THE SOY BEAN: ITS CULTURE AND USES

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THE EXTENSIVE UTILIZATION of the soy bean for forage and the increased use of the beans for oil and for human food have resulted in an enormous increase in the acreage of the crop.

The climatic adaptations of the soy bean are about the same as those of corn. It is more drought resistant and less sensitive to an excess of moisture than cowpeas and corn. The soy bean succeeds best on fertile sandy loams and clay loams.

When sown on land not previously planted to this crop, it is advisable to inoculate it.

The best time for planting soy beans is about that for planting corn.

The variety to plant is of prime importance and should be one adapted to local conditions. About 20 varieties are now handled by growers and seedsmen.

Soy beans may be combined in many systems of crop rotations, their cash value being sufficient to encourage the growing of the beans as one of the main crops.

In combination with other crops, such as corn, cowpeas, and Sudan grass, the soy bean furnishes a well-balanced ration, a large yield, and a great variety of forage.

The large yield of seed, the ease of harvesting it, and the increasing demand for the beans for planting purposes, for food, and for the production of oil and meal recommend the soy bean for seed production.

The feeding value of soy-bean seed compares favorably with that of other concentrated feeds. The growing of seed for feeding will produce, at a moderate cost, at least part of the high protein concentrates necessary for stock feeding and milk production.

The straw obtained from thrashing soy beans for seed is a valuable feed for all kinds of stock.

The variety and palatability of the forms in which the soy bean can be served make it a very desirable article of human food, and its use as such is gradually increasing.

The soy bean makes an excellent hay of high feeding value which is greatly relished by all farm animals. From 1 to 3 tons of hay to the acre, and occasionally 4 tons, are obtained.

As a pasture crop the soy bean can be used to advantage for all kinds of stock. The most profitable method is to pasture with hogs, supplementing the corn ration. Mixed with corn, the soy bean is excellent for ensilage.

No insect or fungous pest has assumed any great economic importance in the culture of the crop. The soy bean, however, is subject to root-knot, a disease caused by an eelworm, or nematode, which occurs in many of the lighter soils of the South. To plant soy beans on such infested soil is a dangerous practice.

THE SOY BEAN: ITS CULTURE AND USES.

CONTENTS.

	Page.		Page.
Commercial importance	3	Varieties	11
Climatic adaptations	3	Soy beans in rotations	17
Soil requirements	4	Soy beans in mixtures	18
Preparation of the seed bed	5	Soy beans for seed	19
Fertilizers	5	Soy beans for hay	25
Inoculation	6	Soy beans for soiling	28
Time of planting	8	Soy beans for pasture	28
Depth of planting	9	Soy beans for ensilage	29
Rate of seeding	9	Soy beans for soil improvement	31
Method of seeding	11	Enemies of the soy bean	32
Cultivation	11		

COMMERCIAL IMPORTANCE.

THE SOY BEAN (fig. 1), also called the soya bean, the soja bean, and in North Carolina the stock pea, is an annual leguminous plant, a native of southeastern Asia. It has been cultivated in China, India, and Japan for more than 5,000 years and in extent of uses and value is the most important legume now grown in these countries. Within the past few years the soy bean has become a crop of special importance in the world's commerce, and large shipments of beans, oil, and meal have been made from Manchuria to America and European countries. The soy bean, which is very rich in protein, is largely utilized by Asiatic people for food, a great variety of products being prepared from it. As the bean contains a valuable vegetable oil, it is also extensively employed in the production of oil and cake.

The soy bean was introduced into the United States as early as 1804, but it is only during the last decade that it has become a crop of much importance. At the present time it is most largely grown for forage. In many sections, especially southward and in some parts of the corn belt, a very profitable industry has developed from the growing of seed. During the past few years the acreage has increased to a very considerable extent. The large yield of seed, the excellent quality of forage, the ease of growing and harvesting the crop, its freedom from insect enemies and plant diseases, and the possibilities of the seed for the production of oil and meal and as a food all tend to give this crop a high potential importance and assure its greater agricultural development in America (fig. 2).

CLIMATIC ADAPTATIONS.

In general the climatic adaptations of the soy bean are about the same as those of corn (fig. 3). The soy bean is especially adapted to the cotton region of the United States and northward to the Ohio

and Potomac Rivers, in which latter region the larger and later varieties, which give yields that make their extensive cultivation very profitable, can be grown. Recent introductions of early-maturing varieties from northern Manchuria mature profitable yields of seed in the northern tier of States, while the later varieties can be grown successfully for hay or ensilage. Under the conditions in the extreme southern parts of the Gulf States the soy bean seldom behaves normally. Although a satisfactory growth of forage is obtained, the pods often do not fill. Similar conditions exist in the Southwest, where extremely hot weather prevails during the period when the pods are maturing. Under irrigation, soy beans have given good results in many sections.

FIG. 1.—A typical mature soy-bean plant.

The soy bean is more drought resistant and also less sensitive to an excess of moisture than either cowpeas or corn. Rabbits are exceedingly fond of the plant, and but for the depredations of these animals the soy bean would be a valuable crop in the semiarid West.

SOIL REQUIREMENTS.

Although the soy bean will succeed on nearly all types of soil, the best results are obtained on mellow, fertile sandy loams or clay loams. In general, the soil requirements of the soy bean may be said to be about the same as those of corn, although soy beans will make a more satisfactory growth on poorer soil than corn, provided inoculation is present, but they will not make nearly as good growth on poor soil as cowpeas. Practical experience indicates that the cowpea succeeds better than the soy bean on the heavier clays and on the lighter sandy soils. With inoculation and moderate

quantities of fertilizer the soy bean thrives well on the sandy soils of the Coastal Plains area. On the vegetable-mold soils of eastern North Carolina excellent yields of beans and forage are obtained, and the crop occupies an important place in the farming systems of this region.

The soy bean does not require a well-drained soil for its best development, although it will not succeed where water stands for any considerable length of time. Swamp and peat soils after being drained and limed have usually been found to produce this crop very well. Soy beans will thrive on soils that are too acid for the successful culture of red clover.

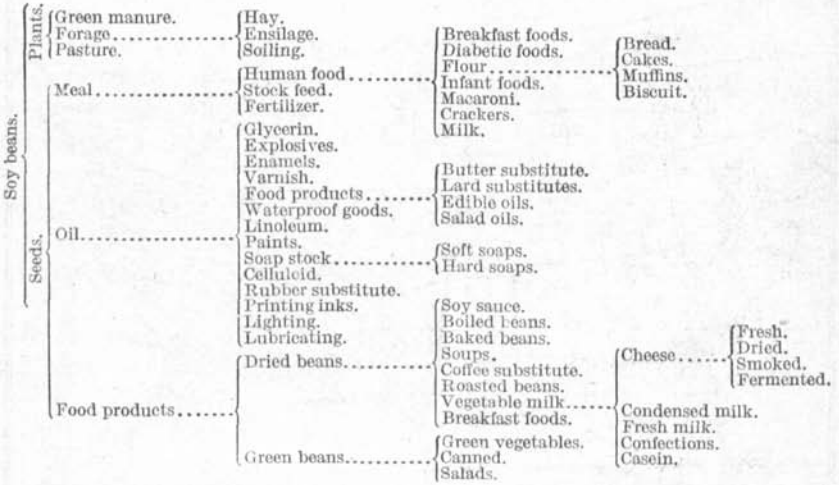

FIG. 2.—Diagram showing the various ways in which the plants and seeds of soy beans are utilized.

PREPARATION OF THE SEED BED.

The preparation of the soil for the soy bean is similar to that for corn, and it, like corn, readily responds to any extra preparation. The land should be plowed early and deep, fitted, and then harrowed at intervals until the beans are planted; otherwise, weeds are likely to choke out the young plants. Disking will give the proper preparation after a crop of early potatoes or peas or for stubble land after wheat or winter oats, provided the soil is moist and mellow. A firm seed bed with a light, loose covering of fine soil, well smoothed by the harrow, is conducive to uniform depth in planting and to a good stand of plants. A soil free from clods insures the best results, especially in seeding broadcast, which may be desirable on the better types of soil.

FERTILIZERS.

