1926	21,699	11,428		4356	2407		6763
1927	22,105	1,828		3990	371		4361
1928	20,050	2,504		3764	325		4089
1929	19,381	12,519		3469	2118		5587
1930	4,109	34,443	1,505	568	5313	383	6264

\* Prepared from figures supplied by the Dominion Bureau of Statistics.

of a little more than 80,000 tons of vegetable oils with a value at the point of consumption of some \$14,000,000. The oils represented include coconut, cottonseed, linseed, palm, peanut, soybean, olive, tung and other oils. All these oils are imported with the exception of linseed of which the consumption in the year in question amounted to about 9,000 tons valued at some \$1,600,000. The value of imported oils thus amounts to the neighbourhood of \$12,400,000 per annum. It will be noticed that soybean oil is used in the soap, paint and food industries but not in the slaughtering and meat packing industry. The latter industry, however, absorbs half of all the oils consumed in Canada. The total consumption of fatty oils in the other three industries in 1930 was 42,000 tons with a value of \$8,000,000. Of this soybean oil represents 3,400 tons with a value of \$500,000, a very small proportion. In 1930 the soap industry was the most important outlet for soybean oil, followed by the paint and then the food industry. This is interesting because in the United States the order is reversed.

The Canadian soap industry in 1930 consumed some 17,000 tons of fatty oils (mainly coconut oil) with a value of \$2,500,000. Of this amount soybean oil represented 3,000 tons valued at \$430,000 or 18% by weight and 17% by value.

The Canadian paint industry in 1930 consumed 12,700 tons of fatty oils (mainly linseed oil) with a value of \$3,360,000. Of this quantity soybean oil amounted to only 302 tons with a value of \$49,000 or 2.4% by weight and 1.5% by value. There is some slight indication from the figures that the relative demand for soybean oil is increasing.

The Canadian food industry in 1930 consumed 13,000 tons of fatty oils (mainly cottonseed oil) with a value of \$2,000,000. In spite of the fact that one expects this to be the chief market for soybean oil, only 5 tons are recorded as having been used in 1930 although figures under other headings such as cooking oil may include some soybean oil. However, even in previous years the annual consumption amounted to only a few hundred tons, and the figures indicate if anything a falling off in the relative popularity of soybean oil in this industry.

The slaughtering and meat packing industry is the largest consumer of fatty oils in Canada, the yearly requirements being 30,000 to 40,000 tons with a value of some \$6,000,000. About two-thirds of this has generally been cottonseed oil, although 1930 saw an extraordinary fall in this commodity, its place being presumably taken by some other oil, if published figures are correct. It is not known to what extent, if any, soybean oil is used in this industry.

It is of some interest to note that during the years 1926-30 the consumption of soybean oil has averaged about 2500 tons per annum. Taking the yield of oil from the bean at 18%, with 33 bushels to the ton and 23 bushels to the acre, the annual consumption of oil represents the product of about 20,000 acres. This is about three times the area under soybeans in Canada at present.

From the statistics for the consumption of the different fatty oils in the soap, paint and food industries and their cost at works, their value in cents per lb. has been worked out and included in Table 31. The figures, however, do not allow of any constructive comment. In Table 32 will be found importers' prices of soybean oil.

Of the 40,000 tons of fatty oil consumed in the soap, paint and food industries about 9,000 tons is linseed oil. The production of linseed oil in Canada is about 20,000 tons a year, so that the home requirements in this oil are fully covered by home production. The 31,000 tons of other oils, however, are all imported. If methods are available or can be found by research for using soybean oil satisfactorily in the three industries mentioned, there should be a ready outlet for it.

#### Consumption of Soybean and Other Oilcake in Canada

The annual consumption of oilcakes of all kinds in Canada is between 30,000 and 40,000 tons, amounting to 39,000 tons in 1930, with a value of a million and a half of dollars, as shown in Table 33. The major portion of this is home produced linseed cake. Soybean cake represents only a few percent but is gaining in popularity the consumption having risen from 200 tons in 1926 to 2,500 tons in 1931. In price it seems to lie between linseed and cottonseed cake. It may be noted that in Germany where there is a big business in Holstein cattle soybean cake represents nearly 50% of the total oilcake consumed and is nearly 10% cheaper than linseed oilcake.

#### Firms Engaged in the Soybean Industry in Canada

The Soy Bean Oil and Meal Co-operative Co. of Canada, Ltd., Chatham, Ont.

