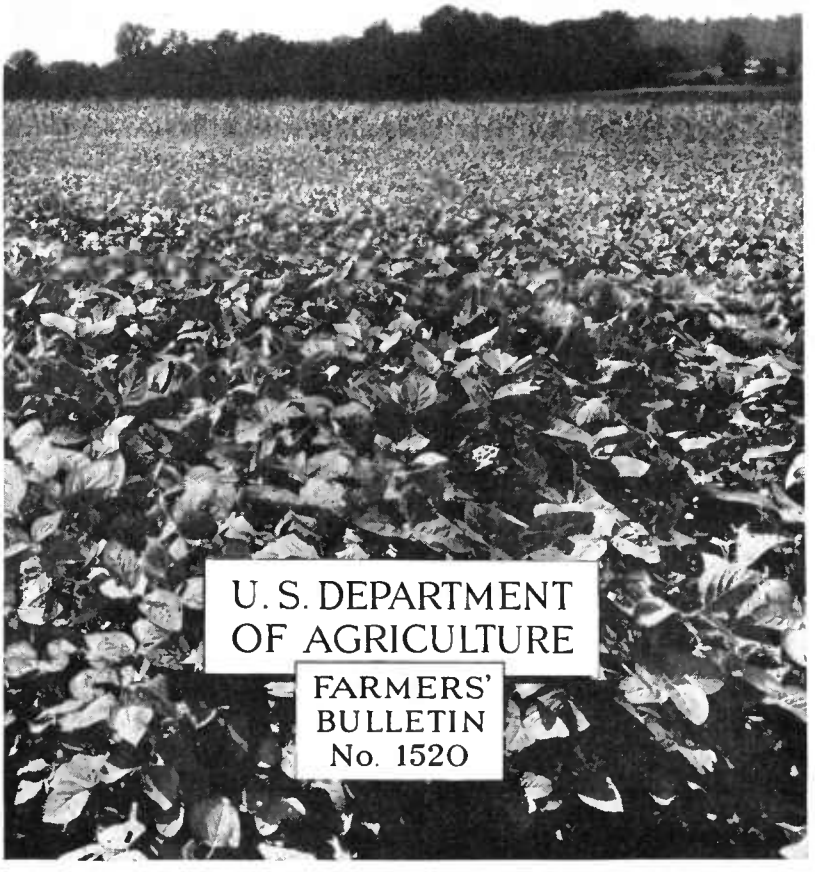
SOYBEANS

Culture

and

Varieties



U. S. DEPARTMENT
OF AGRICULTURE

FARMERS'
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No. 1520

SOYBEANS, an annual summer legume, have been cultivated extensively and highly valued as a food in oriental countries since ancient times.

Acreage of soybeans for seed, hay, pasture, or plowing under, and silage has shown marked increases during the past decade.

The climatic adaptations of the soybean are, in general, about the same as for corn. It is more drought-resistant and less sensitive to an excess of moisture than cowpeas and corn.

Although the soybean will succeed on nearly all types of soil, the best results are obtained on mellow, fertile loams or sandy loams.

One of the best assurances against failure with the soybean is the selection of varieties suited to local conditions.

The best results with soybeans are obtained on a well-prepared seedbed. When sown on land not previously grown to this crop, it is advisable to inoculate. The best time for seeding for a seed or main hay crop is about corn-planting time. The method and rate of seeding will be determined largely by convenience and economy of cultivation and harvesting, variety used, type of soil, climatic conditions, and the purpose for which the crop is grown. Soybean seed should not be sown too deeply. Cultivation of soybeans should be frequent enough to keep down weeds.

The soybean may be used advantageously as either a grain crop or forage crop in many systems of rotations. In combination with other crops, such as corn, cowpeas, Sudan grass, and sorghums, it furnishes a well-balanced ration and a large yield. The drilling of soybeans in grain crops has been found a practical method of growing soybeans in several regions.

The income from soybeans is largely a matter of yields produced and market prices.

Soybeans usually are comparatively free from serious insect pests. At present the seriously injurious insects are grasshoppers, blister beetles, leafhoppers, green clover worm, and velvetbean caterpillar.

Although the soybean is attacked by fungus, bacterial, and virus diseases, no disease of this plant has yet assumed any great economic importance in the United States.

Rabbits and deer are exceedingly fond of the soybean and when numerous enough cause considerable damage to fields.

Washington, D. C.

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SOYBEANS: CULTURE AND VARIETIES

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DESCRIPTION

THE SOYBEAN (*Soja max* (L.) Piper), also called the soya bean, soja bean, Manchurian bean, and in some sections of the Southern States the stock pea, is an annual summer legume native of Southeastern Asia. It is an erect, branching plant, resembling in its early growth the ordinary field or navy bean (fig. 1). The different varieties range in maturity from very early (about 75 days) to very late (200 days or more). With few exceptions earliness is correlated with size, the tallest varieties being latest. Nearly all varieties are pubescent; that is, the stems, leaves, and pods are covered with fine tawny (brown) or gray hairs. The leaves vary widely in shape, size, color, and degree of persistence, and they nearly always begin to turn yellow as the pods ripen; usually they have fallen by the time the pods are mature. The small, inconspicuous flowers are borne in the axil of the leaf and are either white or purple. The pods, usually containing two or three seeds, range in color from very light straw through numerous shades of gray and brown to nearly black. Most varieties have unicolored seeds of straw yellow, olive yellow (greenish yellow), green, brown, or black. In some varieties straw yellow seeds are very pale, especially when old, and they are sometimes erroneously called white, but no truly white or even red seeds are known in soybeans. Bicolored seeds occur in several varieties, the most common of the bicolored patterns being green or yellow with a saddle of black or brown. In some varieties the seeds are brindled brown and black, the two colors being somewhat concentrically arranged.

The cultivated soybean is thought to have been derived from *Glycine ussuriensis* Regel and Maack, which grows wild throughout much of eastern Asia. This species has long, fine, twining stems, small narrow leaves, purple flowers, and small oblong seeds of a sooty-black color.

FIGURE 1.—A typical soybean plant.

HISTORY

Ancient Chinese literature reveals that the soybean was extensively cultivated and highly valued as a food centuries before written records were kept. The first record of the plant is contained in a materia medica describing the plants of China, written by Emperor Sheng Nung in 2838 B. C. Methods of culture, varieties for different purposes, and numerous uses are repeatedly mentioned in later records, indicating the soybean to be of very ancient cultivation and perhaps one of the oldest crops grown by man. It was considered the most important cultivated legume and one of the five sacred grains essential to the existence of Chinese civilization. Soybean seed was sown yearly with great ceremony by the emperors of China, and poets through the ages have extolled the virtues of the plant in its services to humanity.

The soybean was first made known to Europeans by Engelbert Kaempfer, a German botanist, who spent 2 years, 1691–92, in Japan. Seed sent by Chinese missionaries was planted as early as 1740 in botanic gardens in France. The soybean was grown in 1790 in the Royal Botanic Gardens, Kew, England, but apparently no effort was made toward its culture as a crop. The greatest impetus given to the culture of the soybean in Europe was the work in 1875 and subsequent years of Friedrich Haberlandt, of Vienna, who published the results of his investigations in much detail. Although promising results were obtained with the early varieties in several European countries, the soybean did not attain the place in European agriculture Haberlandt had hoped it would. Beginning with the work of Haberlandt, the soybean has been grown experimentally in most of the European countries, but in general the climatic conditions there are not well suited to its culture except in certain parts of Rumania, Czechoslovakia, and the Union of Soviet Socialist Republics.

The first mention of the soybean in American literature was made in 1804 by James Mease, who wrote that "the soybean is adapted to Pennsylvania and should be cultivated." For many years following, however, the soybean was regarded more as a botanical curiosity than as a plant of much economic importance. In 1889 W. P. Brooks, of the Massachusetts Agricultural Experiment Station, brought with him from Japan several varieties, and in 1890 C. C. Georgeson, of the Kansas Agricultural Experiment Station, secured three lots from the same country. Undoubtedly other early importations were obtained from Asia through missionaries, but no definite records have been found. Since 1890 most of our agricultural experiment stations have experimented with soybeans, and many bulletins dealing with the crop have been published. In 1898 the United States Department of Agriculture began the introduction of a large number of soybeans from Asiatic countries. Previous to this time not more than eight varieties, limited in their adaptation to soil and climate, were grown in the United States. Increase of acreage and production in this country has been closely correlated with the introduction of varieties from the Orient and their improvement through selection.

DISTRIBUTION AND PRODUCTION

The soybean is grown to a greater extent in Manchuria than in any other country in the world. It occupies about 25 percent of the total cultivated area and is relied upon by the Manchurian farmer as a cash crop. China, Japan, and Chosen are large producers and the soybean is cultivated more or less also in the Philippines, Siam, Cochin China, Netherland India, and India. In other parts of the world, particularly Germany, England, Soviet Union, France, Italy, Czechoslovakia, Rumania, Mexico, Argentina, Cuba, Canada, New South Wales, New Zealand, Algeria, Egypt, British East Africa, South Africa, and Spain, various degrees of success have been obtained.

In the Western Hemisphere the acreage and production of soybeans at present are concentrated chiefly in the North Central States of the

United States (fig. 2). The acreage of soybeans grown for all purposes has shown marked increases during the past decade, advancing from 2,736,000 acres in 1929 to 7,789,000 acres in 1938. Increase in seed production has been more rapid than the expansion of acreage. In 1920, 14 States produced 3,000,000 bushels of seed, the leading States being North Carolina, Virginia, Alabama, Missouri, and Kentucky; North Carolina alone produced about 55 percent of this total. By 1931 seed production had increased to 15,500,000 bushels, with Illinois, Indiana, North Carolina, and Missouri leading. In 1938, 57,665,000 bushels of seed were produced, of which 51,316,000 bushels (90 percent) were harvested in Illinois, Indiana, Iowa, Missouri, and Ohio; Illinois alone produced 55 percent of the total.

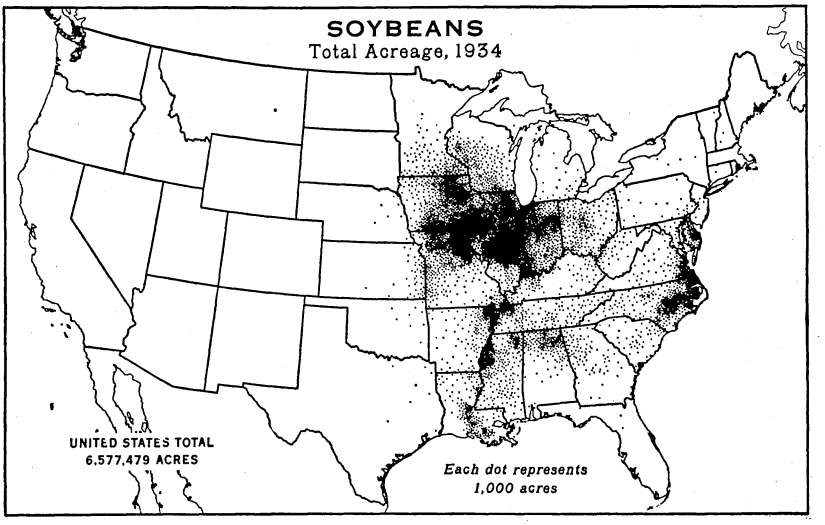

FIGURE 2.—Acreage and production of soybeans are confined largely to the eastern half of the United States. Nearly 70 percent of the total acreage is in Illinois, Indiana, Iowa, Ohio, and Missouri.

CLIMATIC ADAPTATIONS

The soybean seems to be peculiarly sensitive to changes of soil and climate. Differences in the behavior of a variety in different localities are often so striking as to make it appear like another variety. In general, the climatic adaptations of the crop are about the same as for corn. The crop is especially well adapted to the northern half of the Cotton Belt and the southern half of the Corn Belt, where varieties can be grown that produce yields that make extensive cultivation profitable. In the Northern States, however, early varieties introduced from northern Manchuria and Japan mature fair yields of seed, and later varieties can be grown successfully for hay, pasture, or silage.

After the soybean is well started, it withstands short periods of drought, and a wet season does not seriously retard growth or decrease yield. The soybean plant seems to adapt itself not only to

soils but to seasons as well. The period of germination is the most critical stage, when excess moisture or prolonged drought is likely to be injurious. The soybean is less susceptible to frost than are cowpeas, field beans, and corn, light frost having but little effect on the plants when young or when nearly mature.

SOIL PREFERENCES

The soybean will succeed on nearly all types of soil, the best results being obtained on mellow, fertile loams or sandy loams. In general the soil requirements are about the same as those of corn, but the soybean will make a more satisfactory growth than corn on soils low in fertility, provided inoculating organisms are present. The crop will not make nearly such good growth on soils low in fertility as cowpeas, nor does it succeed so well as the cowpeas on the heavier clay soils and the lighter sandy soils. The soybean will do better than clover or alfalfa on soils of low fertility or on acid soils, but for the best results acid soils must be limed and soils low in fertility must be supplied with those mineral elements in which they are deficient. With inoculation and moderate applications of fertilizers, the soybean gives good results on the sandy soils of the Coastal Plain.

A well-drained soil is not necessary, but the best results will not be obtained where water stands on the surface for any considerable length of time. The crop grows well on drained swamplands, provided acidity, when present, is corrected by the use of lime. Excellent yields of seed and forage are procured on some muck soils, and the crop is of considerable importance where such soils occur.

VARIETIES

In the selection of a variety several factors should be considered, the most important of which are adaptation to local climatic and soil conditions and the purpose for which the crop is grown. The number of soybean varieties is very large, and, as many new varieties are being introduced, the most desirable characters for both forage and seed need to be considered. The yield of forage or of seed is the most important single consideration; but other factors, such as habit of growth, maturity, coarseness, ability to retain leaves, color and size of seeds, shattering, and disease resistance, are important. In those regions where the crop is now valuable or is likely to become of value for the production of oil and oil meal or food products, the percentage of oil and protein and the color of the seed should be considered in addition to seed production.

Prior to the introduction of numerous varieties by the United States Department of Agriculture in 1898, not more than 8 varieties of soybeans were grown in the United States, and the culture of these was limited to a few well-defined areas. With the introduction and development of new and improved varieties adapted to a greater range of soil and climatic conditions and uses, acreage and production gradually increased, and the crop has become one of major importance. The Department has made more than 10,000 introductions from China, Manchuria, Japan, Chosen, Java, Sumatra, and India, representing over 2,500 distinct types. This large collection of varieties, ranging

in maturity from 75 to 200 or more days, has shown wide differences in size, shape, color, composition, and quality of seed and in adaptation to soil and climatic conditions in the United States.