When grown on land giving good yields of corn or following corn, as it frequently does, a good crop of soy beans should be produced without direct applications of fertilizers. The use of fertilizers is

recommended, however, where sandy soil predominates or the soil is of low fertility. The application of nitrogenous fertilizers is not necessary, as the soy bean, like other legumes, assimilates the free nitrogen of the air. All fertilizer tests that have been conducted with this crop indicate that the best results, where fertilizers are required, are obtained with stable manure or about 300 pounds of acid phosphate and 250 pounds of wood ashes or 25 pounds of muriate of potash. Where neither the wood ashes nor the potash can be obtained, the acid phosphate may be used alone to good advantage. In using commercial fertilizers it is advisable to work them well into the

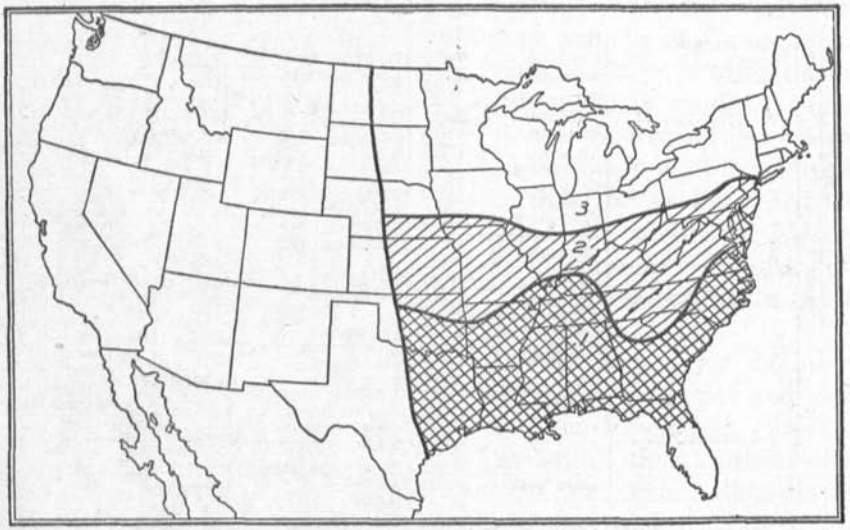

FIG. 3.—Outline map of the United States, showing the areas to which the soy bean is especially adapted, as to varieties and purpose: 1, The later and larger varieties, for seed production; 2, medium and medium-late varieties for seed and the same varieties and later varieties for forage; 3, very early varieties for grain production and the medium and medium-late varieties for forage and ensilage.

soil before planting. The application of lime has been found invariably to increase the yield of soy beans, though they are not as sensitive to lime as red clover, alfalfa, and many other crops.

INOCULATION.

Like other legumes, the soy bean is able to utilize the nitrogen of the air through the action of bacteria which live on the roots of the plant. The presence of these organisms is indicated by the development of nodules or tubercles on the roots (fig. 4). Soy beans will make an indifferent growth in most soils (fig. 5) unless the bacteria are present in the soil. The lack of inoculation is generally indicated by a pale or greenish yellow color of the plant. The soy bean will give very good results, however, on rich soils, even though the bacteria are not present, but in such cases the nitrogen is taken directly from the soil.

Natural inoculation now occurs quite generally throughout much of the area where soy beans are grown extensively. When sown on land which has not been previously planted to this crop, however, it

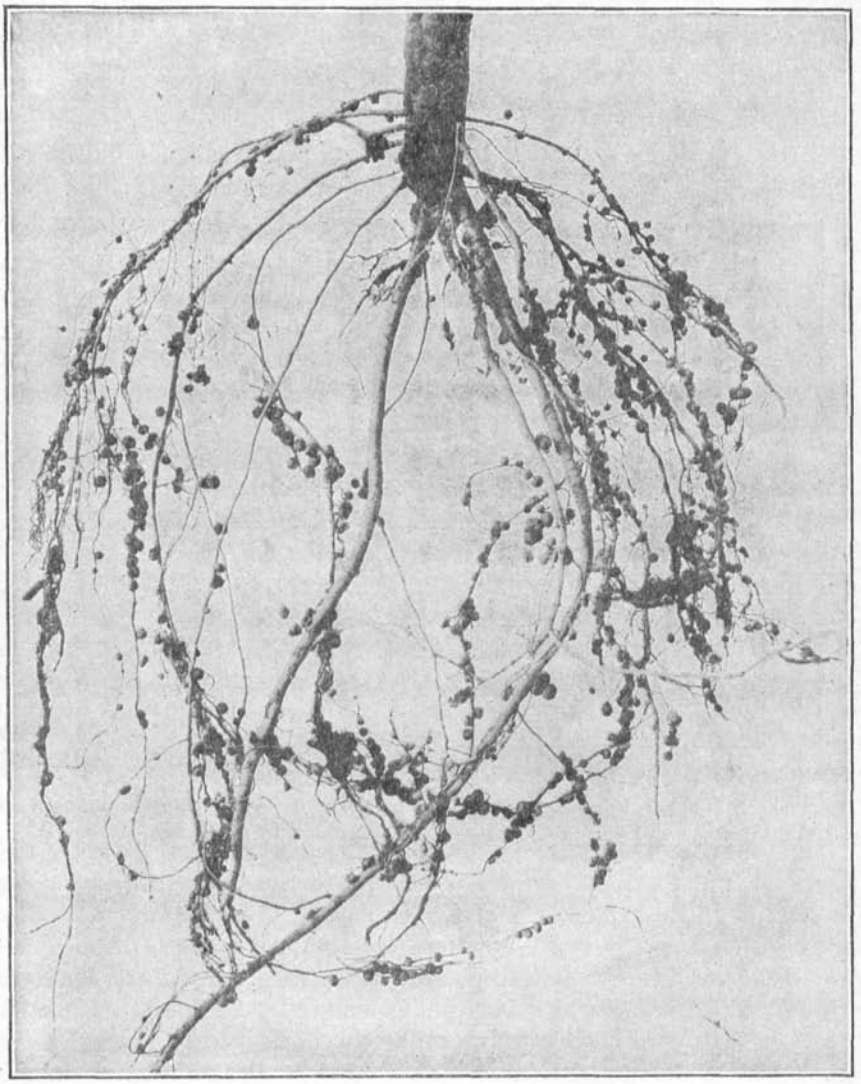

FIG. 4.—Roots of a soy-bean plant, showing abundant development of nodules.

is advisable to inoculate with the proper culture. Inoculation may be obtained either through the use of a pure culture, a limited quantity of which can be procured from the United States Department of Agriculture free of charge, or by the use of inoculated soil from a field where soy-bean plants have previously developed nodules. The inoculated soil may be drilled in at the time of seeding, using the fer-

tilizer box, or by thoroughly mixing a gallon of the soil to a bushel of seed.

Numerous investigations have been carried on relative to the influence of inoculation on the growth and composition of the soy bean. The Michigan Agricultural Experiment Station [1] found that although the presence of the bacteria on the roots in a fairly fertile soil did not notably increase the yield, the inoculated plants were far richer in protein and therefore of greater value than the ones not inoculated. Results obtained by the Wisconsin station [2] indicate that inoculation of the soil is beneficial by increasing the nitrogen content of the plant, the percentage of fertilizer ingredients in the roots, and the protein

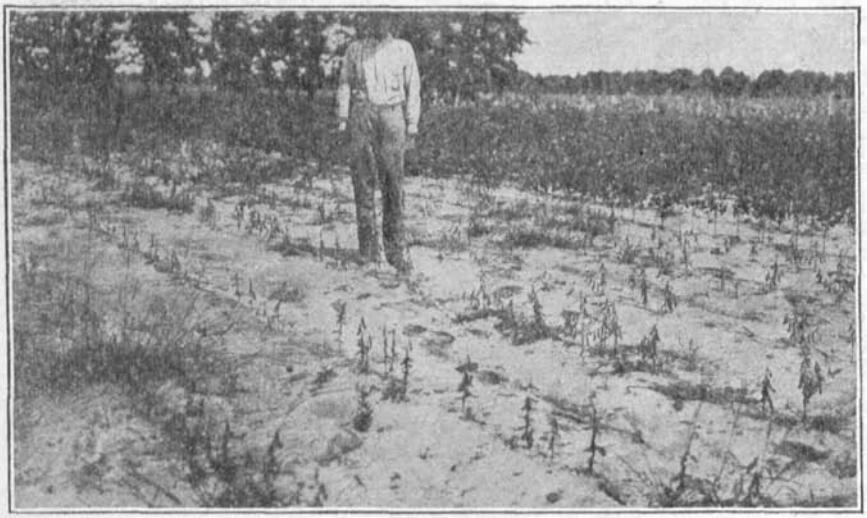

FIG. 5.—A plat of soy beans without inoculation (in the foreground) and an adjacent plat which had been inoculated (in the background).

content of the beans. At the New Hampshire station [3] an inoculated plat of soy beans gave 7.2 tons in green weight to the acre, while an uninoculated plat gave 4.7 tons. Analyses of seeds of inoculated plants at the Timothy Breeding Station in Ohio showed 42.47 per cent protein and for seeds of plants not inoculated, 35.26 per cent protein.