Canadian Soyabeans Ltd., Milton, Ont.

The Vitone Co., Hamilton, Ont.

Dominion Soya Industries, 355, Place Royale, Montreal.



TABLE 31

Relative Value at Works of Oils Consumed in Canada

Calendar Year	Cocoa-nut oil	Cotton-seed Oil	Lin-seed Oil	Palm Oil	Peanut Oil	Soybean Oil	Other Oils
Cents Per Pound							Olive Oil
<u>SOAP</u>							
1926	10.58	7.52	10.98	8.96	9.05	8.71	10.26
1927	9.70	7.72	10.71	8.43	10.00	7.78	19.79
1928	9.10	6.67	7.43	8.15	9.63	7.52	16.22
1929	8.39	6.41	9.65	8.43	8.82	7.55	13.61
1930	7.59	5.96	10.11	7.30	7.08	7.02	7.49
<u>PAINT</u> (5)							Tung Oil
1926			10.51			11.11	10.57
1927			9.38			7.77	10.49
1928			9.21			6.24	6.01
1929			10.04			7.39	5.46
1930			9.01			8.12	8.15
<u>FOOD</u> (1)							Cooking Oil (4)
1926	10.17	11.14			10.56	9.47	5.45
1927	8.52	8.91			9.31	8.16	5.50
1928	(2)	9.53			9.20(3)	7.80	5.10
1929	7.86	9.40			8.36	7.53	4.76
1930	7.19	8.33			7.18	10.83	4.74

✧ Calculated from the figures in Table 30.

(1) - (5) For explanation see foot note to Table 30.

TABLE 32

Importers Prices of Soybean Oil (Montreal and Toronto)<sup>x</sup>

(cents per pound crude in tank cars)

1925	9.2	1929	11.0
1926	9.1	1930	11.0
1927	9.4	1931	7.1
1928	9.7	1932	4.5 (Jan.-Jun. No fluctuations)
(1928	14.6 Blown soybean oil)		

<sup>x</sup> These figures represent an average for the year of the prices on the first day of each month as supplied by the Dominion Bureau of Statistics.

TABLE 33.

Consumption of Oilseed Cake and Meal in Canada

Amount in Tons							Soya as % of total in Ger- many for comparison.
Calendar Years	Cotton- seed	Lin- seed	Palm nut	Soya	Total	Soya as % of total	
1926	+ 8,500	++ 23,000	+ 430	+ 200	32,000	0.6%	
1927	7,000	10,000	360	680	26,000	2.6	
1928	6,300	25,000	460	560	32,000	1.7	34%
1929	10,000	19,000	450	1,560	31,000	5.0	38
1930	7,300	30,400	690	1,190	39,000	3.1	36
1931	4,100		340	2,500			49

Value in Dollars						
1926	+ 271,000	+++ 1,000,000	+ 12,000	+ 8,000	1,291,000	0.6
1927	140,000	890,000	7,100	14,000	1,051,000	1.4
1928	130,000	1,090,000	9,100	11,000	1,110,000	1.0
1929	200,000	940,000	9,000	31,000	1,180,000	2.6
1930	150,000	1,400,000	13,900	24,000	1,588,000	1.5
1931	80,000		6,900	50,000		

Value in Dollars per cwt.				
1926	1.57	2.16	1.39	2.07
1927	1.63	2.21	1.29	1.85
1928	2.26	2.19	0.94	2.04
1929	2.05	2.33	1.13	2.09
1930	1.83	2.30	1.10	1.83
1931	1.09		0.77	1.28

+ As there is no production or export of cottonseed, palm nut or soybean oil cake in Canada, the figures shown are those for imports taken from Trade of Canada.

++ These figures were calculated from the imports minus the exports (Trade of Canada) plus the native production taken from the annual reports on the Linseed Oil Industry published by the Dominion Bureau of Statistics.

+++ These figures are based on the selling value at mill of the total Canadian production reduced to the proportion thereof that the consumption represents.

### Casein

In view of the fact that casein production is being gradually developed in Canada it is of interest to note that a new process for the preparation of casein from soybeans has been worked out in Russia. The annual consumption of milk in the U.S.S.R. for the production of casein is reported to be about 250,000 tons so that considerable importance attaches to the vegetable source. A new factory at Krapatkino in the North Caucasus is now producing the material.

Figures for the imports and exports of casein in Canada are given in Table 34.