State agricultural experiment stations have cooperated with the Department for several years in the study of adaptation of varieties, and are, therefore, in a position to recommend the best varieties for their respective States. Seedsmen and growers are urged to use the varietal names here adopted, and buyers should be careful to specify the variety desired. In view of the fact that more or less fraud in varieties has been practiced because of the close similarity in seed of certain sorts, the prospective purchaser should buy seed from reliable sources only. The planting of imported seed is not to be recommended, as such seed usually consists of a mixture of varieties concerning which nothing is known as to their adaptation and most of which are inferior to the varieties generally grown.

At the present time more than 100 named varieties are handled by domestic growers and seedsmen and are under test by the Department of Agriculture and State agricultural experiment stations. Unfortunately, there is more or less confusion in the names of varieties, the same variety frequently being known under different names. Since new varieties are easily obtained through introduction, selection, and crossing, it is desirable to limit the varieties in trade to the very best. In many States where the soybean has become an important crop, seed of the best varieties are certified by crop-improvement associations.

Varieties for seed production are preferably the yellow-seeded types, which are used for processing for oil, oil meal, and flour, but these varieties may be used also for forage purposes if heavier rates of seeding are used. Forage types are generally those with black or brown seed, and are for the most part smaller seeded, finer stemmed, and more leafy, and they contain less oil than the yellow-seeded varieties. For dry edible beans or green shelled beans, the most suitable varieties are those with straw-yellow or olive-yellow seed, which cook easily and have a mild or nutty flavor. The varieties used for processing usually do not cook easily and have a raw beany flavor. A few black, brown, and bicolored varieties have been found to have superior qualities as green shelled beans. The following varieties of soybeans are recommended for different uses and are classified as to length of growing season:

Very early (100 days or less):

Seed	Cayuga, Mandarin, Minsoy.
Forage	Cayuga, Chernie, Ogemaw, Soysota, Wisconsin Black.
Green vegetable	Agate, Sioux.

Early (101 to 110 days):

Seed	A. K., Aksarben, Dunfield, Elton, Habaro, Hoosier, Illini, Ito San, Manchu, Mandell, Mukden, Pinpu, Richland, Wea.
Forage	A. K. Black Eyebrow, Chestnut.
Green vegetable	Bansei, Chusei, Goku, Kanro, Waseda.
Dry edible	Bansei, Chusei, Goku, Kanro, Waseda.

Medium early (111 to 120 days):

Seed	Harbinsoy, Hongkong, Mansoy, Midwest, Scioto.
Forage	Harbinsoy, Ilsoy, Medium Green.
Green vegetable	Fuji, Hakote, Hiro, Hokkaido, Jogun, Kura, Osaya, Sato, Shiro, Sousei, Suru, Toku, Willomi.
Dry edible	Hokkaido, Jogun, Osaya, Sousei, Suru, Toku, Willomi.

Medium (121 to 130 days):
- Seed—Hurrelbrink, Macoupin, Yokoten.
- Forage—Columbia, Ebony, Kingwa, Lexington, Norredo, Ozark, Peking, Pine Dell Perfection, Sooty, Virginia, Wilson, Wilson-Five.
- Green vegetable—Chame, Funk Delicious, Imperial.
- Dry edible—Funk Delicious, Imperial.

Medium late (131 to 140 days):
- Seed—Arksoy, Chiquita, Dixie, Easycook, Haberlandt, Herman, Hollybrook, Morse, Southern Prolific, Tokyo, Wood's Yellow.
- Forage—Chiquita, George Washington, Laredo, Mammoth Brown, Old Dominion, Tarheel Black.
- Green vegetable—Aoda, Hahto, Higan, Rokusun.
- Dry edible—Easycook, Haberlandt, Higan, Rokusun, Tokyo.

Late (141 to 160 days):
- Seed—Clemson, Delsta, Hayseed, Mamloxi, Mammoth Yellow, Mamredo, Missoy.
- Forage—Barchet, Clemson, Hayseed, Missoy, Pee Dee, Southern Green.
- Green vegetable—Nanda.
- Dry edible—Nanda.

Very late (161 or more days):
- Seed—Charlee, Creole, Delnoshat, Georgian, Monetta, Nanking, Palmetto, White Biloxi, Yelredo.
- Forage—Avoyelles, Biloxi, Charlee, Creole, Georgian, Monetta, Oloxi, Otootan, Palmetto, Yelredo.

DESCRIPTIONS OF VARIETIES

The characteristics of varieties here described are based on varietal experiments conducted at the Arlington Experiment Farm, Arlington, Va., near Washington, D. C. The oil and protein percentages, however, are based on analyses of seed grown in the States in which the variety is generally grown. Extensive cooperative varietal investigations show that many of the varietal characters of the soybean vary more or less with soil and seasonal conditions, cultural methods, locality, and source of seed. Therefore, varieties grown under different conditions from those of the Arlington Farm may vary more or less in maturity, habit of growth, and composition.

Agate.—Introduced under F. P. I. No. 81037, native name, "Kura Kake Daizu," from Sapporo, Hokkaido, Japan, in 1929. This variety is said to be used as an early green vegetable bean. Maturity, about 90 days; pubescence, tawny; flowers, both purple and white, appearing in 35 to 40 days; pods, two- to three-seeded; seeds, straw yellow with brown saddle and brown hilum (seed scar), about 2,816 to the pound; germ, yellow; oil, 19.16 percent; protein, 37.26 percent.[1]

A. K.—A commercial introduction obtained from Manchuria in 1912. Maturity, about 110 days; pubescence, both tawny and gray; flowers, both purple and white, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, straw yellow, the hilum ranging from pale brown to slate black, about 2,650 to the pound; germ, yellow; oil, 18.78 percent; protein, 44.65 percent.

Aksarben.—Introduced in 1913 under F. P. I. No. 36576 from Fakumen, Manchuria, where it is said to be grown extensively for the production of oil. Maturity, about 105 days; pubescence, gray; flowers, both purple and white, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 2,675 to the pound; germ, yellow; oil, 19.56 percent; protein, 38.25 percent.

Aoda.—Introduced under F. P. I. No. 81043, native name, "Ao Daizu," from Hakodate, Hokkaido, Japan, in 1929. A green-seeded variety said to be used as

[1] Moisture-free basis in this and subsequent descriptions applies to all oil and protein analyses.

a green vegetable bean because of its excellent flavor. Maturity, about 140 days; pubescence, gray; flowers, purple, appearing in 65 to 70 days; pods, two-seeded; seeds, green with light-brown hilum, about 1,424 to the pound; germ, green; oil, 18.53 percent; protein, 41.04 percent.

Arksoy.—Introduced under F. P. I. No. 37335 from Pingyang (Heijo), Chosen, in 1914. Maturity, about 140 days; pubescence, gray; flowers, purple, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 3,136 to the pound; germ, yellow; oil, 16.95 percent; protein, 48.14 percent.

Avoyelles.—Selected as a sport in 1932 from the Otootan variety in Avoyelles Parish, La. Maturity, about 170 days; pubescence, tawny; flowers, purple, appearing in 70 to 80 days; pods, two- to three-seeded; seeds, black with black hilum, about 3,248 to the pound; germ, yellow; oil, 18.35 percent; protein, 42.14 percent.

Bansei.—Introduced under F. P. I. No. 81031, native name "Bansei O Saya Eda Mame," from Sapporo, Hokkaido, Japan, in 1929. A large-podded and large-seeded variety said to be used as a green shelled bean. Maturity, about 110 days; pubescence, gray; flowers, purple, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 1,936 to the pound; germ, yellow; oil, 21.72 percent; protein, 39.12 percent.

Barchet.—Introduced under F. P. I. No. 23232, native name, "Ma Liao Tou," from Shanghai, China, in 1908. This variety is said to be grown as a second crop in low-lying rice fields and used mainly as a forage crop for domestic animals. Maturity, about 150 days; pubescence, tawny; flowers, purple, appearing in 80 to 85 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 9,950 to the pound; germ, yellow; oil, 13.87 percent; protein, 47.99 percent.

Biloxi.—Introduced under F. P. I. No. 23211, native name, "Tsze Pi Tou," from Tangsi, China, in 1908. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 85 to 90 days; pods, two- to three-seeded; seeds, dark brown with brown hilum, about 1,875 to the pound; germ, yellow; oil, 19.19 percent; protein, 46.84 percent.

Black Beauty.—The same as Ebony (p. 9).

Black Eyebrow.—Introduced under F. P. I. No. 30744, native name, "Hei Mei Tou," from Wulukai, Manchuria, in 1911. Maturity, about 105 days; pubescence, tawny; flowers, both purple and white, appearing in 35 to 40 days; pods, two- to three-seeded; seeds, brown with black saddle and black hilum, about 2,475 to the pound; germ, yellow; oil, 21.85 percent; protein, 39.60 percent.

Cayuga.—Introduced under F. P. I. No. 65393 from Harbin, Manchuria, in 1925. Maturity, about 100 days; pubescence, tawny; flowers, white, appearing in 35 to 40 days; pods, two- to three-seeded; seeds, black with black hilum, about 3,632 to the pound; germ, yellow; oil, 18.90 percent; protein, 39.78 percent.

Chame.—Introduced under F. P. I. No. 80473, native name, "Cha Mame," from Tokyo, Japan, in 1929. A large-seeded variety said to be used as a green bean boiled in the pod. Maturity, about 125 days; pubescence, tawny; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, light-brown with brown hilum, about 1,904 to the pound; germ, yellow; oil, 21.76 percent; protein, 37.10 percent.

Charlee.—Introduced under F. P. I. No. 71663 from Nanking, China, in 1927. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 90 to 100 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 3,824 to the pound; germ, yellow; oil, 18.51 percent; protein, 42.94 percent.

Chernie.—Introduced under F. P. I. No. 18227, native name, "Tchernie Bobi," from Khabarovsk, Siberia, in 1906. Maturity, about 100 days; pubescence, tawny; flowers, purple, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, black with black hilum; about 4,675 to the pound; germ, yellow; oil, 18.29 percent; protein, 44.21 percent.

Chestnut.—Selection (20405–B) in 1907 from the Habaro variety at the Arlington Farm. Maturity, about 105 days; pubescence, tawny; flowers, purple, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, russet brown with brown hilum, about 3,275 to the pound; germ, yellow; oil, 18.19 percent; protein, 43.00 percent.

Chiquita.—Introduced under F. P. I. No. 27707 from Hankow, China, in 1910. Maturity, about 135 days; pubescence, gray; flowers, both purple and white, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 4,050 to the pound; germ, yellow; oil, 18.18 percent; protein, 43.77 percent.

Chusei.—Introduced under F. P. I. No. 80472, native name, "Chusei O Saya Eda Mame," from Tokyo, Japan, in 1929. A large, yellow-seeded variety said to be the largest soybean used for garden purposes. It has a sweet flavor and is used principally as a green shelled bean, being cooked in the pod. Maturity, about 110 days; pubescence, gray; flowers, white, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 2,096 to the pound; germ, yellow; oil, 14.98 percent; protein, 44.25 percent.

Clemson.—Introduced under F. P. I. No. 71659 from Nanking, China, in 1927. Maturity, about 160 days; pubescence, tawny; flowers, purple, appearing in 90 to 95 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 3,680 to the pound; germ, yellow; oil, 17.37 percent; protein, 44.85 percent.

Columbia.—Introduced under F. P. I. No. 22897, native name, "Da Ching Tou," from Paotingfu, China, in 1908. Maturity, about 125 days; pubescence, gray; flowers, both purple and white, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, green with brown hilum, about 3,350 to the pound; germ, green; oil, 18.65 percent; protein, 38.01 percent.

Creole.—Introduced under F. P. I. No. 71614 from Nanking, China, in 1927. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 90 to 100 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 3,120 to the pound; germ, yellow; oil, 16.93 percent; protein, 45.48 percent.

Delnoshat.—Selection, Delta Station No. 6679, developed by the Delta Branch Station, Stoneville, Miss., in 1924. Maturity, about 165 days; pubescence, gray; flowers, both purple and white, appearing in 90 to 100 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,340 to the pound; germ, yellow; oil, 20.48 percent; protein, 47.58 percent.

Delsta.—Selection, Delta Station No. 6677, developed by the Delta Branch Station, Stoneville, Miss., in 1924. Maturity, about 150 days; pubescence, gray; flowers, white, appearing in 80 to 90 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 1,860 to the pound; germ, yellow; oil, 18.41 percent; protein, 41.04 percent.

Dixie.—Introduced under F. P. I. No. 37330, native name, "Pai Moi," from Pingyang, Chosen, in 1914. Maturity, about 135 days; pubescence, gray; flowers, purple, appearing in 50 to 60 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 1,825 to the pound; germ, yellow; oil, 19.41 percent; protein, 44.98 percent.

Dunfield.—Introduced under F. P. I. No. 36846 from Fanchiatum Station, Manchuria, in 1913. This variety is said to be highly prized for the quantity of oil that the seeds contain. Maturity, about 110 days; pubescence, gray; flowers, purple and white, appearing in 40 to 45 days; pods, two-, three-, or four-seeded; seeds, straw yellow with light-brown hilum, about 3,175 to the pound; germ, yellow; oil, 20.78 percent; protein, 39.69 percent.

Early Green.—The same as Medium Green (p. 13).

Early Virginia Brown.—The same as Virginia (p. 16).

Early Wilson.—The same as Wilson (p. 16).

Early Wisconsin Black.—The same as Wisconsin Black (p. 16).

Early Yellow.—The same as Ito San (p. 11).

Easycook.—Introduced under F. P. I. No. 34702 from Shantung Province, China, in 1894. Maturity, about 135 days; pubescence, gray; flowers, purple, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,700 to the pound; germ, yellow; oil, 21.53 percent; protein, 38.32 percent; especially suitable for food on account of ease of cooking.

Ebony.—Introduced under F. P. I. No. 6386 from Pingyang, Chosen, in 1901. Maturity, about 125 days; pubescence, tawny; flowers, both purple and white, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, black with black hilum, about 5,750 to the pound; germ, yellow; oil, 16.9 percent; protein, 41.40 percent.

Elton.—Introduced under F. P. I. No. 20406 from Khabarovsk, Siberia, in 1906. The Chinese are said to eat these beans boiled or sprouted. Maturity, about 105 days; pubescence, gray; flowers, purple, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 2,625 to the pound; germ, yellow; oil, 18.33 percent; protein, 42.46 percent.