TIME OF PLANTING.

Soy beans may be sown during a period extending from early spring until midsummer, depending largely on the latitude and the

[1] Smith, C. D., and Robinson, F. W. Observations on the influence of nodules on the roots upon the composition of soy beans and cowpeas. Mich. Agr. Exp. Sta. Bul. 224, p. 127–132. 1905.

[2] Woll, F. W., and Olson, G. A. The effect of soil inoculation on the distribution of the fertilizer ingredients in soy beans. *In* Wis. Agr. Exp. Sta., 24th Ann. Rpt., [1906]/07, p. 164–166. 1907.

[3] Prince, F. S. The soy bean in New Hampshire. N. H. Agr. Exp. Sta. Bul. 181, 20 p., 6 fig. 1917.

use to be made of the crop. For grain or as a main hay crop, the best time is about that for planting corn, when the ground has become thoroughly warm. The plants will then start quickly and make a rapid growth. In general, early plantings require more days to mature than late plantings, the difference in the same variety often amounting to three weeks or more. The plants grow slowly in cool weather, and ordinarily there is no advantage in planting earlier than corn, especially the late varieties. As a pasture, green-manure, soiling, or even as a hay crop, the soy bean may be sown as late as August 1 in the South and as late as July 1 in the North.

The extreme dates of successful planting at the Tennessee Agricultural Experiment Station were found to be April 3 and August 6, although June proved to be the most favorable month in which to plant any variety. Similar results were obtained with a large number of varieties planted at 2-week intervals beginning May 1 and extending to August 1 at Arlington Farm, Va. The yields of forage and seed secured from different dates of planting with the Haberlandt variety at Arlington Farm are shown in Table I.

TABLE I.—*Acre yield of forage and seed of the Haberlandt variety of soy beans in date-of-planting tests at Arlington Farm, Va.*

Date of planting.	Green forage.	Dry forage.	Seed.	Date of planting.	Green forage.	Dry forage.	Seed.
	Tons.	*Tons.*	*Bushels.*		*Tons.*	*Tons.*	*Bushels.*
May 1	8.92	2.09	33.3	July 1	7.18	2.00	24.3
May 15	10.06	2.39	34.0	July 15	6.18	1.50	19.3
June 1	8.55	1.90	33.3	August 1	2.63	.87	(1)
June 15	7.54	1.83	25.3				

(1) The planting of August 1 did not mature.

DEPTH OF PLANTING.

The depth of planting is of much importance, as poor stands frequently result from too deep covering. In the heavier types of soil shallow plantings, about 1 inch, tend to lessen the chance of failure due to the formation of a soil crust after heavy rains. In sandy soils or light loams the planting may be deeper, but should not exceed 3 inches. If the seed is planted during a dry period, 3 inches will not be too deep. In case of a rain, a smoothing harrow or weeder may be employed to break any crust which may form on the surface. Under usual spring conditions, comparatively shallow plantings will give the best results.

RATE OF SEEDING.

The quantity of seed to be sown to the acre will necessarily vary somewhat, according to the size of the seed and the purpose for which the crop is grown. The different varieties of soy beans vary widely in size of seed, as shown in figure 6. With rows 24 to 40

inches apart, about 30 pounds of medium-sized seed will be required to the acre. Where sown broadcast for hay, green manuring, ensilage, or soiling, about 90 pounds of medium-sized seed to the acre will be ample. At the Ohio Agricultural Experiment Station [1] in a

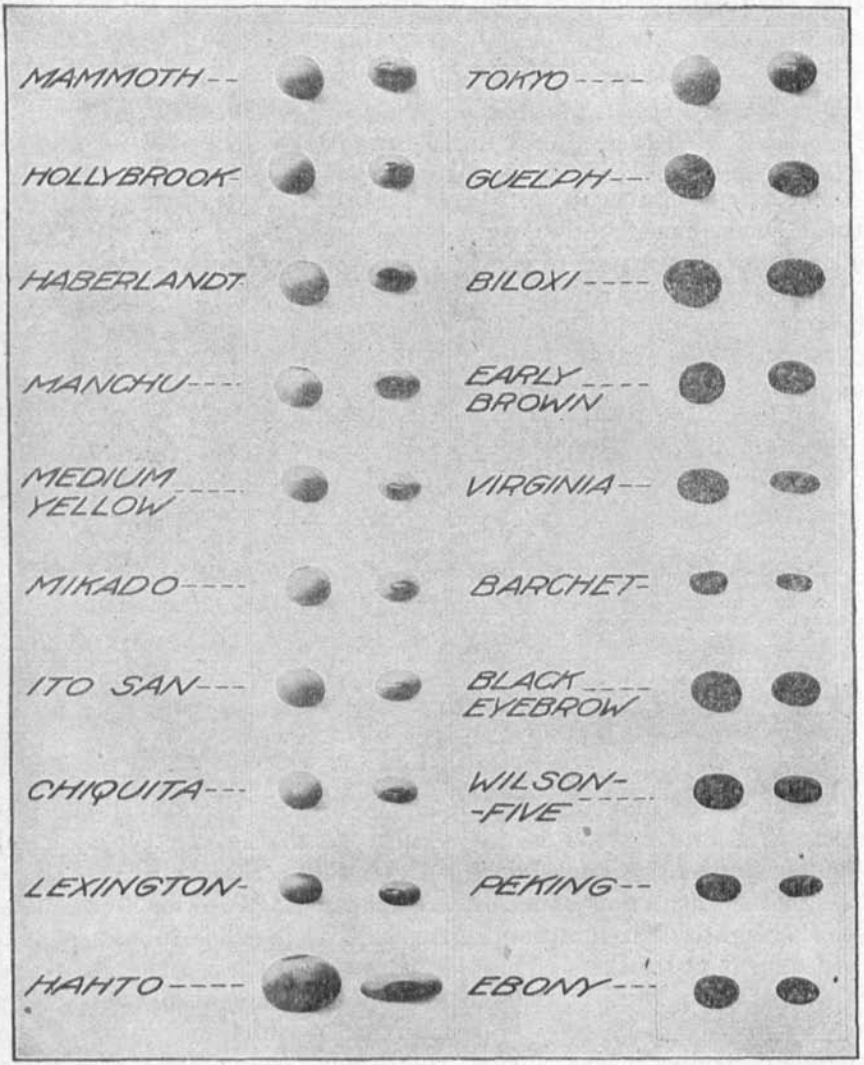

FIG. 6.—Seeds of the most important varieties of soy beans.

3-year method and rate of seeding test, 45 pounds of seed drilled in rows 28 inches apart gave the highest yield of seed and the most economical yield of forage. It was also found that 2 bushels of seed to the acre gave the largest yield of forage, but it was not enough greater to pay for the extra quantity of seed used.

[1] Williams, C. G., and Park, J. B. Soy beans: Their culture and use. Ohio Agr. Exp. Sta. Bul. 312, p. 581–600, 4 fig. 1917.

METHOD OF SEEDING.

Under nearly all conditions the soy bean should be grown in rows and given sufficient cultivation to keep down the weeds. The yield of seed is nearly always greater when grown in cultivated rows. If the land is quite free from weeds and the crop is to be used for hay or soiling, however, drilling or broadcasting will furnish a forage of finer quality. The main objections to solid drilling or broadcasting are the larger quantities of seed required and the greater growth of weeds in cold, wet seasons. Broadcasting and covering the seed with a harrow are seldom advisable. In eastern North Carolina the soy bean is planted in rows 4 feet apart and ridged to facilitate drainage For the best results the plants should be 2 to 4 inches apart.

The ordinary grain drill furnishes, perhaps, the most convenient means either for seeding in rows or broadcast. The width of the rows may be adjusted by covering the feed cups not in use. To prevent splitting the seed, the oats feed should be used. Corn planters can be used satisfactorily, as most of the modern planters have special plates for planting beans.

CULTIVATION.

Under favorable conditions the soy bean germinates in a few days, and cultivation should be begun as soon as the seedling plants appear (fig. 7). One deep cultivation may be given, but afterwards the cultivations should be shallow. The soy bean readily responds to good cultivation and requires about the same number of cultivations as corn. Level cultivation is preferable, as the harvesting can be more easily accomplished.

The harrow or weeder can be used advantageously on soy beans drilled solid which have been up a few days, as this is the only cultivation that can be given them.

VARIETIES.