TABLE 34.

#### Casein in Canada

Fiscal Years	Imports		Exports		Re-exports	
	lbs.	\$	lbs.	\$	lbs.	\$
1927	437,194	61,747	276,501	29,901		
1928	254,418	35,245	318,695	40,195		
1929	329,075	36,122	254,806	35,363		
1930	500,642	63,447	153,314	21,224	224	39
1931	198,318	21,159	171,053	15,279	12,638	3,000
1932	160	(first four months)				

It is said that two concerns are now producing in Canada. One makes about 200,000 lb. a year and has a capacity for double that quantity.



### PART III

#### SURVEY OF THE LITERATURE, 1931-34.

##### Cultivation

Over the period covered by this survey the aspect of the soybean industry which finds most mention in the literature is farming. The subjects treated deal, for example, with (91) the types of soil obtaining in the different localities and the varieties of soybeans most suited thereto, local statistics of acreage and crop, opinions on the best methods of planting and harvesting and the right time therefor, inoculation, crop rotation, soil improvement, farm costs, yields, weeding, ensiling and so forth. Particulars of this type were published in the following bulletins:-

Soybeans (95)  
 Soybeans for silage (63)  
 Soybean utilization (64)  
 Experiments with growing corn and soybeans in combination (65)  
 Effects of inoculation and liming on soybeans grown on the  
   grundy silt loam (66)  
 Corn and soybeans for silage (67)  
 Cayuga soybean (68)  
 Soybeans for Massachusetts (69)  
 Soybeans under irrigation in Colorado (70)  
 Soybeans in Ontario (71)  
 Soybeans in Iowa farming (57)  
 The soybean crop in Missouri (58)  
 New soybean varieties tested (59)  
 Feeding soybeans and soybean oilmeal on Indiana farms (60)  
 Grow more soybeans in Minnesota (61)  
 Soybeans in the Union (S. Africa) (62)  
 U.S. Yearbooks of Agriculture (102)  
 Soybeans for dairy cattle (94)

R.W. Duck (45) discusses questions of soil, seeding, harvesting, etc., and stresses the necessity of keeping weeds from choking the beans.

Edmondson (46) stresses the value of soybeans as an emergency hay crop, and discusses best methods of seeding, cutting, and curing.

The preparation and handling of the seed bed, laying great stress on the necessity of eradicating weeds, is discussed at some length in articles entitled "Getting ready for soys" (47) "Seeding soy beans" (43). According to the latter, soybeans will yield 1.5 - 3 tons of hay or 10 - 30 bushels of seed per acre.

Wiggams (13) describes experiments, which extended over six years, on the effect of growing corn and soybeans in combination on the percentage of dry matter in the two crops. The dry matter of corn was not found to be much changed when grown with soybeans. In the case of the soybeans, however, it seemed to vary.

Soybean hay has been found to be less easily damaged than other hays by the weather in curing and retains good feeding value even though discolored by rain in curing (42). It is considered equal to alfalfa hay (43).

The Bureau of Agricultural Engineering investigated complaints, which came especially from the lower Mississippi Valley, that the ordinary combine could not be used satisfactorily for soybeans, and have suggested a number of modifications. (72).

Stitt (15) investigated the dry matter content of soybeans in comparison with lespedeza and alfalfa. Lespedeza he found to be definitely higher in dry matter than soybeans.

Weatherspoon and Wentz (14) made a statistical study of the relation between certain plant characteristics and yield in over 200 strains of soybeans, and came to the not unlikely conclusion that height and number of pods per plant were the most important characteristics in estimating yield, and that these **characteractors** were greatly influenced by soil differences.

"During the past few years", according to J. Laughland (35) of the Field Husbandry Department of the Ontario Agricultural College, "soy bean demonstrations have been conducted in every county of Ontario, the farmers co-operating with the Department". The average yield of seed over a 3-year period as reported by 92 farmers, was 19 bu. per acre, and that of hay, from 139 tests, was 2.2 tons per acre. The growers reported favorably.

Laughland gave 30-45 lb. as the amount of seed required per acre, when grown for seed production in rows 28 in. apart, and 1 1/2 - 2 bu. when drilled solid for hay.

Cutler (12) has developed a laboratory thresher.