Fuji.—Introduced under F. P. I. No. 81029, native name, "Chusei Kuro Me Daizu," from Sapporo, Hokkaido, Japan, in 1929. A middle-season blackeye variety said to be used as a green shelled bean. Maturity, about 115 days; pubescence, tawny; flowers, both purple and white, appearing in 45 to 50

days; pods two- to three-seeded; seeds, olive yellow with black hilum, about 1,456 to the pound; germ, yellow; oil, 18.45 percent; protein, 42.34 percent.

Funk Delicious.—Introduced by the Funk Seed Farms, Bloomington, Ill., in 1932. Maturity, about 125 days; pubescence, gray; flowers, purple, appearing in 50 to 55 days; pods, two-seeded; seeds, straw yellow with pale hilum, about 1,600 to the pound; germ, yellow; oil, 17.40 percent; protein, 41.31 percent. Suitable as a green shelled bean and a dry edible bean.

George Washington.—Nonshattering selection developed from the Virginia variety by H. S. Clapp, Accotink, Va., in 1921. Maturity, about 135 days; pubescence, tawny; flowers, purple, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 3,200 to the pound; germ, yellow; oil, 20.67 percent; protein, 45.86 percent.

Georgian.—Introduced under F. P. I. No. 71583 from Nanking, China, in 1927. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 90 to 100 days; pods, two- to three-seeded; seeds, straw yellow with pale to brown hilum, about 3,968 to the pound; germ, yellow; oil, 17.41 percent; protein, 45.62 percent.

Goku.—Introduced under F. P. I. No. 80480, native name, "Goku Wase Daihosan Shinbon Daizu," from Tokyo, Japan, in 1929. It is said to be used especially as a green shelled bean, and one of the earliest varieties used for this purpose. Maturity about 110 days; pubescence, gray; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 3,216 to the pound; germ, yellow; oil, 14.55 percent; protein, 45.51 percent.

Guelph.—The same as Medium Green (p. 13).

Habaro.—Introduced under F. P. I. No. 20405 from Khabarovsk, Siberia, in 1906. The Chinese are said to use the sprouts of this variety as a winter vegetable. The beans are also pressed for oil and the oil cake used as a feed for hard-working horses. Maturity, about 105 days; pubescence, both gray and tawny; flowers, both purple and white, appearing in 35 to 45 days; pods, two- to three-seeded; seeds, straw yellow with dark-brown hilum, about 3,100 to the pound; germ, yellow; oil, 20.61 percent; protein, 39.87 percent.

Haberlandt.—Introduced under F. P. I. No. 6396 from Pingyang, Chosen, in 1901. Maturity, about 130 days; pubescence, tawny; flowers, both purple and white, appearing in 55 to 60 days; pods, two- to three-seeded; seeds, straw yellow with dark-brown hilum, about 2,400 to the pound; germ, yellow; oil, 19.15 percent; protein, 41.73 percent. Suitable for food on account of ease of cooking.

Hahto.—Introduced under F. P. I. No. 40118, native name, "Hahto Koroshi Daizu," from Wakamatsu, Japan, in 1915. It is commonly known in Japan as "dove-killer" and is said to be used chiefly as a green shelled bean. Maturity, about 130 days; pubescence, tawny; flowers, purple, appearing in 55 to 60 days; pods, two- to three-seeded; seeds, olive yellow with black hilum, about 1,250 to the pound; germ, yellow; oil, 15.60 percent; protein, 42.80 percent. Suitable as green shelled bean and dry edible bean.

Hakote.—Introduced under F. P. I. No. 81039, native name, "Ao Shiro Daizu," from Sapporo, Hokkaido, Japan, in 1929. A medium-early variety said to be used as a green shelled bean. Maturity, about 115 days; pubescence, tawny; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, olive yellow with black hilum, about 1,440 to the pound; germ, yellow; oil, 18.43 percent; protein, 43.80 percent.

Harbinsoy.—Selection (54606–3) in 1922 at Arlington Farm from F. P. I. No. 54606, received from Penhsiku, South Manchuria, in 1921. Maturity, about 120 days; pubescence, tawny; flowers, white, appearing in 45 to 55 days; pods, two- to three-seeded; seeds, straw yellow with russet-brown hilum, about 2,950 to the pound; germ, yellow; oil, 19.89 percent; protein, 44.16 percent.

Hayseed.—Introduced under F. P. I. No. 71525 from Nanking, China, in 1927. Maturity, about 160 days; pubescence, tawny; flowers, white, appearing in 75 to 85 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 4,176 to the pound; germ, yellow; oil, 19.48 percent; protein, 45.71 percent.

Herman.—Selection from the Haberlandt variety by the North Carolina Agricultural Experiment Station in 1915 and first introduced as Haberlandt No. 38. Maturity, about 135 days; pubescence, tawny; flowers, purple, appearing in 55 to 60 days; pods, two- to three-seeded; seeds, straw yellow with dark-brown hilum, about 2,450 to the pound; germ, yellow; oil, 21.79 percent; protein, 42.22 percent.

Higan.—Introduction under F. P. I. No. 80475, native name, "Higan Mame," from Tokyo, Japan, in 1929. It is said to be a rather late, yellow-seeded variety

having a sweet flavor and used as a green shelled bean. Maturity, about 135 days; pubescence, gray; flowers, purple, appearing in 55 to 65 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 1,984 to the pound; germ, yellow; oil, 22.37 percent; protein, 32.39 percent.

Hiro.—Introduced under F. P. I. No. 86038, native name, "Kuro Daizu," from Obihiro, Hokkaido, Japan, in 1930. It is said to be used as a sweet boiled bean and in the making of a health drink. Maturity, about 115 days; pubescence, tawny; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, black with black hilum, about 1,312 to the pound; germ, yellow; oil, 16.12 percent; protein, 46.84 percent.

Hokkaido.—Introduced under F. P. I. No. 85666, native name, "Hokkaido Tsurunoko," from Tokyo, Japan, in 1930. This is said to be one of the largest yellow-seeded varieties and used for food purposes only. Maturity, about 115 days; pubescence, gray; flowers, both purple and white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 1,232 to the pound; germ, yellow; oil, 21.09 percent; protein, 37.41 percent.

Hollybrook.—Originally found in the Mammoth Yellow variety and introduced by T. W. Wood & Sons, Richmond, Va., in 1902. Maturity, about 135 days; pubescence, gray; flowers, white, appearing in 60 to 65 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,550 to the pound; germ, yellow; oil, 16.38 percent; protein, 44.14 percent.

Hongkong.—Introduced under F. P. I. No. 22406 from Hongkong, China, in 1908. Maturity, about 120 days; pubescence, both gray and tawny; flowers, both purple and white, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, straw yellow with dark-brown hilum, about 2,800 to the pound; germ, yellow; oil, 19.01 percent; protein, 43.50 percent.

Hoosier.—Introduced under F. P. I. No. 30746, native name, "Chin Yuan Tou," from Wulukai, Manchuria, in 1911. Maturity, about 110 days; pubescence, gray; flowers, both purple and white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,510 to the pound; germ, yellow; oil, 19.32 percent; protein, 41.81 percent.

Hurrelbrink.—Selection from the Haberlandt variety made by Frank Hurrelbrink, Taylorville, Ill., in 1902. Maturity, about 125 days; pubescence, tawny; flowers, purple, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, straw yellow with dark-brown hilum, about 2,800 to the pound; oil, 19.01 percent; protein, 43.50 percent.

Illini.—Pure-line selection made from the A. K. variety by the Illinois Agricultural Experiment Station in 1921. Maturity, about 105 days; pubescence, gray; flowers, white, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,750 to the pound; germ, yellow; oil, 20.40 percent; protein, 39.25 percent.

Ilsoy.—Pure-line selection made from the Ebony variety by the Illinois Agricultural Experiment Station in 1913 and first introduced as Illinois 13–19. Maturity, about 120 days; pubescence, tawny; flowers, purple, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 3,250 to the pound; germ, yellow; oil, 18.11 percent; protein, 38.22 percent.

Imperial.—Introduced under F. P. I. No. 81780, native name, "Tsurunoko," from Kotoni, Hokkaido, Japan, in 1929. Maturity, about 125 days; pubescence, gray; flowers, purple, appearing in 50 to 55 days; pods, two-seeded; seeds, straw yellow with pale hilum, about 1,920 to the pound; germ, yellow; oil, 19.88 percent; protein, 41.19 percent. This variety makes an excellent green shelled bean and may be used as a dry edible bean.

Indiana hollybrook.—The same as Midwest (p. 13).

Ito San.—Introduced by the Kansas Agricultural Experiment Station, from Japan in 1890. Maturity, about 105 days; pubescence, tawny; flowers, purple, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum and a brown speck at one end of hilum, about 3,325 to the pound; germ, yellow; oil, 18.14 percent; protein, 41.46 percent.

Jogun.—Introduced under F. P. I. No. 87615, native name, "Shiro Bana Daizu," from Dojogun, Chosen, in 1930. Maturity, about 118 days; pubescence, gray; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 1,360 to the pound; germ, yellow; oil, 17.06 percent; protein, 43.97 percent. May be used as a green shelled bean and is also especially suitable as a dry edible bean on account of flavor and ease of cooking.

Kanro.—Introduced under F. P. I. No. 84928, native name, "Kanro," from Pingyang, Chosen, in 1929. Maturity, about 110 days; pubescence, gray; flowers,

purple, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with pale to light-brown hilum, about 1,488 to the pound; germ, yellow; oil, 17.79 percent; protein, 43.90 percent. This variety makes a well-flavored green shelled bean and is also an excellent dry edible bean.

Kingwa.—A pure-line selection No. 1–21–7, made from the Peking variety and formerly named Pekwa by the West Virginia Agricultural Experiment Station in 1921. Maturity, about 125 days; pubescence, gray; flowers, purple, appearing in 55 to 60 days; pods, three-seeded; seeds, black with black hilum, about 3,808 to the pound; germ, yellow; oil, 15.45 percent; protein, 42.34 percent.

Kura.—Introduced under F. P. I. No. 81042, native name, "Kura Kake Daizu," from Sapporo, Hokkaido, Japan, in 1929. This variety is said to be used as a green shelled bean, easily cooked, and to have a nutty flavor. Maturity, about 118 days; pubescence, tawny; flowers, white, appearing in 45 to 50 days; pods, two-seeded; seeds, black with olive-yellow saddle and black hilum, about 1,456 to the pound; germ, yellow; oil, 20.39 percent; protein, 40.94 percent.

Laredo.—Introduced under F. P. I. 40658 from Yangpingkwan, China, in 1914. In China this variety is said to be adapted to drier lands than other varieties and in the United States it has been found highly resistant to wilt and nematode. Maturity, about 140 days; pubescence, tawny; flowers, both purple and white, appearing in 70 to 75 days; pods, two- to three-seeded; seeds, black with black hilum, about 7,775 to the pound; germ, yellow; oil, 14.93 percent; protein, 42.85 percent.

Large Brown.—The same as Mammoth Brown (p. 12).

Large Yellow.—The same as Mammoth Yellow (p. 12).

Late Yellow.—The same as Mammoth Yellow (p. 12).

Lexington.—Selection (17862–E) from the Sherwood variety, F. P. I. No. 17862, at Arlington Farm in 1907. Maturity, about 130 days; pubescence, gray; flowers, both purple and white, appearing in 60 to 65 days; pods, two- to three-seeded; seeds, olive yellow with brown hilum, about 3,585 to the pound; germ, yellow; oil, 18.66 percent; protein, 41.42 percent.

Macoupin.—Selection developed by Elmer Hulcher, Nilwood, Ill., in 1930. Maturity, about 125 days; pubescence, gray; flowers, white, appearing in 55 to 60 days; pods, two- to three-seeded; seeds, straw yellow with light-brown hilum, about 2,944 to the pound; germ, yellow; oil, 21.53 percent; protein, 39.42 percent.

Mamloxi.—A selection from a cross between the Mammoth Yellow and Biloxi varieties developed by the Delta Branch Station, Stoneville, Miss., in 1925. Maturity, about 145 days; pubescence, gray; flowers, white, appearing in 85 to 90 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,852 to the pound; germ, yellow; oil, 18.58 percent; protein, 46.06 percent.

Mammoth Brown.—No definite information has been obtained as to the origin of this variety. Maturity, about 140 days; pubescence, tawny; flowers, purple, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 1,855 to the pound; germ, yellow; oil, 17.77 percent; protein, 44.06 percent.

Mammoth Yellow.—Nothing definite is known regarding the origin of this variety. It is said to have been grown in North Carolina since about 1880. Maturity, about 145 days; pubescence, gray; flowers, white, appearing in 85 to 90 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,150 to the pound; germ, yellow; oil, 19.57 percent; protein, 45.83 percent.

Mamredo.—Selection, Delta Station No. 488–607, developed by the Delta Branch Station, Stoneville, Miss., in 1924. Maturity, about 150 days; pubescence, gray; flowers, white, appearing in 85 to 90 days; pods, two- to three-seeded; seeds, straw yellow with brown to black hilum, about 3,220 to the pound; germ, yellow; oil, 18.37 percent; protein, 42.98 percent.

Manchu.—Introduced under F. P. I. No. 30593, native name, "Huang Tou," from Ninguta, Manchuria, in 1911. This variety is known to have been grown for 40 years in the Ninguta district and is said to be highly prized by the Chinese for its thin skin, high weight to the bushel, and high oil content. Maturity, about 110 days; pubescence, tawny; flowers, both purple and white, appearing in 45 to 50 days; pods, two-, three-, or four-seeded; seeds, straw yellow with both black and brown hila, about 2,350 to the pound; germ, yellow; oil, 18.85 percent; protein, 41.43 percent.

Mandarin.—Introduced under F. P. I. No. 36653 from Pehtuanlintza, Manchuria, in 1911. Maturity, about 100 days; pubescence, gray; flowers, purple, appearing in 35 to 40 days; pods, two- to three-seeded; seeds, straw yellow with

pale hilum, about 2,910 to the pound; germ, yellow; oil, 18.52 percent; protein, 43.99 percent.

Mandell.—Selection from the Manchu variety developed by the Indiana Agricultural Experiment Station in 1926. Maturity, about 110 days; pubescence, tawny; flowers, purple, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 2,448 to the pound; germ, yellow; oil, 19.05 percent; protein, 44.47 percent.

Mansoy.—Selection from the Manchu variety at Arlington Farm in 1915. Maturity, about 120 days; pubescence, tawny; flowers, purple, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 2,450 to the pound; germ, yellow; oil, 20.99 percent; protein, 39.23 percent.

Medium Early Green.—The same as Medium Green (p. 13).