The variety to be selected is a matter of prime importance and should be one adapted to local conditions and to the purpose for which the crop is grown. It is important, in view of the possibilities of this crop and its greater agricultural development in the United States, to utilize the very best varieties. As the number of soy-bean varieties is very large, and as new sorts are easily secured through selection and introduction, the most desirable characters, both for forage and seed production, need to be considered. Although yield is the most important single consideration, other factors are maturity, habit, coarseness, color of seed, ability to hold leaves, and ease of shattering. In view of the increasing interest in the soy bean for the production of oil, the percentage of oil is second to yield for seed production alone where the crop is likely to become of importance as an oil seed. At the present time about 20 varieties (fig. 6) of soy

beans are handled by growers and seedsmen in this country. During the past 10 years more than 800 lots of seed for testing, with a view to their introduction into this country, have been received by the United States Department of Agriculture from China, Manchuria, Japan, and India. Among these are several that have now become established on the market. Some of the recent introductions have proved so valuable in field trials that they are deemed important acquisitions, and seed will be distributed widely to further their culture.

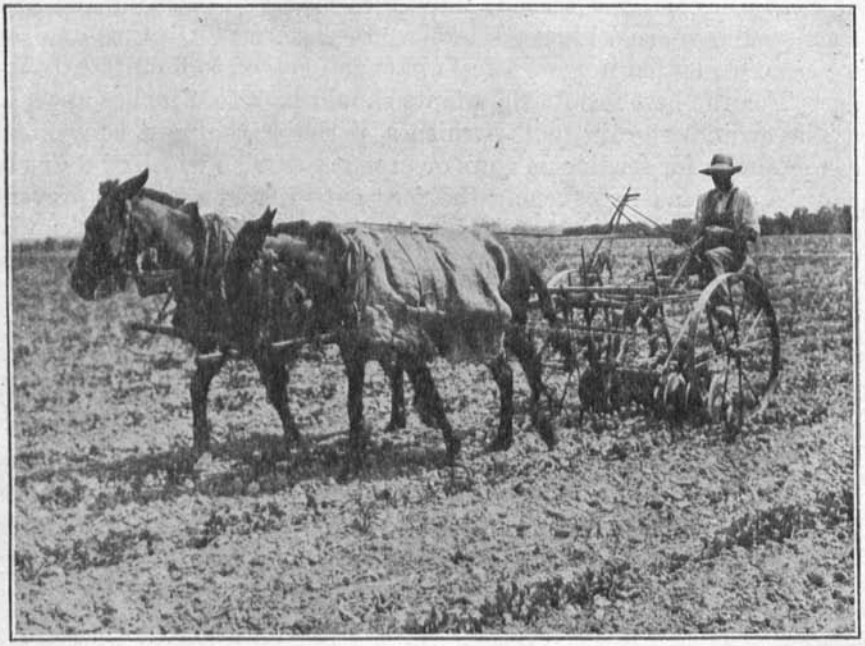

FIG. 7.—Cultivating soy beans. Cultivation should begin as soon as the seedling plants appear.

Unfortunately, considerable confusion in the names of varieties has been caused by growers and seedsmen, the same variety being frequently known under several different names. With the introduction of more varieties, it is readily seen that greater confusion is likely to occur. It is desirable to limit the varieties in the seed trade to the very best sorts. Seedsmen and growers are urged to use the varietal names here adopted, and buyers should be careful to specify the variety desired.

The planting of seed imported from Asiatic countries is not to be advised. Such imported seed consists of a mixture of varieties, most of which are inferior to the best varieties grown in the United States. The United States Department of Agriculture has given considerable attention to the breeding and adaptation of pure strains, and it is believed that in the planting of imported seed an unnecessary risk is taken. The more important commercial varieties and recently im-

proved sorts, with their adaptations and characteristics, are here described.

Barchet.—A late variety, found especially desirable for hay and green manure on the rice lands in the Gulf States. It makes an abundant growth of fine forage. Plants slender, rather inclined to lodge on fertile soils, maturing in about 160 days; pubescence tawny; flowers purple; seeds brown, with a brown seed scar, small, about 645,000 to the bushel; oil, 11.8 per cent; protein, 45.9 per cent.

Biloxi.—This variety (fig. 8) is characterized by its dense bushiness, leafiness, and coarse, erect stems, growing from 4 to 6 feet high. As the Biloxi requires a very long season in which to make its full development, it is adapted only to the southern part of the cotton belt. It is especially suited

FIG. 8.—A field of the Biloxi variety of soy beans in Mississippi.

to the rice lands as a green manure and is also valuable for forage and ensilage. Pubescence tawny; flowers purple; seeds deep brown with a brown seed scar, much flattened, medium large, about 112,000 to the bushel; oil, 20.3 per cent; protein, 46.3 per cent.

Black Eyebrow.—A variety (fig. 9) obtained from Manchuria and found especially adapted to northern conditions both for grain and hay. Plants stout, erect, maturing in about 110 days; pubescence tawny; flowers both purple and white; seeds black, with brown saddle and black seed scar, medium sized, about 148,000 to the bushel; oil, 17.8 per cent; protein, 40.8 per cent.

Chiquita.—The Chiquita has given better results under dry conditions in the semiarid regions than any other variety. It produces not only an abundance of forage but also a heavy yield of seed. This variety is especially suitable for forage or pasture. Plants under favorable conditions semierect with twining terminals, maturing in about 135 days; pubescence tawny; flowers both purple and white; seeds straw yellow, with a brown seed scar, medium small, about 275,000 to the bushel; oil, 17.6 per cent; protein, 46.9 per cent.

Early Brown.—With the exception of the color of the seed, this variety can not be distinguished from Ito San.

Elton.—An early-maturing variety obtained from Siberia and found especially suitable as a grain producer for northern conditions. Plants stout, erect,

maturing in about 110 days; pubescence tawny; flowers purple; seeds straw yellow, with a pale seed scar, medium sized, about 130,000 to the bushel; oil, 17.4 per cent; protein, 40.3 per cent.

Guelph.—The Guelph is also known as Medium Green, Early Green, Medium Early Green, and Large Medium Green. It is esteemed for its forage and as a silage crop in the Northern States. Although a good producer of grain, it is not desirable for this purpose, since the pods shatter badly before all the seeds are mature. Plants stout, erect, maturing in about 115 days; pubescence tawny; flowers purple; seeds green, with a brown seed scar, medium sized, about 149,000 to the bushel; oil, 19.5 per cent; protein, 36.8 per cent.

Haberlandt.—The Haberlandt is a heavy yielder of seed and is also an excellent pasture variety. Plants stout, erect, maturing in about 125 days;

FIG. 9.—A field of the Black Eyebrow variety of soy beans in South Dakota.

pubescence tawny; flowers both purple and white; seeds straw yellow, with a deep-brown seed scar, medium sized, about 144,000 to the bushel; oil, 18.3 per cent; protein, 38.5 per cent.

Hahto.—This variety recently introduced from Japan is a large producer of seed and forage, and the seeds when from three-fourths to full grown make an excellent green vegetable, similar to the Lima or butter bean. Plants stout, erect, maturing in about 135 days; pubescence tawny; flowers purple; seeds olive yellow, with a black seed scar, much flattened, very large, about 75,000 to the bushel; oil, 14.8 per cent; protein, 40.6 per cent.

Hollybrook.—This variety is about two weeks earlier than the Mammoth and therefore can be grown farther north for grain. Plants stout, erect, maturing in about 135 days; pubescence gray; flowers white; seeds straw yellow, with a light-brown seed scar, medium sized, about 176,000 to the bushel, very similar to that of Mammoth, but somewhat smaller; oil, 16.8 per cent; protein, 40 per cent.

Ito San.—This variety is one of the earliest commercial sorts and has been known under the names of Japan Pea, Yellow, Medium Yellow, Dwarf Yellow, Early Yellow, Early White, and Coffee Berry. Although not a heavy yielder of seed or forage, the Ito San is a very desirable variety to grow in a

short season and is especially suited to northern conditions. Plants stout, erect, maturing in about 110 days; pubescence tawny; flowers purple; seeds straw yellow, with a pale seed scar, medium sized, about 172,000 to the bushel; oil, 16.6 per cent; protein, 40.3 per cent. The seed of this variety can always be identified by a little brown speck at one end of the seed scar.

Lexington.—This variety has been found especially suited to Kentucky for grain and forage. Plants stout, erect, maturing in about 125 days; pubescence gray; flowers both purple and white; seeds olive yellow, with a pale to light-brown seed scar, much flattened, medium small, about 215,000 to the bushel; oil, 19.1 per cent; protein, 34.5 per cent.