S. Austin (27) found that exflorated soybean plants stopped growing at the same time as the controls, and that the stems and leaves were very similar with regard to content of moisture, nitrogen and mineral. The only difference appeared to be that the exflorated plants were of a darker green and stayed green longer. They sometimes also showed a slight wrinkling of the leaves.



Bond (28) studied the transfer of nitrogen from the air to the soybean plant. His results showed a quantitative relation between fixation and transfer for nearly the whole life of the host, the rate of transfer being 80-90% of the rate of fixation. From these results it would seem that the plant obtains its nitrogen from the excretions of the bacteria rather than by digesting them with enzymes.

An anatomical investigation of the primary axis of commercial Mammoth Yellow was undertaken by W.H. Bell (34).

A new variety of soybean that keeps its leaves until the seeds are ripe has been introduced in West Virginia. It is called Pekwa (from Peking and W. Va.). It has been described by Garber and Hoover (25).

### Green Manure

Arceneaux and others (7) conducted experiments at the U.S. Sugar Plant Field Station near Houma, La., in 1930, to compare the relative green-manuring value of several leguminous plants and the best method of handling soybeans. It was found that in the sugar-cane rotation, soybeans should be planted in the early spring and yield the maximum green and dry matter and nitrogen when in full bloom.

Soybeans are said to be used more than any other crop for green manure in the orchard, but in dry years it might be more profitable to sow cowpeas(40).

The decreased yield of wheat that occurs when wheat follows soybeans was the basis of an extensive research by Turk (48). He found that "An increase in nitrates following the growth of soybeans should not be expected because of the carbonaceous nature of the root material, which stimulates biological activity, increasing the number of organisms which consume the nitrate. The soil nitrates, however, are increased by incorporating the green parts of the plant, and, therefore, when soybeans are being grown for green manure, they should be burned under in the more immature stages of growth".

According to de Guerpel, wheat grown after soybeans in France was markedly better and stronger than when grown after beets (76).

### Breeding

The question of improving soybeans by breeding, and how this may best be done, has been discussed in a 100-page bulletin by C.M. Woodworth of the University of Illinois (56).



Cutler (16) developed a method that was found very successful in producing soybean hybrids. Seeds of the two parents were sown alternately 34 in. apart in 20-row rows 30 in., or less, apart. Just prior to blossoming, the block was surrounded by a cheese-cloth fence open at the top and, in the instance described, was within 200 ft. of a number of honeybee colonies.

Woodworth (11) has described the progress made to date in the genetic analysis of the soybean.

### Germination of Seeds

Cutler (8) (73) investigated the germinability of seed in the chamber and in the field, and found better germination in the one or the other case according to circumstances such as weather conditions and hard-seededness.

He carried out some 800 germination tests with 40 strains of Manchu. Germinability was found to be an inherent trait peculiar to the strain and perhaps the variety, and can be found associated with high yield.

T.I. Edwards (33) studied the germination of Black Eyebrow soybean seeds at various temperatures. The optimal temperature range was found to be 33-36°.

### Diseases and Parasites

S.G. Lehman (1) continued investigations on frog-eye on stems, pods, and seeds. The fungus was isolated and it was found that plots of soybeans could be infected by scattering diseased leaves over them. It was also found that the fungus could overwinter in diseased stubble if soybeans followed soybeans without an intervening crop, and that diseased seed will introduce the disease into new fields.

E.F. Hopkins (24) investigated the question of leaf wrinkle in soybeans and came to the conclusion that this was a nutritional disorder, but was not able to ascribe it to a particular cause. It appeared to be bound up with the relation of potassium, magnesium, calcium and nitrogen in the nutrient solutions used.

In several counties of Ontario there was a bad outbreak of green clover worm, which attacked beans (38). Dusting or spraying with calcium arsenate and lime was recommended, but it was not stated how successful this was.

### Soil

Albrecht (10), studying the effect of sour soils, found that a certain quantity of calcium was necessary for the growth of the soybean because of the part it plays in the metabolism of the plant (facilitating better symbiosis) and not because of its reduction of the hydrogen ion concentration of the soil.

### Manufacture of Oil Cake

There are three methods of converting the beans to oil and oil meal. They may be extracted with a fat solvent, a process which finds favor in Germany, or they are processed in a hydraulic press or by the so-called expeller process in which the pressing is continuous. In these two processes, which are used more than the extraction process, on the North American continent, the beans are heated. The expeller process is said to give the meal a roasted-nut-like flavor, which is appreciated by the cattle, while the cooking that takes place at the same time enhances the feeding value 200-300% (22). The meal contains 43% digestible protein.