Medium Early Yellow.—The same as Ito San (p. 11).

Medium Green.—Introduced from Japan in 1889 by W. P. Brooks, Massachusetts Agricultural Experiment Station. Maturity, about 120 days; pubescence, tawny; flowers, purple, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, green with dark-brown hilum, about 2,485 to the pound; germ, green; oil, 20.53 percent; protein, 38.79 percent.

Medium Yellow.—The same as Midwest (p. 13).

Midwest.—Introduced under F. P. I. 6556 from central China in 1901. Maturity, about 115 days; pubescence, tawny; flowers, purple, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, straw yellow with pale to brown hilum, about 3,675 to the pound; germ, yellow; oil, 17.61 percent; protein, 44.08 percent.

Minsoy.—Introduced under F. P. I. No. 27890 from the Vilmorin-Andrieux & Co., Paris, France, in 1910. Maturity, about 100 days; pubescence, tawny; flowers, purple, appearing in 30 to 35 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 3,700 to the pound; germ, yellow; oil, 18.48 percent; protein, 43.22 percent.

Missoy.—Introduced under F. P. I. No. 71664 from Nanking, China, in 1927. Maturity, about 160 days; pubescence, tawny; flowers, purple, appearing in 90 to 95 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 4,320 to the pound; germ yellow; oil, 19.16 percent; protein, 42.24 percent.

Monetta.—Introduced under F. P. I. No. 71608 from Nanking, China, in 1927. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 85 to 95 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 2,976 to the pound; germ, yellow; oil, 17.46 percent; protein, 42.27 percent.

Morse.—Introduced under F. P. I. No. 19186 from Yingkow (Newchwang), Manchuria, in 1906. This variety is said to be most commonly used for oil in South Manchuria, the pressed cake being used locally and also exported to southern China for fertilizing purposes. When mature, its pods are said to withstand moist conditions much better than the yellow-seeded varieties grown in central and northern Manchuria. Maturity, about 130 days; pubescence, gray; flowers, both purple and white, appearing in 60 to 65 days; pods, two- to three-seeded; seeds, olive yellow with brown hilum, about 2,500 to the pound; germ, yellow; oil, 20.69 percent; protein, 40.01 percent.

Mukden.—Selection (50523–Q) at Arlington Farm in 1921 from F. P. I. No. 50523, native name, "Hsiao Chin Huang Tou," received from Mukden, Manchuria, in 1920. Maturity, about 105 days; pubescence, gray; flowers, white, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,750 to the pound; germ, yellow; oil, 18.85 percent; protein, 45.86 percent.

Nanda.—Introduced under F. P. I. No. 95727 from Shariin, Chosen, in 1932. Maturity, about 145 days; pubescence, gray; flowers, purple, appearing in 70 to 75 days; pods, two-seeded; seeds, straw yellow with pale hilum, about 1,952 to the pound; germ, yellow; oil, 17.35 percent; protein, 46.22 percent.

Nanking.—Introduced under F. P. I. No. 71597 from Nanking, China, in 1927. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 85 to 95 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 5,600 to the pound; germ, yellow; oil, 14.14 percent; protein, 47.50 percent.

Norredo.—No definite information has been obtained as to the origin of this variety, which was previously grown as Indiana Laredo. Maturity, about 125 days; pubescence, both gray and tawny; flowers, both purple and white, ap-

pearing in 55 to 60 days; pods, two- to three-seeded; seeds, black with black hilum, about 5,856 to the pound; germ, yellow; oil, 15.97 percent; protein, 41.39 percent.

Northern Hollybrook.—The same as Midwest (p. 13).

Ogemaw.—Introduced by E. E. Evans, West Branch, Mich., in 1902, as a cross between the Early Black and Dwarf Brown varieties. Maturity, about 90 days; pubescence, tawny; flowers, white, appearing in 30 to 35 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 3,125 to the pound; germ, yellow; oil, 21.48 percent; protein, 35.87 percent.

Old Dominion.—Introduced under F. P. I. No. 44512 from Yihsien, Shantung, China, in 1917. This variety is said to be used as animal feed. Maturity, about 140 days; pubescence, gray; flowers, purple, appearing in 70 to 75 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 6,525 to the pound; germ, yellow; oil, 14.76 percent; protein, 46.08 percent. The leaves of the variety persist after the seeds are fully mature.

Oloxi.—A selection, formerly Coker's Black Beauty, developed from a cross of the Biloxi and Otootan varieties by the Coker Pedigreed Seed Co., Hartsville, S. C. Maturity, 170 days; pubescence, tawny; flowers, purple, appearing in 90 to 95 days; pods, two- to three-seeded; seeds, black with black hilum, about 4,100 to the pound; germ, yellow; oil, 14.77 percent; protein 44.88 percent.

Osaya.—Introduced under F. P. I. No. 80465, native name, "Chusei O Saya Eda Mame," from Tokyo, Japan, in 1929. A large yellow-seeded variety said to be used principally as a green shelled bean. Maturity, about 115 days; pubescence, gray; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with pale-brown hilum, about 1,792 to the pound; germ, yellow; oil, 18.14 percent; protein, 46.30 percent.

Otootan.—Introduced from the Hawaiian Islands in 1911 by C. K. McClelland, Georgia Experiment Station. It is said to have come originally from Taiwan (Formosa), where it is used for soil improvement purposes. Maturity, about 175 days; pubescence, tawny; flowers, purple, appearing in 90 to 95 days; pods, two- to three-seeded; seeds, black with black hilum, about 6,150 to the pound; germ, yellow; oil, 16.44 percent; protein, 45.63 percent.

Ozark.—Introduced under F. P. I. No. 37272, from Seizen district, Kogen Province, Chosen, in 1914. Maturity, about 130 days; pubescence, tawny; flowers, purple, appearing in 60 to 65 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 2,800 to the pound; germ, yellow; oil, 18.63 percent; protein, 46.14 percent.

Palmetto.—Introduced under F. P. I. No. 71587 from Nanking, China, in 1927. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 90 to 95 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 3,408 to the pound; germ, yellow; oil, 16.85 percent; protein, 44.32 percent.

Pee Dee.—A selection, Coker's No. 31–15, developed from a cross of the Laredo and Otootan varieties by the Coker Pedigreed Seed Co., Hartsville, S. C. Maturity, 145 days; pubescence, tawny; flowers, purple, appearing in 85 to 90 days; pods, two- to three-seeded; seeds, black with black hilum, about 5,100 to the pound; germ, yellow; oil, 13.95 percent; protein, 43.28 percent.

Peking.—Selection (17852–B) at Arlington Farm in 1907, from the Meyer variety, F. P. I. No. 17852, received from Peking, China, in 1906. Maturity, about 125 days; pubescence, tawny; flowers, both purple and white, appearing in 55 to 60 days; pods, two- to three-seeded; seeds, black with black hilum, about 6,388 to the pound; germ, yellow; oil, 15.16 percent; protein, 38.65 percent.

Pine Dell Perfection.—Selection developed from natural hybrid by P. M. Griesenauer, Williamsburg, Va. Maturity, about 130 days; pubescence, tawny; flowers, purple, appearing in 60 to 65 days; pods, two- to three-seeded; seeds, black and brown, the colors usually in concentric bands, with black hilum, about 3,696 to the pound; germ, yellow; oil, 18.30 percent; protein, 40.25 percent.

Pinpu.—Introduced under F. P. I. No. 28050, native name, "Chin Yuan," from near Harbin, Manchuria, in 1910. Maturity, about 105 days; pubescence, gray; flowers, purple, appearing in 35 to 40 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,675 to the pound; germ, yellow; oil, 20.42 percent; protein, 39.98 percent.

Richland.—Selection (70502–2) made in 1927 at Arlington Farm from F. P. I. No. 70502, introduced from Changling, Manchuria, in 1926. Maturity, about 105 days; pubescence, gray; flowers, purple, appearing in 35 to 40 days; pods, mostly three-seeded; seed, straw yellow with light-brown hilum, about 3,232 to the pound; germ, yellow; oil, 19.60 percent; protein, 35.40 percent.

Rokusun.—Introduced under F. P. I. No. 80481, native name, "Rokusun Daizu," from Tokyo, Japan, in 1929. A large flat yellow-seeded variety said to be used as a green shelled bean. Maturity, about 140 days; pubescence, tawny; flowers, purple, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 1,584 to the pound; germ, yellow; oil, 18.07 percent; protein, 43.18 percent. This variety makes an excellent dry edible bean, cooking easily and having a good flavor.

Sato.—Introduced under F. P. I. No. 81041, native name, "Kuro Daizu," from Sapporo, Hokkaido, Japan, in 1929. A black-seeded variety said to be used as a green shelled bean and also in making sweet bean paste and candied beans. Maturity, about 115 days; pubescence, tawny; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, black with black hilum, about 1,488 to the pound; germ, yellow; oil, 17.48 percent; protein, 48.73 percent.

Scioto.—Selection from the Manchu variety by the Ohio Agricultural Experiment Station in 1925. Maturity, about 120 days; pubescence, tawny; flowers, purple, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, straw yellow with black hilum, about 2,960 to the pound; germ, yellow; oil, 22.24 percent; protein, 38.18 percent.

Shiro.—Introduced under F. P. I. No. 81036, native name, "Ao Shiro Daizu," from Sapporo, Hokkaido, Japan, in 1929. This variety is said to be used as a green shelled bean. Maturity, about 115 days; pubescence, tawny; flowers, white, appearing in 40 to 45 days; pods two- to three-seeded; seeds, olive yellow with black hilum, about 1,632 to the pound; germ, yellow; oil, 18.66 percent; protein, 42.27 percent.

Sioux.—Introduced under F. P. I. No. 81021, native name, "Aoshiro Eda Mame," from Sapporo, Hokkaido, Japan, in 1929. An early greenish-yellow variety said to be used as a green vegetable bean. Maturity, about 85 days; pubescence, tawny; flowers, purple, appearing in 30 to 35 days; pods, two-seeded; seeds, olive yellow with black hilum, about 3,000 to the pound; germ, yellow; oil, 15.69 percent; protein, 50.22 percent.

Sooty.—Selection (16790–B) at Arlington farm in 1907, from F. P. I. No. 16790, received from Hangchow, China, in 1905. Maturity, about 125 days; pubescence, both gray and tawny; flowers, both purple and white, appearing in 55 to 60 days; pods, two-, three-, or four-seeded; seeds, rusty black with black hilum, about 5,825 to the pound; germ, yellow; oil, 16.28 percent; protein, 41.60 percent.

Sousei.—Introduced under F. P. I. No. 80476, native name, "Sousei O Saya Eda Mame," from Tokyo, Japan, in 1929. This is said to be one of the earliest garden varieties of soybeans and to possess a sweet flavor when used as a green-shelled bean. Maturity, about 115 days; pubescence, tawny; flowers, purple, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 1,840 to the pound; germ, yellow; oil, 16.04 percent; protein, 48.38 percent.

Southern Green.—Introduced under F. P. I. No. 62839 from Nanking, China, in 1925. Maturity, about 145 days; pubescence, gray; flowers, white, appearing in 70 to 75 days; pods, two- to three-seeded; seeds, green with brown hilum, about 2,576 to the pound; germ, green; oil, 23.16 percent; protein, 40.87 percent.

Southern Prolific.—Introduced under F. P. I. No. 37250 from Keijo (Seoul), Chosen, in 1914. Maturity, about 135 days; pubescence, gray; flowers, purple, appearing in 65 to 70 days; pods, two- to three-seeded; seeds, straw yellow with light-brown hilum, about 2,350 to the pound; germ, yellow; oil, 19.50 percent; protein, 46.42 percent.

Soysota.—Introduced under F. P. I. No. 28019 from Dammann & Co., Naples, Italy, in 1910. Maturity, about 100 days; pubescence, tawny; flowers, purple, appearing in 30 to 35 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 4,900 to the pound; germ, yellow; oil, 19.86 percent; protein, 44.60 percent.

Suru.—Introduced under F. P. I. No. 89128, native name, "Tsurunoko," from Kyojyo, Chosen, in 1930. This variety is said to be used largely in making confections. Maturity, about 115 days; pubescence, gray; flowers, both purple and white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with pale hilum, about 1,320 to the pound; germ, yellow; oil, 21.57 percent; protein, 39.21 percent.

Tarheel Black.—Introduced under F. P. I. No. 14952 from Shanghai, China, in 1905. Maturity, about 140 days; pubescence, tawny; flowers, both purple and white, appearing in 70 to 75 days; pods, two- to three-seeded; seeds, black with

black hilum, about 2,710 to the pound; germ, yellow; oil, 17.76 percent; protein, 45.47 percent.

Toku.—Introduced under F. P. I. No. 86129, native name, "Toiku Shichigo Daizu," from Obihiro, Hokkaido, Japan, in 1930. Maturity, about 115 days; pubescence, gray; flowers, white, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 1,952 to the pound; germ, yellow; oil, 17.61 percent; protein, 42.97 percent.

Tokyo.—Introduced under F. P. I. No. 8424, native name, "Ita Mame," from Yokohama, Japan, in 1901. Maturity, about 140 days; pubescence, gray; flowers, purple, appearing in 70 to 75 days; pods, two- to three-seeded; seeds, olive yellow with pale hilum, about 2,260 to the pound; germ, yellow; oil, 19.27 percent; protein, 45.47 percent.

Virginia.—Selection (19186–D) from the Morse variety at Arlington Experiment Farm in 1907. Maturity, about 125 days; pubescence, tawny; flowers, purple, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, brown with brown hilum, about 3,455 to the pound; germ, yellow; oil, 19.82 percent; protein, 40.08 percent.

Waseda.—Selection (80461–1) made in 1929 at Arlington Experiment Farm from F. P. I. No. 80461, native name, "Wase Eda Mame," introduced from Tokyo, Japan, in 1929. Maturity, about 110 days; pubescence, tawny; flowers, purple, appearing in 45 to 50 days; pods, two- to three-seeded; seeds, straw yellow with pale to brown hilum, about 2,016 to the pound; germ, yellow; oil, 18.52 percent; protein, 43.40 percent.

Wea.—Introduced under F. P. I. No. 30600, native name, "Chin Yuan Tou," from Shuangchengfu, Manchuria, in 1911. This variety is said to be highly prized in Manchuria for its thin skin, heavy weight per bushel, and high oil content. Maturity, about 110 days; pubescence, gray; flowers, purple, appearing in 40 to 45 days; pods, two- to three-seeded; seeds, straw yellow with dark olive-brown hilum, about 3,246 to the pound; germ, yellow; oil, 21.89 percent; protein, 38.75 percent.