Mammoth.—The Mammoth (fig. 10) is the standard commercial late variety, more extensively grown at the present time than any other. It yields well both in grain and forage, but for grain it can not be expected to mature north

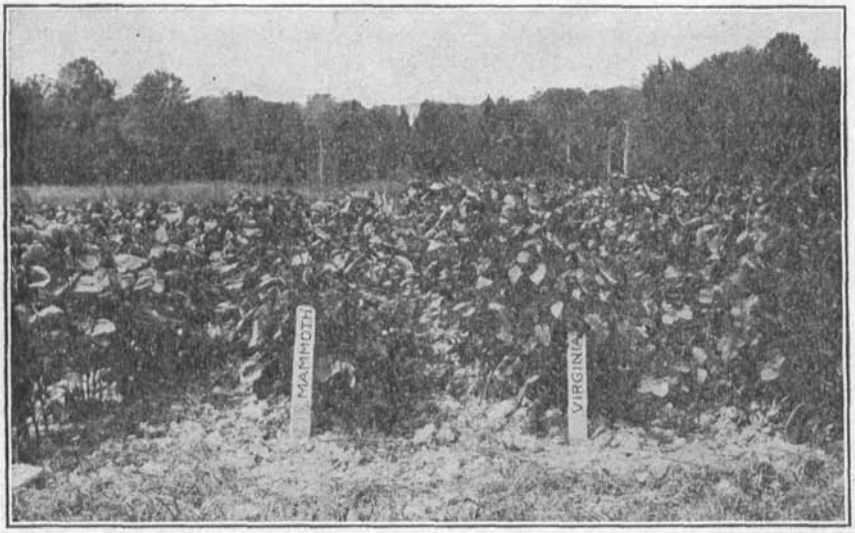

FIG. 10.—Plats of the Mammoth and Virginia varieties of soy beans at Arlington Farm, Va.

of Virginia and Tennessee. As forage, however, it can be utilized much farther north. Plants erect, coarse, maturing in about 145 days; pubescence gray; flowers white; seeds straw yellow, with a light-brown seed scar, medium large, about 129,000 to the bushel; oil, 18.6 per cent; protein, 37.6 per cent.

Manchu.—A variety, obtained from northern Manchuria, that has given excellent results in the Northern States both for grain and forage. Plants stout, erect, maturing in about 110 days; pubescence tawny; flowers purple; seeds straw yellow, with a slate-black seed scar, medium sized, about 141,000 to the bushel; oil, 19.18 per cent; protein, 37.19 per cent.

Medium Yellow.—A well-known variety that has been grown under the names Early Yellow, Mongol, Banner, and Roosevelt, and also erroneously as Hollybrook and Ito San. This variety gives an excellent yield of seed and is also suitable for forage. Plants stout, erect, maturing in about 115 days; pubescence tawny; flowers purple, seeds straw yellow, with a seed scar ranging from pale to light brown, medium small, about 262,000 to the bushel; oil, 19.3 per cent; protein, 34.1 per cent.

Mikado.—This variety, especially suited to the Central States, produces a good yield of seed and forage. It is about one week later than Medium Yellow, but otherwise appears to be identical with that variety.

Peking.—The Peking (fig. 11) is an excellent grain producer and with its rather fine stems and abundant foliage makes one of the best forage sorts. In variety tests the Peking, Sable, and Royal varieties appear to be identical, and it is quite evident that the latter two are selections from the Peking. Plants slender, erect, maturing in about 120 days; pubescence tawny (a small percentage of the plants have gray pubescence and twining terminals); flowers both purple and white; seeds black with a black seed scar, much flattened, medium small, about 384,000 to the bushel; oil, 15.9 per cent; protein, 39 per cent.

Shanghai.—This variety has been grown in North Carolina under the name of Tarheel Black. It gives a very good yield of seed and forage, but is inferior to many of the other sorts. Plants stout, erect, maturing in about 140

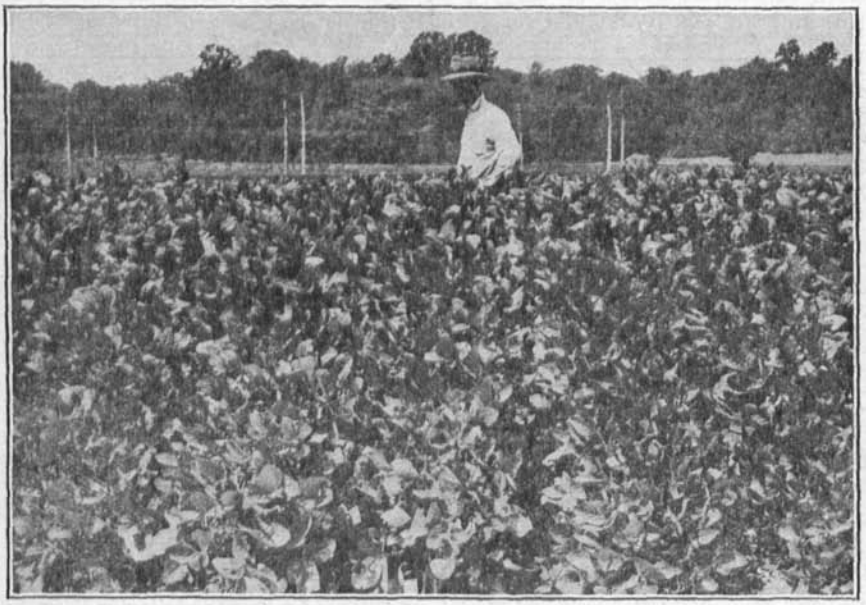

FIG. 11.—A field of the Peking variety of soy beans grown in 24-inch rows.

days; pubescence tawny; flowers white; seeds black, with a black seed scar, slightly flattened, medium sized, about 164,000 to the bushel; oil, 18.6 per cent; protein, 35.2 per cent.

Tokyo.—A variety giving rather a coarse growth, but an excellent producer of grain. It is especially suitable as a grain variety for North Carolina, Tennessee, and southward, being adapted to about the same area as the Mammoth. The plants are stout and erect, maturing in about 145 days; pubescence gray; flowers both purple and white; seeds olive yellow, with a pale seed scar, medium sized, about 135,000 to the bushel; oil, 18.4 per cent; protein, 35 per cent.

Virginia.—The Virginia (fig. 10) on account of its abundant growth and large yield of seed makes an excellent forage. It is recommended as a suitable variety for hay or ensilage and as such can be grown throughout the greater part of the corn belt. Plants slender, erect, with vining terminals, maturing in about 125 days; pubescence tawny; flowers purple; seeds brown, with a brown seed scar, much flattened, medium small, about 250,000 to the bushel; oil, 17.8 per cent; protein, 40.2 per cent.

Wilson-Five.—This variety is a pure field selection from the Wilson and produces an abundance of fine forage and a good yield of seed. Plants slender,

erect, maturing in about 120 days; pubescence gray; flowers purple; seeds black, with black seed scar, much flattened, medium small, about 328,000 to the bushel; oil, 18.4 per cent; protein, 37.8 per cent.

Yokotenn.—A variety found especially suitable as a grain for Tennessee conditions. Plants stout, erect, maturing in about 125 days; pubescence gray; flowers both purple and white; seeds straw yellow, with a pale seed scar, very large, about 70,000 to the bushel; oil, 19.2 per cent; protein, 36 per cent.

SOY BEANS IN ROTATIONS.

The soy bean may be combined advantageously in many systems of crop rotations. It is especially adapted to short rotations, taking either an entire season or a part of a season following some grain

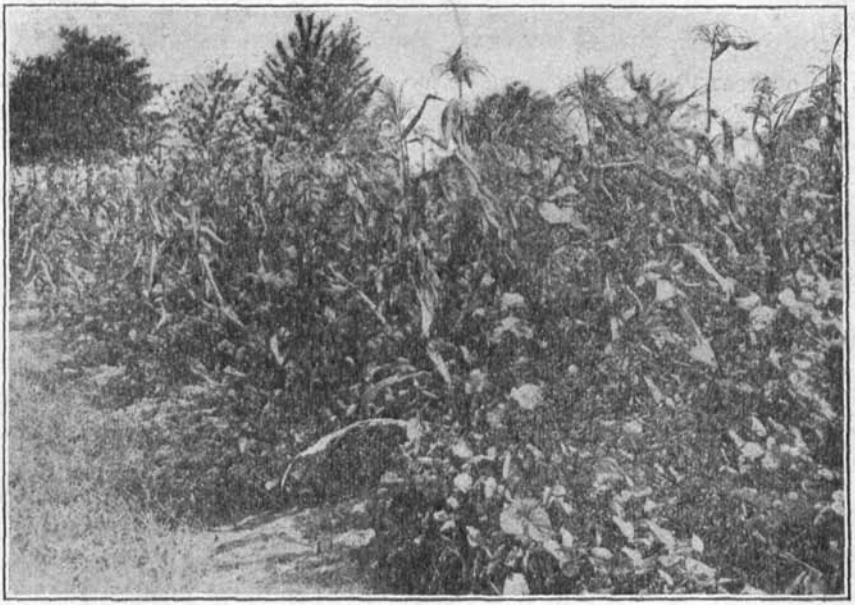

FIG. 12.—A field of soy beans and corn grown for ensilage.

crop. The cash value of the seed is sufficient to encourage growing the beans as one of the main crops. When the whole season is thus devoted to soy beans, they may take any place in a rotation system where corn can be used. In the Southern States the crop is adapted to practically the same place in rotations as cowpeas.