Horvath (93) has described the manufacture of oil, cake and some products in some detail.

### Composition of the Soybean

The composition of the soybean is as follows (99):-

	%
Protein	40
Fat	20
Carbohydrate	20
Crude fibre	4
Lecithin	2
Ash	5
Moisture	9
Starch	Trace
Enzymes (urease, diastase, etc.)	Trace

### Properties and Composition of Soybean Oil

When heated to 600°F. some soybean oils show little or no precipitate, and bleach to a pale or colorless oil. These are known as "nonbreak" oils according to Smith and Kraybill (18), and are desired for many purposes, especially in making paints and varnishes. Soybean oil from the hydraulic or expeller process, when heated to 600°F., develops a dark color and a dark precipitate and is called a "break oil". Smith and



Kraybill studied the effect of moisture content and temperature of pressing. It was found that there is a critical temperature of pressing (about 65°C. for Manchu beans with 4% moisture) above which the oil becomes a break oil. For beans with higher moisture content this critical temperature is lower.

It is said that 15-18% of soybean oil in linseed-oil paints increases the elasticity and pliability of the film, makes it more lustrous and inhibits yellowing (99).

The composition of soybean oil is as follows (99):-

Glycerides of palmitic and stearic acid	10-14
" " linolenic acid	2
" " linolic acid	53
" " oleic acid	30

### Feedstuffs

Shrewsbury and Bratzler (2) carried out feeding experiments with rats to investigate the cystine deficiency of rations of corn and soybeans. Feeding experiments with rats and pigs were also carried out by Shrewsbury, Vestal and Hauge (6) in which it was found that rats and young pigs did not thrive on a basal ration of corn, soybeans and mineral, but that an improvement occurred when casein was added. However, no evidence was obtained that casein protein supplemented soybean protein. It was further found that cooked soybeans had a definitely superior nutritive value to that of raw soybeans but less than that of casein. The addition of dried yeast (3%) was found not of economic value.

Experiments carried out at Purdue University on feeding soybeans and late-cut soybean hay to dairy cattle showed that the butter fat content of the milk could be raised within 12 to 48 hours and that this increase could be maintained for 80 days (77).

In a series of tests under the supervision of Prof. C.C. Culbertson (36), whole soybeans were compared with soybean and linseed oil meal in rations for steers. The whole beans were found to be not as profitable a feed as the oil meals.

For feeding beef cattle, 2-2.5 lb. of soybean oil meal daily per 1,000 lb. of live weight is a satisfactory amount; for hogs, 1-2 bags of soybean oil meal with one bag of tankage fed in a self feeder with corn either shelled or in the ear. (22).



S. Bull shows by statistics that in no more than 4% of the cases can the increase in soft pork of late years be due entirely to soybeans having been fed in the ration. He thinks that a lot of the trouble comes from marketing under-finished hogs of a late-maturing type.

Fat pork is attributed by Coultas (22) to feeding soybean meal instead of soybean oil meal.

In experiments carried out at Purdue University on the feeding of soybeans to pigs it was found that firm pork was produced when pigs weighing 75 lb. or more and of sufficient thrift to gain rapidly were fed soybeans in their rations, but that this was not the case with pigs weighing less than 50 lb., and especially unthrifting, light-weight pigs, which would not make rapid gains. It was found that "1 lb. of soy beans with minerals will replace 1 lb. of tankage on pasture, and in the dry lot it takes 1 1/2 lb. of soy beans to replace 1 lb. of tankage". Soybeans "should not take up more than 14% of the swine ration". (78).

Liberal feeding of soybeans to pigs is strongly advised against by Ferrin (52).

Tomhave and Mumford (50) carried out a number of tests to determine the value of ground soybeans as a source of protein for feeding chicks. They did not find that it was very satisfactory but that one-third of the meat scrap could be replaced by soybeans without seriously affecting the growth or mortality. Ten per cent or more of ground soybeans in the laying rations for pullets decreases egg production and increases mortality (51), but an addition of 10% of soybean to an all mash laying ration did not affect cold storage properties of the eggs.

Soybean oil meal of good quality forms an excellent supplement for poultry and steers according to experiments cited by J.M. Evvard (79). Minerals should be added when this oil is fed to livestock and poultry as a supplement to farm grains.

Seulke (75) discusses the value of soybean oil meal as a feed.