White Biloxi.—Selection developed from a natural hybrid by the Delta Branch Station, Stoneville, Miss., in 1925. Maturity, about 165 days; pubescence, tawny; flowers, purple, appearing in 85 to 90 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,230 to the pound; germ, yellow; oil, 17.05 percent; protein, 46.60 percent.

Willomi.—Selection (81044–1) made in 1931 at Arlington Farm from F. P. I. No. 81044, native name, "Akita Daizu," introduced from Hakodate, Hokkaido, Japan, in 1929. Maturity, about 115 days; pubescence, gray; flowers, purple, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, straw yellow with pale-brown hilum, about 1,312 to the pound; germ, yellow; oil, 18.31 percent; protein, 44.63 percent.

Wilson.—Introduced under F. P. I. No. 19183 from Yingkow (Newchwang), Manchuria, in 1906. Maturity, about 125 days; pubescence, both gray and tawny; flowers, both purple and white, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, black with black hilum, about 2,400 to the pound; germ, yellow; oil, 17.32 percent; protein, 44.00 percent.

Wilson-Five.—Selection (19183–5) from the Wilson variety at Arlington Farm in 1912. Maturity, about 125 days; pubescence, gray; flowers, purple, appearing in 50 to 55 days; pods, two- to three-seeded; seeds, black, with black hilum, about 5,025 to the pound; germ, yellow; oil, 16.04 percent; protein, 44.13 percent.

Wisconsin Black.—Received as Early Black by the Wisconsin Agricultural Experiment Station in 1898 and developed into a pedigreed strain. Maturity, about 100 days; pubescence, tawny; flowers, purple, appearing in 30 to 35 days; pods, two- to three-seeded; seeds, black with black hilum, about 3,085 to the pound; germ, yellow; oil, 16.39 percent; protein, 46.09 percent.

Woods' Yellow.—Selection from Mammoth Yellow variety at Williamson Farm, T. W. Wood & Sons' Experimental Farm, Amelia County, Va., in 1934. Maturity, about 135 days; pubescence, gray; flowers, white, appearing in 60 to 65 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 1,600 to the pound; germ, yellow; oil, 17.69 percent; protein, 44.73 percent.

Yelredo.—A nonshattering selection, Coker's 319, from a cross between the Mammoth Yellow and Laredo varieties developed by the Coker Pedigreed Seed Co., Hartsville, S. C.,Maturity, 165 days; pubescence, tawny; flowers, purple, appearing in 90 to 95 days; pods, two- to three-seeded; seeds, straw yellow with light-brown hilum, about 5,120 to the pound; germ, yellow; oil, 18.12 percent; protein, 45.17 percent.

Yokoten.—Introduced under F. P. I. No. 19981, native name, "Shiro Mame," from Yokohama, Japan, in 1907. Maturity, about 130 days; pubescence, gray; flowers, both purple and white, appearing in 60 to 65 days; pods, two- to three-seeded; seeds, straw yellow with brown hilum, about 2,175 to the pound; germ, yellow; oil, 19.50 percent; protein, 39.13 percent.

PREPARATION OF THE SEEDBED

The best results with soybeans are obtained on a well-prepared seedbed. In general the land should be prepared as for corn and, like corn, soybeans respond to any extra preparation of the soil. The seedbed is best prepared either by fall or early spring plowing which, followed by frequent harrowings or light diskings before seeding, kills the weeds just starting in the surface soil. Thorough and proper preparation of the soil will control to a great extent the weeds that otherwise would be likely to choke out the young plants or later in the season seriously cut down the production of seed. A firm seedbed with a light, loose covering of fine soil, well smoothed by the harrow, is conducive to uniform depth in seeding and to a good stand of plants. A soil free from clods insures the best results, especially when seeding in close drills, a method which may be desirable on the better types of soil and has become the practice generally for both hay and seed production in the Corn Belt.

In the preparation of a seedbed for soybeans, disking alone is seldom sufficient except after a crop of early potatoes or peas or after oat or wheat stubble where the soil is moist, mellow, and relatively free of weeds. Land plowed early and prepared properly for soybeans and cultivated thoroughly during the growing season furnishes an excellent seedbed for grains without further preparation. In such a rotation it is essential to have a variety of soybeans that will mature well ahead of the time for seeding the grain.

FERTILIZERS AND LIME

When soybeans are grown on land giving good yields of corn or when grown following corn, as is frequently done, they should produce a good crop without direct applications of fertilizers. The use of fertilizers, however, is recommended on sandy soils or soils of low fertility.

In general it has been found from extensive fertilizer experiments that the application of nitrogenous fertilizers is not necessary, as the soybean, like other legumes, when inoculated assimilates the free nitrogen of the air. On soils of low fertility, however, an application of manure or nitrate of soda, cottonseed meal, or some other nitrogenous fertilizer added to the fertilizer mixture will be found advantageous in starting the crop.

Investigations indicate that where fertilizers are needed, the best results are obtained with stable manure, or about 300 pounds of superphosphate and 25 to 50 pounds of muriate of potash (250 pounds of wood ashes, if the potash is not available). When neither wood ashes nor potash is available, superphosphate may be used alone to good advantage. In using commercial fertilizers it is advisable to work them well into the soil before seeding.

The soybean is not so sensitive to acid soils as are red clover, alfalfa, and many other crops. The application of lime on acid soils,

however, has been found invariably to increase the yield of hay and seed and the nitrogen content of both vines and seed. Liming apparently stimulates the production of nodules. The oil content of the seed, however, has been found to decrease and the protein content to increase in direct proportion to the quantity of lime applied.

INOCULATION

Like other legumes, such as clovers, alfalfa, peas, and beans, soybeans are able to utilize the nitrogen of the air through the action of bacteria on the roots. The presence of these organisms is indicated by the development of nodules or tubercles on the roots (fig. 3).

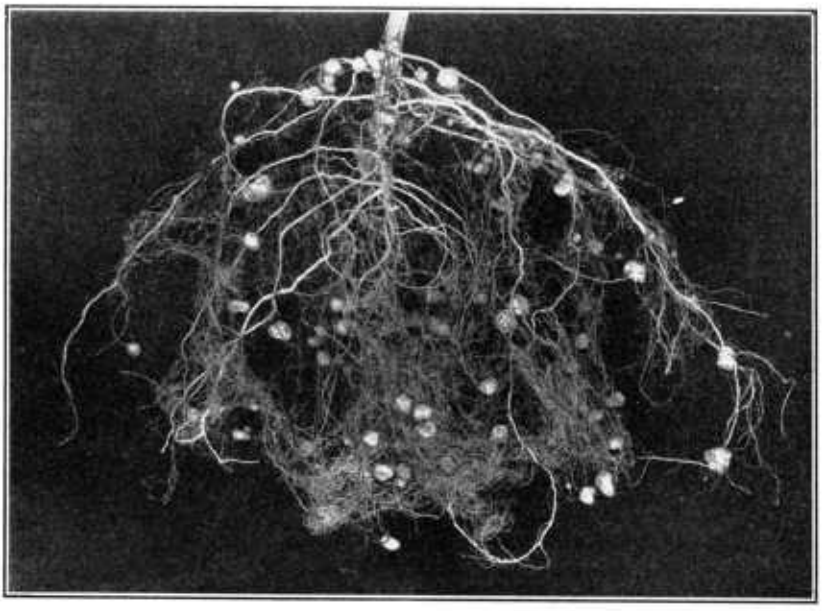

FIGURE 3.—Roots of a soybean plant, showing abundant development of nodules.

The bacteria of soybean nodules will not inoculate any other of the commonly cultivated legumes, nor will the bacteria found in the nodules of other legumes inoculate soybeans. Extensive bacteriological investigations have shown that some varieties of soybeans are more difficult to inoculate than others. Different strains of soybean bacteria have been isolated that show differences in virility with different varieties of soybeans.

Where the crop is grown for the first time, soybeans make a rather indifferent growth unless inoculated. The lack of inoculation is nearly always indicated by a pale- or yellowish-green color of the plant. The soybean, however, may give good results on fertile land even though the bacteria are lacking; on such land the plant draws most of its nitrogen from the soil rather than from the air, as it does when inoculated. Natural inoculation now occurs throughout

much of the region where soybeans are extensively grown. To obtain the best results when the crop is planted on land on which it has not been grown previously, it is advisable to inoculate.

Inoculation is most easily accomplished when the soil is neutral or alkaline. When a soil once becomes inoculated no further attention to this feature is necessary, provided a crop of soybeans is grown occasionally on the land. The Wisconsin Agricultural Experiment Station reports that in a fertile neutral loam, soybean bacteria were known to have lived more than 18 years; but as a rule the number of bacteria in a soil decreases rapidly after 2 or 3 years. The disappearance is more rapid in an acid than in a neutral or alkaline soil. At the Arlington Farm, fields were inoculated for soybeans about 30 years ago, and, although no bacteria have been applied since, soybean plants on any portion of the farm bear an abundance of nodules. The crop, however, has been planted at least once in 3 or 4 years on various fields.

Inoculation may be effected through the use of pure cultures of the bacteria or by the application of soil from a field where well-inoculated soybeans were grown the preceding year. Pure soybean cultures may be purchased from commercial seed firms, and many State agricultural experiment stations furnish them at cost. These cultures are applied directly to the seed shortly before seeding.

In former years the soil-transfer method was used, about 400 to 600 pounds of inoculated soil to the acre being broadcast and harrowed in. Although good results were obtained with this method, it involved considerable labor and also the possibilities of scattering weed seed and spreading plant diseases. Modified soil methods are now being used successfully. A common method consists of moistening 1 bushel of seed with a solution of 3 ounces of glue or sugar dissolved in 1 quart of water and thoroughly mixing 2 quarts of finely sifted, inoculated soil with the moistened seed. Another method is to make a thin mud of inoculated soil and apply it to the seed; or a bushel of seed may be thoroughly mixed with a gallon of finely sifted, inoculated soil. After soybeans have been inoculated in one field, soil may be taken from this field to inoculate others.

TIME OF SEEDING

Soybeans may be sown during a period extending from early spring until midsummer, depending largely on the latitude and the use to be made of the crop.

For a grain or main hay crop the best time for seeding is about corn-planting time, or when the soil has become thoroughly warm, as conditions then are most favorable for the best germination and rapid growth of the crop. Soybeans germinate and grow very slowly in a cold, wet, or dry soil. Early seedings require longer than late seedings to mature, the difference in the same variety amounting to 3 weeks or more. One of the principal objections to early sowing is the difficulty of working a seedbed sufficiently to kill weeds. Ordinarily there is no advantage in seeding earlier than corn-planting time, especially with the late varieties. For pasturage,

green manure, soiling, or even for hay, the soybean may be sown as late as August 1 in the Southern States and July 1 in the Northern States.

METHODS OF SEEDING

Various successful methods of seeding soybeans are employed in different regions where large acreages are devoted to this crop. Soybeans are sown either in rows sufficiently wide to allow cultivation or in close drills. Broadcasting the seed and covering with a harrow is seldom practiced and is not advisable. The method of seeding will be determined largely by convenience and economy of cultivation and harvesting, rate of seeding, variety used, type of soil, climatic conditions, and the purpose for which the crop is grown.

With the development of machinery adapted to soybean production, there has been a marked change in methods of planting during the past few years, especially in the Corn Belt. Experience shows that factors favoring the seeding of soybeans in rows are higher yield of seed and hay, larger beans, more uniform stand, higher percentage of foliage, less lodging, lower seed requirements in planting, and less chance of poor results in the case of inexperienced growers. Drilling in close rows, however, has some important advantages, such as producing a finer quality of hay, eliminating the need for special machinery, and decreasing the cost of production.

For seed production, under nearly all conditions the crop should be grown in rows and given sufficient cultivation to keep down the weeds. In some sections, especially in the Southeast, the row method is also employed in the production of forage. In that section it is a common practice to grow the corn in rows from 6 to 7 feet apart, with rows of beans for seed production alternating between. Rows from 24 to 36 inches apart usually give the best results on fertile soils, but rows from 36 to 42 inches are most satisfactory on medium fertile and poor soils. In some sections the highest yields of seed have been obtained from rows 21 to 30 inches apart. In the Southern States, where the larger and later varieties are used, soybeans are usually sown in rows 3 to 4 feet apart. Where the combine is to be used some objection has been found to soybeans grown in rows because of the tendency to ridge the land during cultivation; care should be exercised to keep the surface soil level if a combine is to be used in harvesting. In the Corn Belt, experienced growers who use proper cultural methods are able to produce a crop of hay or seed more economically in close drills than in rows.

For hay, soiling, or green manure the soybean is usually sown in close drills. If the land is free from weeds or is given a thorough cultivation with the harrow, weeder, or rotary hoe when the weeds are small, larger yields and a finer quality of forage will be obtained by drilling in close rows. The main objections to this method are the larger quantities of seed required, the increased competition of weeds in cold, wet seasons, and the decrease in yields of seed and forage under drought conditions.

When soybeans are to be seeded with corn for silage or pasture, various methods of growing are practiced. The beans may be sown

in the same hill with the corn, in the same row with corn but in alternate hills, in alternate rows with corn, or with two rows of corn and two of soybeans alternating. The corn may be checked and the beans either checked with the corn or drilled, or both the corn and beans may be drilled. In the Southern States, especially in North Carolina, at the last working of the corn soybeans are sown broadcast for hog pasture. North of the Cotton Belt, soybeans sown at the last cultivation of corn seldom make a satisfactory growth.

The ordinary grain drill (fig. 4) furnishes perhaps the most satisfactory means for sowing in rows or in close drills. The space between rows may be adjusted by covering the feed cups not wanted.

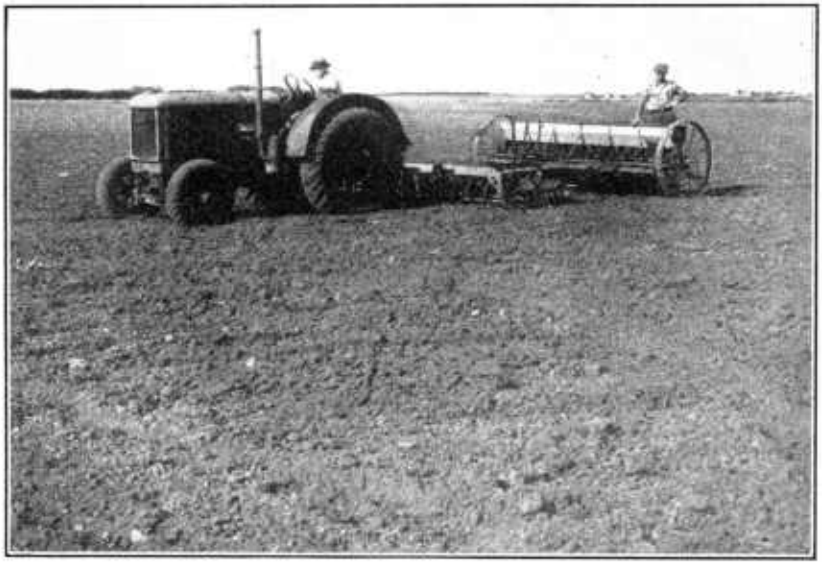

FIGURE 4.—The ordinary grain drill may be used for sowing either in rows or in close drills.