The small grains may follow soy beans, and the soil requires but little preparation after a crop of soy beans. In North Carolina and Tennessee a soy-bean crop is often grown between two wheat crops or between two oat crops. A rotation of corn, soy beans, wheat, and clover is practiced quite generally in many sections north of the Ohio River. In some sections the soy bean is substituted for oats in such 4-year rotations as corn, oats, wheat, and clover or potatoes, oats, wheat, and clover. The soy bean can also be used as a catch crop

where new seedings or grass and clover have failed and on wheat or oat stubble fields where clover or grass has not been sown or has not succeeded. As a crop after early potatoes or cannery peas and as an orchard cover crop, the soy bean is highly recommended, as it will produce a large quantity of fall pasturage or material for plowing under on soils in need of organic matter.

SOY BEANS IN MIXTURES.

The soy bean may be satisfactorily grown in combination with other farm crops. Although the chief advantage, perhaps, is a better balanced ration, the results of experiments indicate a larger yield of forage, as well as a greater variety.

SOY BEANS AND COWPEAS.

Soy beans and cowpeas make a very satisfactory mixture for hay or even for pasture, and the yield is nearly always greater than that of either crop alone. In this mixture tall strong-growing varieties of soy beans are desirable, as they tend to support the vining cowpeas. Varieties of these crops having about the same maturity should be selected.

In sowing a mixture of soy beans and cowpeas it is essential to have more soy-bean plants than cowpeas, so that the vining growth of the cowpeas may be supported properly. One bushel of soy beans and one-half bushel of cowpeas give excellent results if drilled broadcast, but if planted in 3-foot rows about one-half of this quantity of each is sufficient. The planting, whether in cultivated rows or broadcast, can be done best with an ordinary grain drill.

The time of cutting hay will depend on the relative stage of growth of the two crops. As nearly as possible, both plants should be at that stage of growth giving the best quality of hay. This time is when the soy-bean seed is about full grown and the first pods of the cowpeas are ripe. The harvesting and curing of a mixture of cowpeas and soy-bean hay is more easily accomplished than cowpeas alone, but is slightly more difficult than in the case of soy beans alone.

SOY BEANS AND CORN.

Soy beans are more generally grown with corn than with any other crop (fig. 12). Various methods of growing the two crops together are practiced in different sections of the country. The beans may be planted in the same hills with the corn, in alternate hills with corn in the same row, in alternate rows of each, or there may be two rows of each. The soy bean is rarely broadcasted in mixture with corn. In some sections the broadcasting of soy beans in corn at the last cultivation for hog pasture or soil improvement is quite generally practiced. When soy beans are grown with corn by these methods, the crop may be used for pasture or harvested for ensilage.

SOY BEANS AND SORGHUMS.

Soy beans grown in combination with sorghums make an excellent hay or ensilage crop. The tall-growing vining varieties of soy beans, like the Virginia and Wilson-Five, and either the Amber or Orange varieties of sorghum are preferable. This mixture is, perhaps, most satisfactory in cultivated rows, as the sorghum is apt to choke out the soy beans when broadcasted unless the sorghum is planted thinly. When sown in rows, about 15 pounds of sorghum and 45 pounds of soy beans will be sufficient.

SOY BEANS AND SUDAN GRASS.

Sudan grass is an excellent crop for growing in combination with soy beans (fig. 13). Not only a better yield, but a better balanced forage is obtained, as the Sudan grass is low and the soy bean high in protein. The best results are to be obtained by broadcasting, planting about 50 pounds of soy beans and 10 pounds of Sudan grass to the acre. This mixture is cut for hay about the time the soy-bean seeds are nearly full grown. The hay is easily harvested and cured.

SOY BEANS FOR SEED.

The soy bean is a very profitable crop when grown for seed, and the seed-growing industry is being developed in many cotton-growing sections and in the southern part of the corn belt. The character of growth, its uniform maturing habit, and its large yield of grain recommend the soy bean for seed production. The many disadvantages which attend the harvesting of cowpeas are not common to the soy bean.[1] The increased demand for seed for planting purposes and the utilization of the dried beans as food and for the production of oil and meal have brought about greatly increased prices. The seed of the best varieties of soy beans is selling for $2.50 to $4 per bushel of 60 pounds. As the merits of the crop are better appreciated, the demand is not likely to diminish. Utilizing soy-bean seed as feed is distinctly profitable. In addition to the value of the seed, the benefit to the land on which the beans have been grown and the use of the thrashed vines as a source of feed must be taken into consideration.

YIELDS OF SEED.

The average yields of soy-bean seed to the acre in various sections of the United States range from about 15 bushels in the Northern States to about 25 bushels in the northern part of the cotton belt. The average yield in eastern North Carolina, the largest seed-producing section in the country, is about 25 bushels, although many fields produce 35 bushels or more to the acre. Maximum yields of 50 bushels to the acre have been reported from North Carolina and Tennessee. The seed yields of the more important varieties now handled by growers and seedsmen are shown in Table II. These yields, as re-

[1] Morse, W. J. Harvesting soy-bean seed. U. S. Dept. Agr., Farmers' Bul. 886, 8 p., 7 fig. 1917.

ported by investigators at the various agricultural experiment stations, differ greatly with the same variety. This, in most cases, may be attributed to the adaptation of the variety to certain localities for seed production. In general, the figures show the average yields for a number of years and indicate the best seed-producing sorts.

TABLE II.—*Average yields of seed to the acre of the best varieties of soy beans at different agricultural experiment stations.*

Variety	Arlington Farm, Va.	Delaware.	Georgia.	Illinois.	Indiana.	Kansas.	Kentucky.	Maryland.	Mississippi.	Ohio.	Tennessee.	Virginia.	Wisconsin.
Mammoth	21.2	.....	14.9	.....	15.5	.....	18.0	10.1	36.6	.....	23.9	.....	.....
Hollybrook	18.1	29.2	9.7	.....	.....	.....	16.2	.....	14.6	.....	22.9	.....	.....
Guelph	18.2	15.2	.....	16.9	24.7	.....	.....	.....	14.6	23.9	16.5	16.6	21.3
Ito San	17.6	21.9	10.1	14.3	21.3	12.4	8.0	10.5	30.0	21.2	20.2	18.4	15.6
Haberlandt	25.8	23.3	13.9	21.7	.....	3.8	14.0	17.5	13.3	.....	25.7	18.3	.....
Medium Yellow	22.4	26.9	.....	13.3	23.0	19.7	.....	15.8	.....	22.2	25.9	.....	16.3
Wilson	25.5	32.2	14.2	18.4	20.1	.....	10.2	16.0	.....	.....	.....	.....	.....
Peking	30.5	32.7	14.1	11.0	18.6	.....	.....	16.7	23.3	.....	.....	15.0	.....
Ebony	16.4	25.2	.....	17.8	21.8	.....	10.0	19.8	.....	23.9	25.0	.....	.....
Virginia	26.6	27.1	21.8	.....	.....	.....	.....	20.1	.....	.....	.....	.....	.....
Early Brown	22.0	.....	.....	.....	21.7	17.7	.....	.....	.....	.....	18.1	.....	20.3

FEEDING VALUE.

The feeding value of soy-bean seed, which contains from 30 to 46 per cent protein, is very high and compares favorably with other concentrated feeds. The growing of soy-bean seed will enable the farmer to produce at a moderate cost at least part of the high-protein concentrates necessary for stock feeding and milk production. When fed to sheep and hogs, the beans can be fed whole, but in general it is preferable to crack or grind them. Practical experience has shown that it is necessary to mix the beans with corn or peas first and then grind together into meal. Owing to the high content of protein, soy-bean seed should always be fed in mixture with a less concentrated feed. The amount of digestible nutrients in soy-bean seed, as shown in Table III, would indicate that it compares very favorably with those of other concentrated feeds.