Laird (23) found that rats fed on distilled water and white soy curds did not thrive, but when a dyestuff obtained from Gardenia jasminoides Ellis (which has long been used for this purpose in China) was added to the curd, the rats showed marked increases in weight.

Hints on growing and feeding soybeans, as well as figures comparing yields and feeding values of some supplementary forage crops are given by Briggs (39).

Soybean protein contains the four amino acids necessary for animal growth viz: lysine, cystine, histidine and tryptophane.

Csonka and Jones (4) reported the results of colorimetric determinations of cystine, tryptophane and tyrosine in glycinin preparations from 10 different varieties of soybeans. The oil content of nine of these varieties and the characteristics of the extracted oils were determined by Jamieson, Baughman and McKinney (5). The most striking difference found in the oils was in their iodine numbers and thiocyanogen values. Although the oil content of the different varieties showed a considerable range, the percentage of saturated and of unsaturated acids showed a remarkable constancy.

D.B. Jones (90) analyzed a number of varieties of soybeans with a view to seeing if there were any essential differences in the nutritional values of the proteins of different varieties. No very great differences were found in the amino acid contents.

Studies on the proteins and oil have been made at the Hokkaido Imperial University (85).

Investigations of soybean proteins have been under way since 1925 at the Tokyo Imperial Industrial Research Laboratory, under the direction of Dr. Minoru Mashino. Dr. Mashino has recently been awarded the medal for special merit in research of the Society of Chemical Industry of Japan (86).

Neal and Becker (3) investigated the change in chemical composition (protein, N-free extract, fibre, ether extract and ash) of soybeans during the ensiling process. It was found that the losses were comparable to those recorded for ensiled corn plants or grasses.

### Edible Products

Lecithin, it is reported (91), is now being made on a large scale as a by-product in the extraction of soybeans by the Hansa-Mühle Co. of Hamburg, Germany, which has a plant that can produce about 2% of lecithin from 1000 tons of beans per day. Soybean lecithin has properties similar to those of egg yolk. It reduces surface tension and has special properties of its own as an emulsifier and softener. It finds use in the textile, rubber, chocolate, and bakery trades. A consulting laboratory has been established in London, England, by the manufacturers.

A soybean flour called Soyolk (82) is said to be made from the whole soybean, but may be kept without going



rancid. It is said to be used by large food manufacturers in Great Britain, the Dominions and the United States and on the continent of Europe as an improver for bread, puddings, breakfast cereals, meat and fish pastes, sausages and candy. Flavored with cocoa it forms a beverage and may be used in this way for baby and invalid foods.

Floya, the product of another manufacturer (83), is a soybean flour containing only 0.1% of fat. The claims made for this product are that it blends easily with other flours, dissolves and emulsifies well, needs no sifting, is better than dried milk as a moisture absorber and retainer, carries twice its own weight of liquid, regenerates weak flours by strengthening the gluten, improves the cutting properties of bread, increases food value, accelerates fermentation and is yeast food.

Soy meal bread is being made on a factory scale in Australia according to a press notice.

A soybean preparation called Wytase (J.R. Short Milling Co., Chicago) has the capacity for bleaching natural wheat flour (93).

A new type of fine-ground soybean flour, "Nusoy", is said (19) to combine whiteness and absence of soybean odor and flavor.

The protein content is 68% and the oil content 1.7%. It can be used in white bread and other baked goods, e.g. sausage, bologna, wieners and macaroni. The process of manufacture is patented.

Much effort, it is said, is being expended in the United States towards establishing the use of soybeans as a green vegetable. In 1933 practically every experiment station that could grow soybeans at all was to have growing a full list of green vegetable varieties climatically suited to their States (44).

Field and others (26) studied the use of cooked whole-bean paste instead of egg as a stabilizer in mayonnaise and salad dressings. Emulsions made with soybeans appeared to be less sensitive to low temperatures than those stabilized with egg, but to be more sensitive to excessive amounts of seasonings, especially salt, but the evidence on these points was not conclusive.

In Missouri 10 charitable and penal institutions raised 150 acres of soybeans for human food in 1932. The beans were regarded as a great delicacy by the inmates and resulted in a sharp reduction in the cost of the ration (44).



A collection of recipes using soybeans was published by the Bureau of Science, Manila. Many, however, require also alugbati, bagoong, tokua, and other unusual ingredients (49).