To prevent splitting the seed, the oats feed should be used. Corn planters are also very generally used for sowing soybeans either alone or with corn, as most of the modern planters have special plates for soybeans, or a special soybean attachment can be obtained for the planter. The practice of mixing corn and soybeans and drilling from the same grain box does not give very satisfactory stands of either crop. This may be overcome to some extent by using a small quantity of seed and stirring frequently, or by using a mixture of one-third soybeans and two-thirds corn and keeping the mixture uniform by occasional stirring. To insure even distribution for silage, the practice of seeding the corn in checks and the soybeans with a hand planter one way between the corn hills gives excellent results. In some sections the corn is drilled in first, followed by drilling the beans. In the Southern States the cotton planter is used extensively. The sugar-beet drill may be used to advantage for drilling soybeans in rows.

Within the past few years the seeding of one or two drill widths of soybeans about fields of corn has become a common practice in several areas of the Corn Belt (fig. 5). When the corn is cultivated, the land in soybeans permits the turning of cultivators at the ends of the corn rows without damage to the corn and practically no injury to the soybeans. Later the soybeans are harvested for hay, leaving ample room for the harvesting of the corn without loss at the row ends.

FIGURE 5.—One or two drill widths of soybeans are frequently sown about a field of corn as an aid in cultivation of the corn.

RATE OF SEEDING

The quantity of seed to be sown to the acre will necessarily vary somewhat according to the variety or size of seed, method of planting, viability of the seed, character of the soil, climatic conditions, and the purpose for which the crop is grown. Because so many factors are involved, no standard rule can be given as to the exact quantity of seed to be used under general conditions. Extensive investigations indicate that the rate of seeding can vary more or less without greatly affecting the yield of forage or seed.

Varieties of soybeans differ widely in size of seed, ranging from 1,232 to the pound for the Hokkaido to 9,950 to the pound for the Barchet. Furthermore, the size of the seed in the same variety will vary somewhat in different seasons and in different localities, depending largely on soil and seasonal conditions.

Much heavier rates of seeding are practiced in those sections where the weeder, harrow, or rotary hoe is used for cultivation. Heavier rates of seeding allow for a certain loss of plants that may result from thorough cultivation, and produce higher yields of finer forage. Heavier seedings are generally practiced in moderately fertile to very productive soils, but in the less fertile soils and under dry conditions lighter rates should prevail.

Good soil-management practices, such as the growing of sod crops or soil-building legumes before the soybean crop, are beneficial in reducing erosion, increasing soybean seed yields, and controlling some of the soil-borne diseases that attack the crop. The soybean crop then leaves the soil in a good mellow condition for the succeeding crop.

PREPARATION OF SEEDBED

The successful production of soybeans is dependent in part on a well-prepared seedbed. Land should be prepared as carefully for soybeans as for corn, and, like corn, soybeans respond to any extra preparation of the soil. The seedbed is best prepared by either fall or early spring plowing, which, followed by frequent harrowings or light diskings before seeding, kills the weeds starting in the surface soil. Spring plowing is favored by most of the experienced growers because soybeans frequently follow corn, which often is not harvested

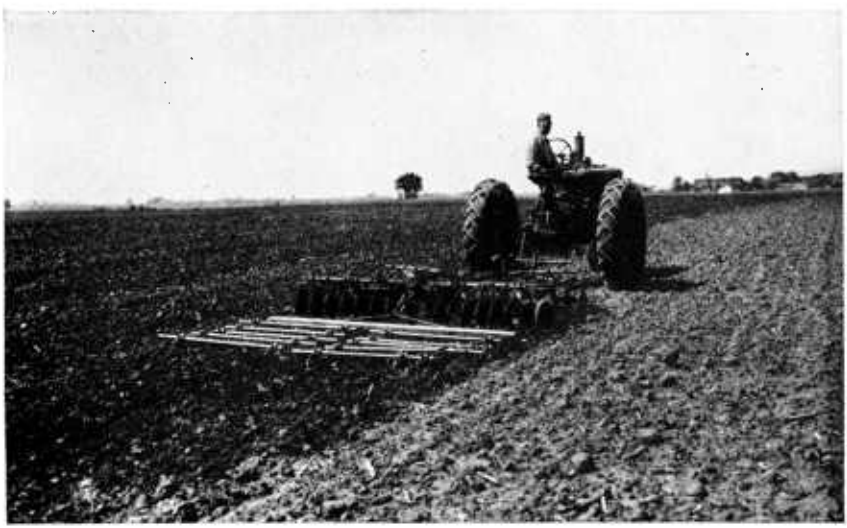

Figure 5.—A well-prepared seedbed is conducive to uniform depth of planting and a good stand of soybeans.

in time for fall or early winter plowing, and also the cornstalks remaining on the surface have some value in erosion control. Thorough and proper preparation of the soil will to a great extent control weeds that otherwise would be likely to choke out the young plants or cut down seriously the production of forage or seed later in the season. A firm seedbed with a light, loose covering of fine soil, well smoothed by the harrow (fig. 5), aids in seeding to a uniform depth and in obtaining a good stand of plants. A soil free from clods insures the best results, especially when seeding is done in close drills.

In the preparation of a seedbed for soybeans, disking alone is seldom sufficient except after a crop of early potatoes or peas or after oat or wheat stubble where the soil is moist, mellow, and relatively free of weeds. Land plowed early and prepared properly for soybeans and cultivated thoroughly during the growing season makes an ex-

young plants appear. If the soil is of a heavy type and forms a hard crust after a rain, a light cultivation with the rotary hoe or harrow should be given to break the crust.

When soybeans are sown in close drills for hay or grain, the weeder, harrow, or rotary hoe may be used if necessary until the plants are 8 to 10 inches high. Experience has shown that the cultivation of drilled or broadcast seedings will give much larger yields of hay with a smaller percentage of weeds. If the weeds are allowed to get started, the weeder and harrow are quite effective in killing them. The rotary hoe is a valuable implement to cultivate both closely drilled and row seedings. It is especially suitable for working soil that is packed, and it gives excellent results when followed by a weeder or a harrow.

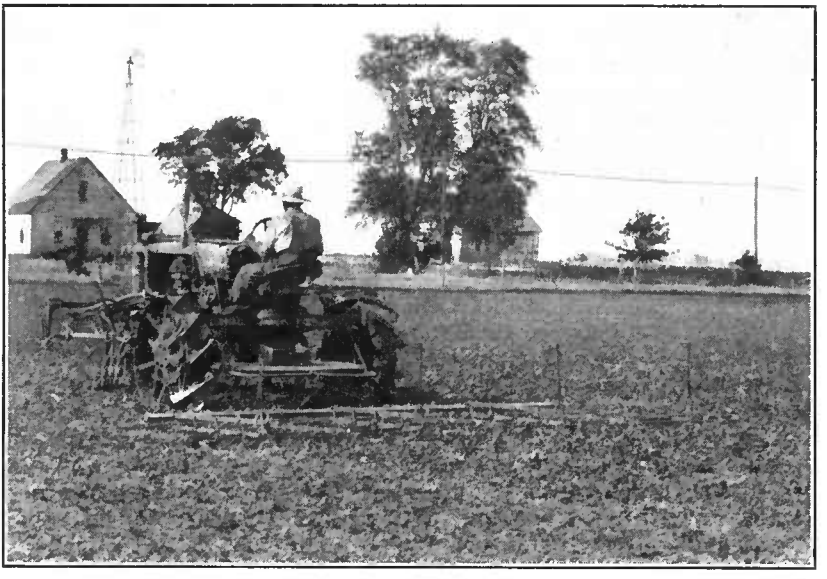

FIGURE 6.—The spike-tooth harrow, with teeth slanting backward slightly, is used extensively in cultivating soybeans.

In using the spike-tooth harrow (fig. 6), the teeth should be slanted backward slightly, and the cultivations should be across the rows.

Soybeans in rows are usually cultivated with the ordinary corn cultivator, the two-horse corn cultivator being the most commonly used and the most satisfactory implement generally available for this purpose. However, the weeder, harrow, or rotary hoe may be used as for solid seedings in the early stages of growth, thereby reducing later work with the cultivator. The sugar-beet cultivator gives excellent results when the beans are grown in narrow rows.

Cultivation of soybeans should be frequent enough to keep down weeds. At the blooming stage they should produce sufficient shade to control the growth of weeds. Comparatively little injury results if they are cultivated during the heat of the day when the plants are tough. If continued after flowering, cultivation may cause injury to the blossoms and reduce the seed yield by breaking the branches. It

is not advisable to cultivate soybeans when they are tender from rain or dew, as the plants are then easily bruised or broken. Usually two or three cultivations after the beans are up will be sufficient. Level cultivation is preferable, as it makes harvesting easier.

SOYBEANS IN ROTATIONS

The soybean may be used advantageously as either a grain crop or a hay crop in many systems of crop rotations, but no standard rotation can be given that will apply to every farm. The place of the soybean in any rotation system will depend on the soil, the purpose for which the crop is grown, and the other crops used in the rotation. The soybean is especially valuable in short rotations with corn, cotton, and small grains as an entire-season or a part-season crop. When the whole season is devoted to soybeans, they may occupy any place in a rotation where corn can be used. In regions where cowpeas are grown soybeans are adapted to practically the same place in rotations as cowpeas.

When small grains follow soybeans, little preparation of the soil is necessary for seeding the grain. In some sections a soybean crop is grown between two wheat crops or two oat crops. A rotation of corn, soybeans, wheat, and clover is very common north of the Ohio River. Soybeans may be profitably substituted for oats in such rotations as corn, oats, wheat, and clover, or potatoes, oats, wheat, and clover.

Results obtained over a period of 15 years in the rice-growing district of Louisiana show that where the soybean has been grown in rotation with rice, weeds, especially red rice, have been eradicated, a better quality of soybean seed has been produced, and the yields of rice have been greater than where commercial fertilizers were used.

The soybean can also be used as a catch crop where new seedings of grass and clover have failed and on wheat- or oat-stubble fields where clover or grass has not been sown. As a crop after early potatoes or canning peas and as an orchard cover crop, the soybean is highly recommended, because it will produce a larger quantity of fall pasturage or material for plowing under on soils in need of organic matter.

SOYBEANS IN MIXTURES

Soybeans may be satisfactorily grown in combination with other crops, such as corn, cowpeas, Sudan grass, Johnson grass, and sorghums. The chief advantage of the mixture is the production of better balanced feed, and the yields are often somewhat better than when the crops are grown separately. When used for hay, the mixture is more easily cured. The practice of combining soybeans with other crops, especially corn, has increased very rapidly during the past few years, indicating that the results are highly satisfactory.

SOYBEANS AND CORN

Soybeans are more generally grown with corn than with any other crop (fig. 7). When grown with corn, the mixture is commonly used for pasturage or silage. In some of the Southern States, however, corn and soybeans are grown in alternate rows for seed production.

FIGURE 7.—Soybeans seeded in the same row with corn. They are more generally grown with corn than with any other crop.

Extensive investigations have been carried on by various experiment stations to determine the results that may be expected from a mixed planting of soybeans and corn. Experimental results show that the yield of corn is invariably reduced, especially the grain, from 5 to 25 percent or more, the decrease depending on the soil, seasonal conditions, and method and rate of planting. The smaller yield of corn may be partly compensated for by the yield of soybeans. In general, the yield of soybean seed has not equalled the loss of corn, but the mixed crop has produced more nitrogen than corn alone.

SOYBEANS AND COWPEAS

Soybeans and cowpeas in combination make a very satisfactory mixture for hay, pasture, or green manure. The yield of this mixture is nearly always greater than that of either crop alone, and the curing of the cowpeas is easier because of the soybean plants. Varieties of these crops that mature at about the same time should be used. Such varieties of cowpeas as the Whippoorwill, New Era, and Groit can be grown to good advantage with Wilson, Peking, Wilson-Five, and Virginia soybeans for forage purposes. Later varieties of cowpeas, such as Unknown (Wonderful), Brabham, Iron, and Red Ripper, should be grown with varieties of soybeans maturing at the same time as the Mammoth Yellow.

In sowing a mixture of soybeans and cowpeas it is best to have more soybean plants than cowpeas so that the vining cowpeas may have support. From 1 to 1½ bushels of soybeans and ½ to 1 bushel of cowpeas are required per acre in close drills, whereas in 3-foot

rows, one-half of these quantities is sufficient. The ordinary grain drill is the best implement for seeding.

The time of cutting this combination for hay will depend on the relative growth of the two crops. Both plants should be cut at that stage of growth giving the best quality of hay, which is when the soybean seed is one-half to full-grown and the first pods of the cowpeas are mature.

SOYBEANS AND SUDAN GRASS

Sudan grass is an excellent crop for growing in combination with soybeans for hay (fig. 8). The best results with this mixture are obtained in the regions most suitable for soybeans or where irrigation

FIGURE 8.—A field of soybeans and Sudan grass grown in mixture for hay.

is possible, under which conditions not only a better yield but a better balanced forage is obtained, as the Sudan grass is low and the soybeans high in protein. Under semiarid conditions, Sudan grass invariably crowds out the soybeans. The harvesting of the mixture is not difficult, as the erect, stiff stems of the Sudan grass support the soybean plants, which tend to vine more or less when grown in combination with tall-growing crops. The mixture should be cut for hay about the time the Sudan grass is in full bloom.

The seeding of Sudan grass and soybeans as a main hay crop has increased rapidly during the last few years. Extensive tests carried on by several experiment stations show the yields to range from 2 to 4 tons to the acre. Good results are obtained by seeding with a grain drill about 60 pounds of soybeans and 10 pounds of Sudan grass to the acre. Another method practiced successfully is to first plant the soybeans in rows at the usual rate of seeding. The land should be kept free of weeds by level, shallow cultivation until the plants are about 6 inches high. Sudan grass should then be seeded between the

rows, either drilled or broadcast, at the rate of 20 to 25 pounds to the acre, according to the fertility of the soil, and worked lightly into the soil.