TABLE III.—*Average digestible nutrients in soy-bean seed and other concentrates.*[1]

Feeding stuff.	Digestible nutrients (per cent).			
	Total.	Protein.	Carbohydrates.	Fat.
Soy-bean seed	85.9	30.7	22.8	14.4
Cottonseed meal (choice)	78.2	37.0	21.8	8.6
Linseed meal (new process)	75.9	31.7	37.9	2.8
Wheat middlings	69.3	13.4	46.2	4.3
Wheat bran	60.9	12.5	41.6	3.0

[1] Henry, W. A., and Morrison, F. B. Feeds and Feeding, ed. 17, 691 p. Madison, 1917.

Soy-bean seed ground into meal has been found a most excellent feed for dairy cows. The Massachusetts Agricultural Experiment Station [1] compared soy-bean meal and cottonseed meal, using the same

[1] Brooks, W. P. Relative value of cottonseed meal and soja-bean meal as food for milch cows. *In* Mass. Hatch Agr. Exp. Sta., 6th Ann Rpt., 1903, p. 13–14. 1904.

ration otherwise. The quantity of milk produced from the soy-bean ration was slightly larger. The butter from the cows fed cottonseed meal was of firmer texture, but not nearly as good otherwise as the butter from the cows fed soy-bean meal. These results would indicate that ground soy beans are superior to cottonseed meal for both milk and butter production. At the Tennessee station,[1] in a similar comparison of the same two feeds, the yields both of milk and butter fat were about 5 per cent greater for the soy-bean meal. It was found at the Kansas station[2] that when soy beans formed one-half of the concentrates of the ration soft butter was produced.

As a supplement to corn meal for growing and fattening pigs, the Wisconsin station[3] found that ground soy beans proved about 10 per cent superior to wheat middlings, figuring the cost of the feeds as the same. The Indiana station[4] compared rations of two parts of corn meal and one part of soy-bean meal with corn meal and wheat middlings in equal proportions and with five parts of corn meal and one part of tankage for pork production. The soy-bean ration produced the largest daily gains, and this with the smallest quantity of feed consumed for each pound of gain. The Kansas station[5] has tested the value of soy-bean meal in combination with corn meal and with kafir meal in comparison with the two latter feeds alone in feeding hogs. The feeds were mixed in the proportion of four-fifths corn or kafir and one-fifth soy beans. Larger gains, varying from 13 to 37 per cent, were made in every case on the mixed rations than on corn or kafir alone. The Missouri station[6] in a comparative feeding trial of soy-bean meal with linseed meal and tankage showed that the three feeds were equally effective in promoting the growth of young hogs.

In feeding trials with sheep at the Wisconsin station[7] soy beans produced larger gains for a given amount of feed and a heavier clip

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[1] Price, J. N. Home-grown rations in economical production of milk and butter. Tenn. Agr. Exp. Sta. Bul. 80, p. 31–50. 1908.

[2] Otis, D. H. Experiments with diary cows. Kans. Agr. Exp. Sta. Bul. 125, 141 p., 39 fig. 1904.

[3] Humphrey, G. C., and Fuller, J. G. Soy beans versus wheat middlings as a supplement to corn meal for growing and fattening pigs. *In* Wis. Agr. Exp. Sta., 21st Ann. Rept. [1903]/04, p. 32–40, 6 fig. 1904; 22d Ann. Rept., [1904]/05, p. 21–30, 3 fig. 1905; 23d Ann. Rpt. [1905]/06, p. 33–46, 3 fig. 1906.

[4] Skinner, J. H. Soy beans, middlings, and tankage as supplemental feeds in pork production. Ind. Agr. Exp. Sta. Bul. 108, 32 p., 4 fig. 1905.

[5] Cottrell, H. M., Otis, D. H., and Haney, J. G. A new drought-resisting crop—soy beans. Kans. Agr. Exp. Sta. Bul. 92, 28 p., 3 fig. 1900.

Erf, O., and Kinzer, R. J. Swine feeding test with sorghum-seed meal, kafir-corn meal, soy-bean meal, and corn meal. Kans. Agr. Exp. Sta. Press Bul. 141, 2 p. 1905.

[6] Forbes, E. B. Specific effects of rations on the development of swine. Mo. Agr. Exp. Sta. Bul. 81, 69 p. 1909.

[7] Richards, W. B., and Kleinheinz, Frank. The value of soy beans as a part of a grain ration for lambs. *In* Wis. Agr. Exp. Sta., 21st Ann. Rpt. [1903]/04, p. 51–55. 1904.

Humphrey, G. C., and Kleinheinz, Frank. The value of soy beans in grain rations for lambs. *In* Wis. Agr. Exp. Sta., 22d Ann. Rpt. [1904]/05, p. 65–68. 1905.

of wool. In one experiment two lots of 10 lambs each were fed the same roughage. One lot received shelled corn and whole soy beans in equal proportions, while the other received the same quantities of shelled corn and whole oats. The average gain of each lamb during a period of 12 weeks was 16.2 pounds when soy beans constituted a part of the ration and but 13.7 pounds when oats were used. A pound of gain was produced on 6.11 pounds of grain and 7.11 pounds of roughage in the soy-bean ration, while 7.28 pounds of grain and 8.62 pounds of roughage were required in the oats ration. In another experiment the same rations were fed for 12 weeks to two lots of

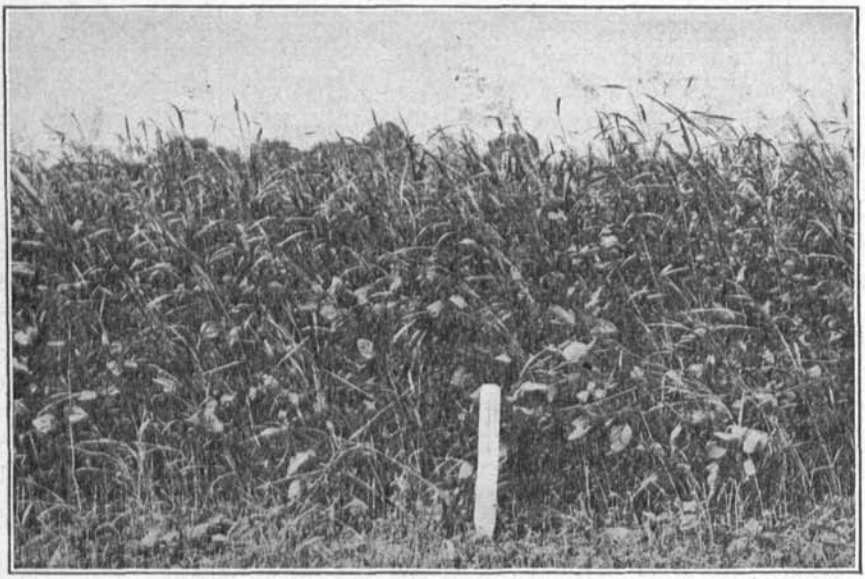

FIG. 13.—A field of soy beans and Sudan grass grown in mixture for hay.

8.62 pounds of roughage were required in the oats ration. In anpounds in weight and produced 95.1 pounds of wool, as compared with 71 pounds increase in weight and a production of 81.3 pounds of wool for the lot receiving the oats ration. The second lot also consumed more feed per pound of gain.

FOR HUMAN FOOD.

In Asiatic countries, especially China and Japan, the soy bean and the various food products made from it are so largely consumed that it is second only to rice in importance as a food crop. Until 1916 the soy bean had been used but little in the United States for food and only as a special diet for persons requiring foods of a low starch content. Much interest has been shown during the last two years in the possibilities of the soy bean for food. The United States Department of Agriculture and many schools of cookery and domestic

science have conducted successful experiments in utilizing the dried beans in the manner of the navy bean and the green beans (fig. 14) when three-fourths to full grown as a green-vegetable bean. The variety and palatability of the forms in which the bean can be served make it a very desirable article of food, and undoubtedly it will grow in favor as it becomes better known. Soy-bean meal or flour may be used as a constituent of bread and muffins and in pastry.

FOR OIL AND MEAL.