Although soybean products have been highly praised for their nutritive value, it has been said that the rough, indigestible matter that they contain calls for moderation in their use in the diets of people with sensitive digestive tracts (42).

According to J. Pollak (20), soybean bread has been produced in Austria, which contains only one-fourth as much sugar-forming compounds as normal bread, and in taste and appearance is scarcely distinguishable from ordinary whole-grain bread. It is (Dec. 1933) being made on a factory scale and costs considerably less than the baked products hitherto used by diabetics. Further, a soybean milk has been produced by M. Adler which is completely neutral to the tests and scarcely distinguishable from cows' milk. In chemical composition and physical properties it appears to be quite equal to animal milk. It can be produced at a low cost.

Macaroni may contain as much as 30% soy flour, while some chocolate bars are known to contain 60% (99).

The commercial lecithin obtained from soybeans contains 70% true lecithin and 30% oil or fat (99).

#### Detection in Food

The presence of soybean in flour, alimentary pastes, meat products, and unleavened bread may be determined by a qualitative chemical method devised by LaWall and Harrison (17). It is based on the fact that soybeans contain urease which is present in much smaller quantity in other beans and is absent in cereals. If it is, therefore, warmed with urea, the evolution of ammonia (litmus) indicates the presence of soybean. A number of colorimetric and microscopic tests are also mentioned.

A method for determining the amount of pentosans in soybeans and soybean milk is described by Chiu (30). For four kinds of soybeans tested the pentosan content varied from 4.41 to 5.24% and in 10 milks made from one of these kinds of soybean, from 0.051 to 0.149%.

#### Inedible Products

A superior waterproof glue of great strength is said (March, 1934) to be made by a secret process from soybean oil meal, large quantities of the meal being used in this way (74).

The Forest Products Laboratory in Ottawa has been reported in the press to have developed a new glue from a by-product of soybean oil

Soybean glue of excellent quality has apparently been in use on the Pacific coast for a number of years (93). It has some special and valuable properties. It is said to be prepared by heating the meal with lime and then treating with caustic soda (99). It is used in the manufacture of plywood and insulating boards for refrigerators, because it is water resistant.

The residue from the cleaning of soybeans at the mill was investigated with considerable care by K. Meyer (87). It was found to consist of 46% fragments of soybean, 36% fragments of earth and silica and the rest seed of various specified kinds.

The Germans are said to be making a casein plastic "sojalith" from soybeans (76). One method of obtaining the casein is to treat the soy meal with salt solution and borax (99).

### Economics

The subject of marketing soybeans on the basis of United States standards has been discussed by Barr (88). Figures of an economic nature have also been published by the same author (89).

The Wesson refractometer test has been advocated in the United States as part of the National Grain Inspection Service for the rapid and accurate determination of the oil content of soybeans (54). The United States Federal Inspection Service is under the direction of the Bureau of Agricultural Economics, Washington D.C. (42).

### Imports of Soy Products into Canada (97)

#### Soy sauces

	Gal.	\$
1931	75,325	34,360
1932	78,311	34,625
1933	85,737	34,868

#### Peanut and soyabean oil, N.O.P., edible

	Gal.	\$
1931	211,023	104,753
1932	175,275	85,476
1933 Jan.-Mar.	21,284	11,106
Apr.-Dec. x	46,868	23,808

x soyabean oil only



Peanut and soyabean oil for the manufacture of soap and peanut oil for canning fish.

		Gal.	\$
1931		1,024,140	410,009
1932		146,760	45,617
1933	Jan.-Mar.	214,174	94,084
	Apr.-Dec. xx	148,864	72,903

xx soyabean oil only

Soyabeans, soyabean cake and soyabean meal for use exclusively in the manufacture of cattle food and of fertilizers.

	Cwt.	\$
1931	50,085	23,873
1932	38,593	52,296
1933	28,992	49,214

In Canada in 1933 there were 10 plants in operation in the linseed and soybean oil industry, with a total capital investment of \$3,022,676. The value added to the raw materials used by manufacture was \$544,438 and they furnished employment to 201 persons. How this is divided between linseed and soybean is not stated (98).