SOYBEANS AND MILLET

Soybeans and millet are not especially recommended as a mixture. The millet matures earlier than any of the better varieties of soybeans. The best results have been obtained by drilling in close rows 1 bushel of such varieties as the Wilson or Virginia soybeans and 20 pounds of millet to the acre.

SOYBEANS AND SORGHUM

Soybeans may be grown in combination with sorghums for hay, as a soiling crop, or for silage. Such varieties of soybeans as the Virginia, Kingwa, or Peking and either the Amber or Orange varieties of sorghum are best suited for this mixture. The best results are obtained in cultivated rows, as the sorghum is likely to choke the soybeans when sown broadcast unless the sorghum is sown thinly. When sown in rows, about 15 pounds of sorghum and 45 pounds of soybeans per acre will be sufficient.

SOYBEANS DRILLED IN SMALL GRAINS

Investigations at the Missouri Agricultural Experiment Station indicate that the drilling of soybeans in grain crops is a practical method of growing soybeans in southeastern Missouri and that the grain yields are not reduced by this method. Adverse weather conditions may cause a partial or total failure of the bean crop, but over a period of years fairly good average yields have been obtained. This method has been tried in other sections of the State but with little or no success. Usually wheat has been planted as a companion crop with soybeans because it is generally more profitable than other grains; on poor sandy land, rye is superior to wheat for this purpose. Oats can be made a satisfactory companion crop by seeding evenly at a moderately low rate on a well-prepared seedbed. The beans may be sown in wheat at any time in the spring after the soil is reasonably warm and until the grain begins to joint. In the Missouri investigations, it was found that the Laredo, Virginia, and Wilson were the best varieties for growing in combination with grain, the rate of planting the beans being governed by a number of factors. If the land is in good condition and reasonably warm, 75 pounds of seed of the Wilson or Virginia type is sufficient. For early planting or for planting on a poor seedbed where the beans cannot be covered properly, this rate should be increased.

At the Tennessee Agricultural Experiment Station soybeans have been seeded on winter oats for several years in late March, the grain drill being set for a shallow sowing. The Tokyo and Laredo varieties were used, both varieties making some growth before the oats were harvested. The Tokyo, however, made sufficient growth to interfere with cutting. Three advantages of this practice were found: It gives good yields of soybean hay; keeps the soil occupied with a growing crop during the time of the year when heavy rains occur, thus reducing soil erosion; and eliminates the cost of an extra

plowing and seedbed preparation. These tests were conducted on fertile soil in years of good rains in April and May. The practice has not been tested on poor soils, nor in years of low rainfall during these months.

Laredo and Otootan soybeans have been successfully grown when planted with a grain drill in fall-sown oats the last of March or the first of April at the Delta branch station of the Mississippi Agricultural Experiment Station. The practice of growing a soybean crop and oat crop on the same land the same year was found a very economical method of producing feed and building up Delta soils.

COST OF PRODUCTION

The income from soybeans is largely a matter of yields produced and market prices. Profits depend, of course, on the differences between production and income. Not only is the acre cost of producing soybeans affected by the growing and the harvesting methods used, but the yield of beans or hay is also affected and, consequently, the unit cost per bushel of beans or ton of hay. Cost figures continually show wide variations from farm to farm even where conditions are similar. The total cost of the hay crop is less variable than that of the seed crop because it does not include the cost of threshing, which is an important item for the seed crop and differs widely from one locality to another.

INSECT ENEMIES OF SOYBEANS[2]

Soybeans usually are comparatively free from serious insect pests. It is probable that when this crop is more extensively grown, insect enemies will multiply and new foes of the plant will develop. At present, however, the seriously injurious kinds may almost be counted on the fingers of one hand. They are grasshoppers, blister beetles, leafhoppers, the green clover worm, and the velvetbean caterpillar.

GRASSHOPPERS

Grasshoppers attacking soybeans belong to the species commonly injurious to alfalfa throughout the country, such as the red-legged (*Melanoplus femur-rubrum* DeG.), lesser migratory (*M. mexicanus* Sauss.), and differential (*M. differentialis* Thom.) grasshoppers. They are more likely to become injuriously numerous in semiarid climates, but during dry summers they may multiply sufficiently to cause serious injury wherever soybeans are grown. Fortunately, grasshoppers attacking soybeans may be destroyed by means of the usual remedy, which consists in the application of poison-bran bait prepared as follows:

Wheat bran	pounds	50
Crude arsenic	do	2
or sodium arsenite (liquid)	quart	1
Water	gallons	6

The poison and the bran should be very thoroughly mixed while dry. Water is then added to make a damp but not sloppy mash.

[2] Revised by C. M. Packard, principal entomologist, Division of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine.

When sodium arsenite is used it should be mixed with the water before this is added to the bran. The bran should be thoroughly dampened, but should not be wet enough to interfere with ease in distribution. This bait should be scattered broadcast thinly and uniformly at the rate of about 8 to 10 pounds (wet weight) to the acre. If the bait is distributed in lumps there may be danger of poisoning fowls or farm animals, but there is no danger whatever of this when it is properly distributed. The best time for scattering the bait is in the early morning.

BLISTER BEETLES

In recent years blister beetles of several species (*Epicauta vittata* Fab., *E. pennsylvanica* DeG., *E. lemniscata* Fab.) have been so injurious to soybeans in some of the Southern and Western States as to occasion considerable alarm. The beetles usually appear very suddenly and feed so rapidly as to strip the plants completely in a short time. The young, or larvae, of these beetles devour the eggs of grasshoppers, and in this respect the insects are of considerable benefit. When the adult beetles attack crops they may be destroyed effectively by dusting the infested plants with a mixture of equal parts of powdered sodium fluosilicate and hydrated lime at the rate of about 15 pounds to the acre. Sodium fluosilicate is a comparatively new insecticide, which is a byproduct of the manufacture of superphosphate and is poisonous to man in about the same degree as is arsenic. When applied as recommended, this insecticide kills the beetles within 24 hours and the plants suffer no appreciable injury. Arsenic in any form is not very effective for these insects. Where soybeans are being grown for hay they may be cut immediately and thus saved from the beetles, but in this case very prompt action is necessary as blister beetles feed rapidly and may consume most of the crop before it can be cut.

LEAFHOPPERS

Among the more common leafhoppers attacking soybeans are the potato leafhopper (*Empoasca fabae* Harriss) and a species known as *Agallia sanguinolenta* Prov., which has no common name. These insects puncture the leaves with their beaks and feed on the sap of the plants. They cannot be combated successfully by the application of arsenical insecticides, but require the use of contact poisons, most of which are more or less expensive to use. A mixture of one-half pint of 40-percent nicotine in 50 gallons of soapy water applied as a spray should be effective when used against these insects on soybeans, although very little experimental work has been done with leafhoppers on this crop. The young or wingless forms are killed readily by this mixture, but the adult insects do not succumb so easily. Bordeaux mixture has been found to give protection when used as a spray against leafhoppers on field and garden beans, but little is known regarding its effects when applied to soybeans.

GREEN CLOVER WORM

The green clover worm (*Plathypena scabra* Fab.), which is the caterpillar of an inconspicuous, soot-colored moth, feeds on a variety

of plants of the bean family and ordinarily escapes the notice of growers. In 1919, however, it caused widespread injury to soybeans in the South Atlantic coastal plain. Many fields were so defoliated that they did not produce a crop. The following year the insects were present in smaller numbers. The green clover worm is always present in the region mentioned, however, and may at any time become numerous enough to repeat the severe injury of 1919. In case this worm becomes abundant, its control may be accomplished by dusting with the following mixture:

Lead arsenate (powdered)	pound	1
Hydrated lime	pounds	8

This dust should be applied evenly but thinly at the rate of about 18 pounds to 1 acre of soybeans. Any efficient form of hand or power duster may be used. It is possible to apply such a dust by hand, but this is a tedious process and requires considerably more of the dust than if a machine is used.

The poison should be applied as promptly as possible after the infestation is noticed. Unless the beans are cut for forage very soon after the poison is applied there is no danger of poisoning stock in feeding. Where early use of the crop as forage is intended, it may be saved by immediate cutting without applying the poison dust.

VELVETBEAN CATERPILLAR

The velvetbean caterpillar (*Anticarsia gemmatilis* Hbn.) is the young stage of a night-flying moth that is incapable of surviving the winter in continental United States.

In Louisiana, however, it may produce as many as three generations in a single season, and since 1929 it has done serious injury to soybeans in Louisiana, Mississippi, Alabama, and Georgia.

The full-grown caterpillar is about 1½ inches in length and usually black but sometimes green in ground color. It bears a middle stripe of green on the back and from one to three light stripes along the sides. However, the under side, or belly, is always dark.

The caterpillars begin feeding on the tender leaves near the tops of the plants, working downward and devouring the leaves and buds completely as they go. Even the tender stems, together with the developing pods, may be devoured. Soybeans seem to be the favorite food plant in the Gulf States, although cotton, horsebeans, and kudzu are recorded as being fed on to some extent.

Control of this insect may be secured by dusting soybeans with cryolite (sodium fluoaluminate) either natural or synthetic, and preferably of the light or 80 percent grade. This dust should be applied at the rate of from 10 to 20 pounds per acre on soybeans of medium size. It is rather important that dusting is done only while the plants are dry, as otherwise slight burning may result. A second application of dust may be necessary about 10 days later in order to destroy the newly hatched caterpillars.

Soybeans planted for hay may be saved without applying poison by cutting them promptly when the caterpillars appear in them. The late varieties of soybeans, such as Otootan, have been most seriously attacked, whereas the earlier ones, such as Palmetto and Laredo, have been observed to escape injury.

Other insects may cause considerable damage to soybeans. Most of the caterpillars that feed habitually on legumes, such as alfalfa, clover, and cowpeas, will feed occasionally on soybeans. Among these are the armyworm, the garden webworm, and the rose leaf tier. Most of the beetle enemies of alfalfa, clover, and garden beans may be expected to feed on soybeans to some extent when their welfare or survival requires it. Aphids occasionally are troublesome, but their attacks usually are sporadic and seldom can be met successfully.

ARMYWORMS AND OTHER CATERPILLARS

Nearly all caterpillars that feed on soybeans may be destroyed by similar methods. As they swallow large quantities of the leaves, it is possible to poison them quickly by applying to the plants any safe arsenical poison that may be available. Of such poisons, arsenate of lead is perhaps the least likely to burn the plants. When used as a spray, 1 pound of powdered arsenate of lead to 50 gallons of water is effective for caterpillars, such as the armyworm (*Cirphis unipuncta* Haw.), the fall armyworm (*Laphygma frugiperda* S. and A.), the corn earworm (*Heliothis obsoleta* Fab.), or other climbing cutworms, when feeding on forage crops.

Where it is desired to destroy armyworms of either kind without applying the poison directly to the soybeans, this may be accomplished by distributing the poisoned bait as recommended for the destruction of grasshoppers but with the addition of molasses, 1 gallon to 50 pounds of bran. This bait is a standard insecticide for such caterpillars and usually is very effective. It is, of course, necessary in all cases to apply such remedies before the plants have been defoliated. Immediate cutting of the crop is recommended where the soybeans are grown for hay.

Caterpillars that feed within webs, such as the garden webworm, are difficult to control with poison. Where a crop is being raised for hay and becomes infested with caterpillars immediate cutting is recommended.

MEXICAN BEAN BEETLE

Soybeans sometimes are attacked by the Mexican bean beetle (*Epilachna varivestis* Muls.), although it evidently prefers other legumes as food. It is very possible that in time this insect may become adapted to soybeans and become a serious pest. When it becomes necessary to protect the crop against attacks of this insect and the plant is not being grown for hay, it may be sprayed with cryolite (sodium fluoaluminate), either natural or synthetic, in proportion of 3 pounds in 50 gallons of water. As the Mexican bean beetle feeds on the under surfaces of the leaves, it is necessary to adjust the spray nozzles so as to apply the spray to these parts of the plants. The spray should be applied at the rate of 90 to 100 gallons to an acre. When the crop is to be used for hay and becomes infested, immediate cutting is recommended.

OTHER BEETLE ENEMIES

Among the other beetles that occasionally attack soybeans is the clover root curculio (*Sitona hispidulus* Fab.). It is a small beetle

with a grayish snout which lives normally on clover and alfalfa. It gnaws the buds and foliage of soybeans and other legumes and may injure the crowns and roots of the plants. When this insect is numerous it is advisable to plant soybeans in rotation with corn or cotton.

The bean leaf beetle (*Cerotoma trifurcata* Forst.) occasionally feeds on soybeans as well as cowpeas and garden beans. It resembles in a general way the spotted cucumber beetle. The larvae of this insect may also feed on the nitrogenous nodules on the roots of the plants. The adults gnaw holes in the leaves and may be poisoned with arsenate of lead, as recommended for caterpillars, or with cryolite, as recommended for the Mexican bean beetle. These poisons should be applied as soon as the beetles appear. Where grown for hay, infested soybeans may be saved by being cut immediately.

Flea beetles (*Systena blanda* Melsh. and others) of several species are especially numerous in the Gulf States, and frequently attack soybeans. They may be repelled or poisoned, where necessary, by the foregoing methods.

CHINCH BUGS

The chinch bug (*Blissus leucopterus* Say) does not feed on soybeans, and there is good evidence to show that injury to corn by this insect is considerably lessened by the practice of growing soybeans with the corn. The chinch bug thrives best in locations that are dry and warm. A fatal fungus disease attacks it under humid conditions, and where soybeans are grown with corn they produce a dense shade about the lower parts of the plant that is unfavorable for the bugs. Extensive experiments conducted by the Illinois Agricultural Experiment Station demonstrated that the bugs were much less numerous on corn grown with soybeans than on corn grown alone. Fields planted to soybeans and corn produced good crops, whereas in adjoining fields of corn alone the crop was destroyed or very severely injured.

SOYBEAN DISEASES[8]

Although the soybean is affected by several destructive diseases in Asiatic countries, no disease of this plant has yet assumed any great economic importance in the United States. It is attacked here, however, by fungus, bacterial, and virus diseases. Some of these diseases are of sufficient consequence to deserve more attention than has hitherto been given them by plant pathologists and agronomists. Undoubtedly failure to give due recognition to the prevalence of these diseases may cause severe losses as the seed sources become more highly infested. Effective control measures should be studied, and varieties possessing inherent high resistance to the more serious diseases developed.

PURPLE SPOT

Purple spots on soybean seed have been reported from various sections of the United States. This disease has been ascribed by various Japanese investigators to *Fusarium*, *Cerosporina*, or to purely physiological factors, respectively. One of the investigators

[8] Prepared with the advice and cooperation of H. W. Johnson, pathologist, Division of Forage Crops and Diseases, Bureau of Plant Industry.

was inclined toward the third theory, as he was able largely to eliminate the disease by cultural practices.

In the United States purple spot has been noted during the seasons when rainfall was above normal at the time the seed was maturing. Seed with purple spot, when planted and grown during a normal season, showed no signs of the disease.

BACTERIAL BLIGHT

Bacterial blight (*Bacterium glycineum* Coerper) has been reported from various parts of the United States. This disease occurs commonly on the leaves as small angular spots which are first yellow or light brown in color and later become dark brown to nearly black. These spots may also occur on the stems and pods. The diseased tissues may eventually become dry and drop out, giving the leaves a ragged appearance. Under favorable conditions, it spreads rapidly from the point of original infection to adjacent plants. Investigations show that the bacteria are seed-borne and also survive in dead leaves until the next growing season. Studies indicate that soybean varieties vary greatly in their relative susceptibility to bacterial blight, the Midwest variety being especially susceptible.

Another bacterial blight caused by *Bacterium sojae* Wolf has been found in North Carolina. This disease resembles that caused by *B. glycineum* so closely that it is doubtful whether they could be differentiated with certainty in the field.

BACTERIAL PUSTULE

Bacterial pustule (*Bacterium phaseoli* var. *sojense* Hedges) is quite distinct from bacterial blight and other bacterial diseases of the soybean. In the later stages this disease is characterized by angular, reddish-brown spots on the leaves ranging in size from small specks to large, irregular, brown areas. Yellow margins often occur around the brown areas. Frequently the leaves have a ragged appearance owing to the dropping out of portions of the larger spots. Although the disease is confined chiefly to the foliage, the pods may also become infected and show spotting similar to that on the leaves. In studies on varietal resistance of the soybean to the bacterial pustule disease at the North Carolina Agricultural Experiment Station, the Columbia and Lexington varieties were found to be entirely free from the disease; other varieties possessed varying degrees of resistance. This disease is prevalent in North Carolina and is known to occur also in Texas, Louisiana, South Carolina, Virginia, Arkansas, Delaware, and Kansas.

MOSAIC

Soybean mosaic, a virus, has been reported from several States, and in Illinois it has been listed as one of the most common and destructive diseases of the soybean. Although the symptoms resemble those characterizing mosaic diseases in general, soybean mosaic is not known to infect any other plant. Plants affected with mosaic become stunted, petioles and internodes are shortened, and leaflets are mis-

shaped and puckered with dark-green puffy areas along the veins. The pods are stunted and flattened, and the yield of seed is materially reduced. The disease is seed-borne, and the virus is still viable in seed 2 years old. Studies at the Indiana Agricultural Experiment Station showed that varieties differ widely in regard to susceptibility. Mosaic appears to be most prevalent in Midwest, Haberlandt, and Black Eyebrow varieties, the Midwest proving very susceptible. Soysota and Virginia have escaped infection. It was also found that varieties seem to differ in their ability to transmit mosaic through the seed.

FUSARIUM BLIGHT OR WILT DISEASE

Investigations have shown that the fusarium on soybeans is identical with the organism *Fusarium bulbigenum* Cke. and Mass. var. *tracheiphilum* (E. F. S.) Wr. producing the wilt of cowpeas. The disease is characterized by a chlorosis and shedding of the leaves or leaflets, followed by the death of the plants. It has been observed in several localities in North Carolina on soils infested with cowpea wilt and reported also in Louisiana and Alabama. Infection is thought to occur through the roots. The character of the soil appears to influence the amount of infection, the largest proportion of diseased plants occurring in coarse, sandy soils. Root rots caused by *Rhizoctonia* and *Sclerotium rolfsii* Sacc. and other root injuries are believed to increase materially the percentage of diseased plants in the field. In susceptibility studies of different soybean varieties at the North Carolina Agricultural Experiment Station the Black Eyebrow variety showed marked resistance. The Mammoth Brown and Haberlandt varieties, although not free from the disease, showed a high degree of tolerance and matured a fair crop of seed. In South Carolina on infested soil, the Laredo, Palmetto, Monetta, Creole, Charlee, and Clemson appeared highly resistant to wilt.

FROGEYE LEAF SPOT

Frogeye leaf spot, caused by the fungus *Cercospora daizu* Miura, attacks chiefly the leaves, frequently the pods, and to some extent the stems of the soybean plant. It also goes through the pod and enters the coat of the seed. The fungus winters over on diseased stems, leaves, and pods left in the field after harvest. The leaves shed unseasonably, causing losses to the hay and seed crops. The dissemination of the disease occurs through the sale and use of diseased seed, and thus far seed disinfectants have failed to give satisfactory control of the disease in field tests.

BROWN SPOT

Brown spot (*Septoria glycines* Hemmi) is primarily a leaf-spot disease, but it also appears on the stems and pods as the plants approach maturity. The disease is characterized by brown or reddish-brown, angular spots appearing on both surfaces of young leaves, which become discolored and fall, the disease working toward the top of the plants. By late summer, if conditions are favorable for the spread of the disease, the older leaves become so spotted that it is difficult to

distinguish individual lesions. On the stems the disease manifests itself by the presence of indefinitely margined, brown discolorations that may nearly or completely encircle the stems. The spots on the pods are similar in all respects to those on stems. Brown spot spreads most rapidly in damp, warm weather and in places that are incompletely drained. As with other diseases of this crop, studies indicate that there are very manifest differences in varietal resistance. Investigations at the North Carolina Agricultural Experiment Station suggest the probability that brown spot is seed-borne and that contaminated seed is the agency by which it is disseminated.

SUNBURN

Investigations of a diseased condition of soybeans at the Arizona Agricultural Experiment Station indicated that the primary cause was sun-burning of the leaves or aphid injury, fungus infection being secondary. The fungus was isolated and is described as *Alternaria atrans* Gibson. The first indication of the disease is said to be the appearance of small, brick-red spots on the upper surface of the leaves, usually between the veins. Field and laboratory tests with Otootan, Biloxi, Virginia, Mandarin, Barchet, Tarheel Black, Tokyo, and Peking varieties showed sunburn and injury by the fungus on all varieties except Biloxi. Virginia was especially susceptible.

DOWNY MILDEW

Downy mildew is a leaf disease caused by the organism *Peronospora sojae* Lehman and Wolf. It was first reported by the North Carolina Agricultural Experiment Station from several places in North Carolina. It has also been reported in Delaware, Kentucky, West Virginia, Georgia, Ohio, Alabama, Mississippi, Louisiana, Indiana, Massachusetts, New Jersey, Illinois, and Missouri. The disease is characterized by indefinite chlorotic areas which change to grayish-brown lesions with well-defined, dark-brown borders. Grayish-colored masses of conidiophores are usually present on the under surfaces of the lesions.

As yet there has been no indication of this disease on stems or pods. Some defoliation occurs on the most susceptible varieties, but the disease, though widely distributed, has not been serious in any locality.

POD AND STEM BLIGHT

Pod and stem blight, caused by the fungus *Diaporthe sojae* Lehman, has been reported as occurring in North Carolina, Indiana, and Delaware. It occurs on pods, stems, and infrequently on the leaves, causing a premature death of the plants, failure of the young seed to develop, and a molding and decay of the seed in the later stages of development. The organism winters over on stems and seed. Relatively high humidity is conducive to infection and spread of this disease, losses being greater in rainy seasons than dry. The use of disease-free seed and crop rotation are recommended as control measures.

ANTHRACNOSE

Anthracnose (*Glomerella glycines* Hori) affects the stems and pods of the soybean. It is characterized by the presence of numerous black pustules uniformly scattered over the affected surface and by causing premature death of plants and failure of pods to fill. The organism is seed-borne. The ascogenous stage was found on diseased stems that over-wintered in the field and was developed in pure culture.

This disease was observed to be causing considerable injury to soybeans in field tests at Quincy, Fla., during the summer of 1937. The pods were covered with the black acervuli of the fungus, and when seeds were found they were much reduced in size and discolored from fungus decay. If badly diseased seed is planted, it germinates poorly and the stand is greatly reduced.

STEM ROT

Another disease found particularly in the sandy soils of the South where high temperatures occur is stem rot, caused by the fungus *Sclerotium rolfsii* Sacc. The soybean is very susceptible to this fungus, which attacks the stem of the plant at the soil level and grows downward forming round, brownish sclerotia about as large as mustard seed on the roots. The root dies, and the whole plant gradually succumbs. It has been noted in Mississippi and several other Southern States. In some small areas in the Delta section of Mississippi, 25- to 30-percent loss has been reported, whereas in other places about 5 percent of the plants have been killed. Rotation is the only known control applicable to field practice, but, because the disease attacks all summer legumes adapted to growth in the areas where it occurs in most severe form, the planning of a soil-improving rotation is made increasingly difficult.

PYTHIUM ROOT ROT

Another root rot known to occur on the soybean is caused by *Pythium debaryanum* Hesse. The infected plants develop a wet-rot condition near the soil level, extending somewhat up the stem and down into the roots. The rotted portions become badly disintegrated, and the plants wither and die. Very little is known of the distribution of this root-rot disease, but as the fungus attacks a number of other plants, it may be expected that, under suitable conditions, the disease may occur wherever soybeans are grown.

ROOT KNOT

Root knot is caused by a tiny eelworm or nematode (*Heterodera radicicola* (Greef) Muell.) which lives for the most part in the roots of cultivated plants. It bores its way into the young roots, procures its food from them, and so irritates the tissues that galls are produced. The food supply is used up, or its passage upward is prevented by galls, and the result is the stunting or death of the plant.

Instead of normal roots as found in healthy plants, those attacked by root knot have numerous irregular swellings or galls over the entire root system (fig. 9). The root knot galls are quite different

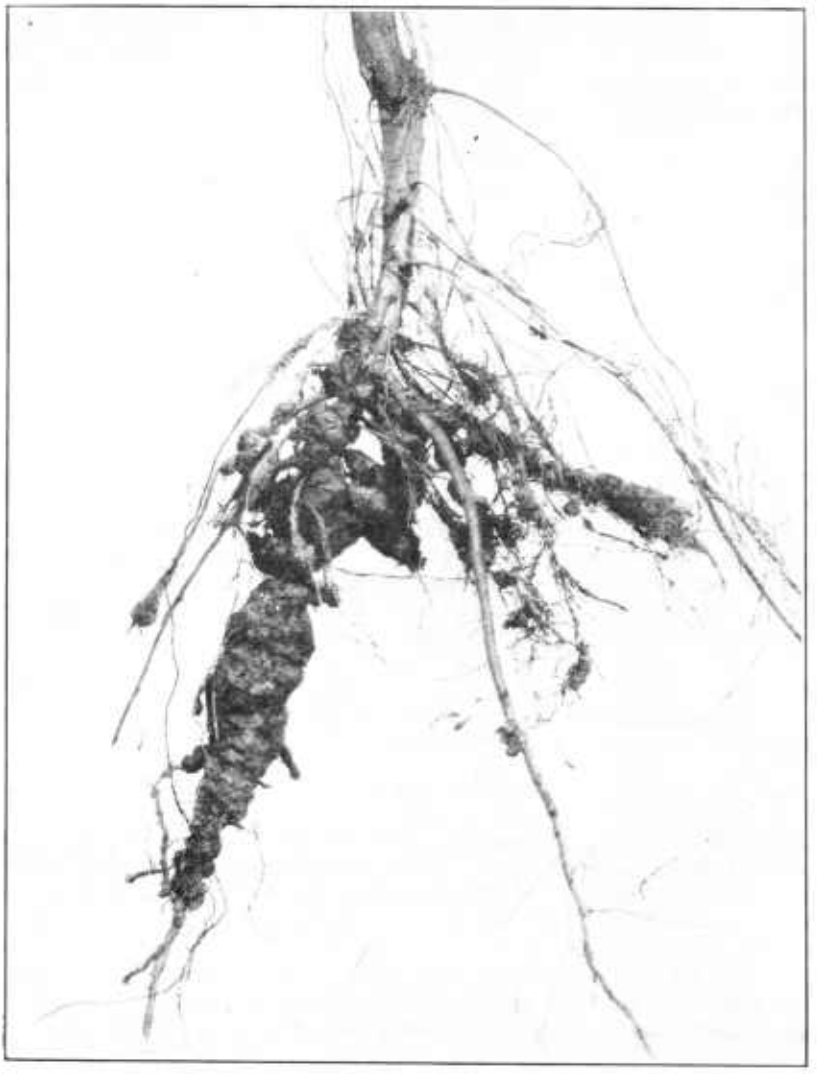

FIGURE 9.—Roots of a soybean plant, showing galls caused by the nematode *Heterodera radicicola*.

from the nodules of the beneficial nitrogen-gathering organism. Nodules are attached loosely to the roots, whereas root knot galls are enlargements of the roots themselves. Root knot often causes considerable injury to soybeans in many parts of the Southern States, where this pest is prevalent.

The most effective and practical method of controlling root knot combines the use of resistant varieties of soybeans with other known immune crops in the rotation. Susceptible varieties of soybeans or other crops should not be planted on infested land until it has been rotated for 1 to 3 years with immune crops to starve out the nematodes.

Soybean varieties vary markedly in resistance to root knot. The Laredo variety has thus far shown the greatest resistance.

OTHER ENEMIES OF SOYBEANS

Rabbits are exceedingly fond of the soybean and when numerous cause considerable damage. In parts of the Great Plains region where moisture conditions are favorable and in the Gulf coast region, failures with the soybean have been due chiefly to rabbits. The greatest damage is done while the plants are young and tender. Numerous observations have been reported where rabbits showed particular preference for certain varieties. Where rabbits are abundant, soybean culture is practically impossible unless the field can be enclosed with rabbitproof fencing or very large areas of the crop are grown. The dusting of the plants on the outer rows with lime and either dusting or spraying with some arsenical poison (calcium arsenate) have prevented serious damage from rabbits.

In the Northern States reports have been made of damage to small areas of soybeans by woodchucks. In many sections deer have done much damage to soybean fields.

In South Dakota, because of shortage of vegetation, pheasants did considerable damage to soybean plantings, eating the seedlings as they emerged and the seed as the plants matured. Pigeons, when numerous, will also cause considerable injury to soybean plantings by picking off and eating the cotyledons just as the seedlings are emerging or picking out the planted seed from the rows.

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