Burlison and Whalin (9) have collected a number of statistics on the soybean industry in the United States including acreage and yield per acre, acreage harvested for beans and hay, and with livestock also imports, exports and duties. A lengthy list of soy products is given including under the heading "Canadian Products" the following: Milquo (soy milk), Vi-Tone (Chocolate), Soya flour, Soyex-Malt-Cocoa drink, Soyex and Macaroni. For the United States the following is the distribution of soybean oil by industries: Paints and varnishes 25%, soap 25%, edible products 20%, and linoleum and waterproofing products 12 1/2%. It is stated that more than half of the acreage grown to soybeans each year is cut for hay and that the production of beans in 1931 was 18 million bushels.

Consumption of soybean oil in the U.S. in 1929 by industries as given by the Bureau of the Census and quoted in Chemical Markets (29) is as follows:-

	lb., in thousandths
Total apparent consumption	19,359
Lard compound or substitute	82
Margarine	11
Soap	6,400
Paint and varnish	5,815
Miscellaneous	7,051



Crop and yield figures for soybeans and flax seed in the United States appear in "Soybeans for oil and meal, 1932" (92).

Another estimate of the annual consumption of soybean oil is as follows (99):-

	lb.
	000's omitted
Paints and lacquers	9,000
Soaps and candles	9,000
Cooking oil, mayonnaise, sardines, lecithin	5,000
Linoleum and oilcloth	4,000
Printing ink	3,500
Oleomargarine and lard substitutes	1,500

Questions dealing with the economics of the soybean industry in the United States including supply, consumption, marketing, inspection and grading, valuation, prices and trade have been discussed in a 115-page bulletin of the University of Illinois, published in December, 1932 (55).

Efforts have been made in the United States to have soybeans dealt with on the futures market, but without success, for the crop is too small (42).

The growth of the soybean industry in the United States has been thought to be the cause for the falling off of exports of copra and palm oil from Malaya to that country (53).

In England this year (1934) a crop of 20 acres of soybeans is being harvested on Mr. Henry Ford's estate at Boreham near Chelmsford. This is the largest experiment that has been made in England and promises a very satisfactory yield. It is reported that soybean oil is used at Ford's works in the United States to make a plastic of secret composition (100).

Almost the largest crop of soybeans ever produced in Manchuria was harvested in 1933, while exports for the first six months of the 1933-34 crop year were the smallest in the past eight years and prices the lowest in nearly 20 years. Exports, not only of beans but also of oil and meal, have been falling for the last three years. From April to July, 1934, however, prices at Dairen were rising. At the beginning of the third quarter the stocks of soybeans in Manchuria were the largest on record. Farmers are reported to have used soybeans for fuel. The government has been encouraging the farmers in the north to grow more wheat, and in the south to plant cotton and hemp. The yield of soybeans was estimated by the Economic Research Committee of the South Manchurian Railway at 19.5 bu. per acre as compared with 16.5 last year (80,81).

A perhaps comparatively unknown cause of the Sino-Japanese trouble in Manchuria is mentioned by Roquemore (21): "Japan which is now conquering Manchuria for the third time has been given farming concessions which China is trying to take back. The only solution to the trouble is to conciliate these countries so that Japan will recognize China's sovereignty and China will recognize Japan's rights".

The fact that many Japanese farmers planted soybeans in Manchuria thus starting that country along the road to prosperity and that China now wants those fields of soybeans, undoubtedly constitutes in a large measure the "nubbin" of the Far East dispute.

This subject has also been discussed by Richardson (96).

In Germany, efforts are being made to become independent of foreign supplies of soybeans (84). Experiments in growing them are being carried out at about 100 locations in the country and satisfactory results obtained. Hybridization experiments are being carried out not only with the object of obtaining healthy, erect and good-yielding plants, but also with the object of obtaining beans with a high content of oil and protein. It was found that generally, but perhaps not always, the oil content would fall as the protein content was increased. Tables of analytical figures for various districts and varieties of bean are given in the original article to demonstrate the correlation between the various bean characteristics. No relation was found between physical appearance and chemical composition.

At the agricultural farm at Pusa, India, three varieties of soybeans have been selected as suited to cultivation in that district. It is considered advantageous to sow soybeans with corn, the corn being harvested in September while the soybeans are allowed to stand for seed till December or January (32).

A statement with regard to soybean cultivation in the Philippine Islands is given by Cruz and West (31) of the Bureau of Science, Manila. The composition of soybeans grown in the Philippines, which is given, does not differ materially from that of beans grown elsewhere. Only a few thousand tons are produced annually, and since the soybean would supplement the native diet of rice, the Bureau of Science is taking steps to popularize it.



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