Soy beans, in addition to their forage and food value, contain a valuable oil which is utilized to a very considerable extent in Europe

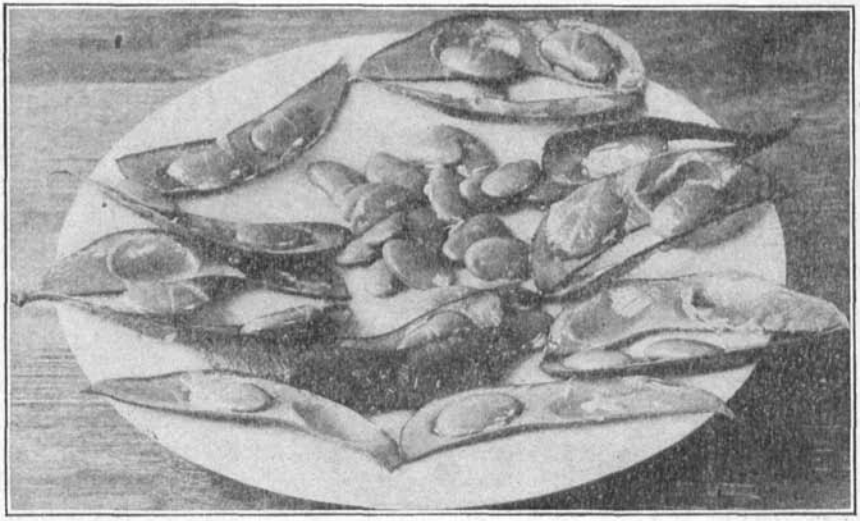

FIG. 14.—Seeds and pods of the Hahto variety of soy beans, the seeds being especially valuable as a green vegetable.

and America for culinary purposes, as a paint oil, in soap manufacture, and in many other industries.[1] The soy-bean cake remaining after the oil is expressed is ground into meal and makes a highly nitrogenous foodstuff which can be used for human food and as stock feed. Practical experience, supplemented by careful experiments, indicates the value of the meal as a feed for all kinds of live stock.

VIABILITY OF SOY-BEAN SEED.

The seed of the soy bean loses its viability rather rapidly, and it is not safe to plant seed 2 years old without a germination test. The seed spoils easily if not properly handled, and special care should be exercised in curing and storing it. Under favorable storage conditions well-cured seed will retain its viability four or five years, but this has been found to vary according to variety, as shown in Table IV.

[1] Piper, C. V., and Morse, W. J. The soy bean, with special reference to its utilization for oil, cake, and other products. U. S. Dept. Agr. Bul. 439, 20 p., 3 fig. 1916.

TABLE IV.—*Percentage of viability of the seed of different varieties of soy beans stored for periods of 1, 2, and 4 years.*

Variety.	Seed color.	1 year.	2 years.	4 years.
Shanghai	Black	99.0	93.0	43.5
Chernie	do	94.0	76.5	46.5
Jet	do	92.5	60.0	19.5
Ebony	do	94.0	71.5	4.0
Guelph	Green	97.5	86.5	1.5
Ito San	Straw yellow	100.0	83.0	2.5
Haberlandt	do	76.0	2.5	0
Mammoth	do	77.0	32.5	0.5

COST OF PRODUCTION.

The cost of production of soy-bean seed in general will be very little different from that for corn when the crop is planted in rows and cultivated. Usually soy beans are given one or two cultivations less than corn, but if the rows are spaced closer than those of corn the cost will be practically the same.

Data collected from leading growers of the soy bean in large seed-producing sections show the cost of production per acre to range from $7 to $17, with the average about $10.50. In those sections where special bean harvesters are used for gathering the crop in the field, the cost of harvesting is less than when the vines are thrashed. However, the straw obtained in the thrashing of the vines is a valuable feed and brings from $7.50 to $12.50 a ton.

SOY-BEAN STRAW.

The straw obtained from thrashing the soy bean for seed is a valuable feed for all kinds of stock. In many sections where this crop is grown extensively for seed it is baled at the time of thrashing and sold in the immediate locality to liverymen, dairymen, and stock feeders.

The Ohio Agricultural Experiment Station[1] conducted a series of experiments to compare corn stover and soy-bean straw for fattening lambs when fed with shelled corn and linseed-oil meal. It was found that soy-bean straw produced 6.6 per cent greater gain on a smaller amount of feed per 100 pounds of gain than did corn stover.

The Tennessee station[2] compared soy-bean straw and corn stover as roughage in the production of milk and butter. The ration containing soy-bean straw was found superior to that containing corn stover. This ration produced more pounds of milk and butter fat and produced them more cheaply than the corn-stover ration. In every case there was less loss in milk and butter fat during the feeding of soy-bean straw than during the feeding of corn stover. It was concluded from these tests that soy-bean straw is a valuable addition to the roughage in the feeding of dairy cows.

[1] Carmichael, B. E., and Hammond, J. W. Rations for fattening range lambs. Ohio Agr. Exp. Sta. Bul. 245, p. 685–722, 4 fig. 1912.

[2] Price, J. N. Home-grown rations in economical production of milk and butter. Tenn. Agr. Exp. Sta. Bul. 80, p. 31–50. 1908.

SOY BEANS FOR HAY.

The soy bean when cut at the right stage of growth and properly cured makes an excellent hay of high feeding value that is greatly relished by all farm animals. As compared with hay from other leguminous crops, soy-bean hay is equal or superior to any. The use of this hay as a source of protein, which can be produced on the

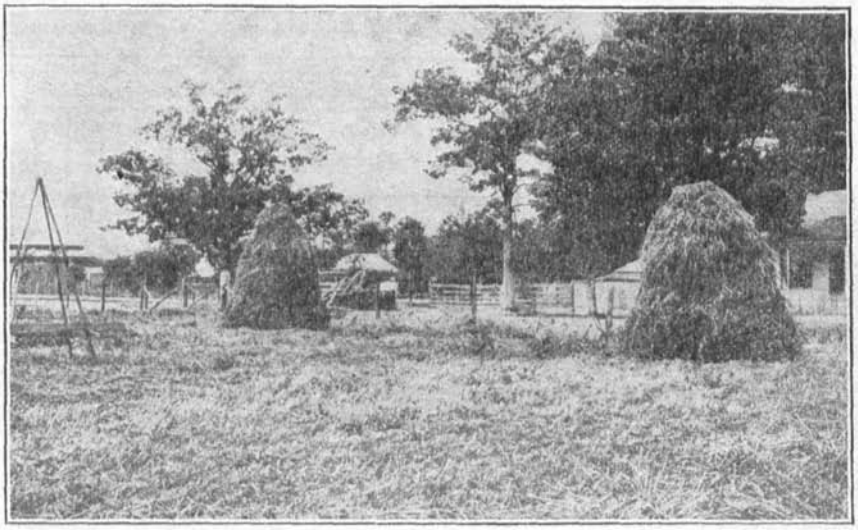

FIG. 15.—Soy-bean hay on frames. Under unfavorable weather conditions hay can be successfully cured in this way.

farm to balance feeds for growing stock or for milk, should reduce the quantity of high-priced concentrated feeds which it is necessary to purchase.

TIME OF CUTTING.

The soy bean may be cut for hay at any time from the setting of the seed until the leaves begin to turn yellow. The crop is best fitted for hay, however, when the seeds are well formed, for at this stage of growth the largest yield and the best quality of hay will be obtained. If the harvesting is done earlier, the percentage of protein will be higher, but the total yield will not be so large and the difficulty of curing much greater. If the cutting is delayed, the stems rapidly become hard and woody and decline in feeding value, and if left too long there is much loss in leaves. Table V shows the variation in the composition of hay of the Mammoth variety at different stages of development.

CURING SOY-BEAN HAY.

Soy-bean hay can be much more readily and easily cured than that of cowpeas. Under promising weather conditions the cutting may begin as soon as the dew is off the plants and continue for the rest of the day. After being left in the swath until thoroughly wilted

the hay should be raked into windrows before the leaves become dry and brittle and left for a day or two, depending on the weather. The hay can then be placed in small shocks or bunches. Most of the curing is done in the shock, and if well put up the hay will withstand considerable wet weather without damage. Four or five days of fair weather is ample time for making soy-bean hay ready to be stacked or housed. The bunches should be opened a few hours before hauling.

TABLE V.—*Composition of soy-bean hay at different stages of development.*[1]

Stage of growth.	Constituents (per cent).					
	Moisture.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
Full bloom	5.11	19.22	1.45	38.56	26.50	9.16
Pods forming	5.35	12.72	1.06	42.50	30.82	7.55
Seed half developed	5.40	10.31	2.34	44.73	30.45	6.77
Seed fully developed	5.30	15.94	7.83	38.76	25.97	6.20

[1] Analyses made by the Bureau of Chemistry, U. S. Department of Agriculture.

Under unfavorable weather conditions curing frames can be used to good advantage. These frames are usually three or four sided pyramids made of boards or poles 3 to 6 feet long, fastened together at the top and held by crosspieces near the base (fig. 15). With these frames a hollow shock is formed, thus allowing the free circulation of air, which lessens the danger of spoiling and secures better curing. Although the hay, as a general rule, should be in a well-wilted condition when placed on the frame, well-cured hay has been obtained by placing the soy-bean plants on the frames as soon as cut.

Soy-bean hay should be thoroughly cured before it is stacked or housed. The hay may be placed in good-sized stacks or under cover. When stacked in the open it is essential that grass or some other material that sheds rain be placed over the stack. Poles or logs placed in the center of the stack so as to leave passages for air will greatly lessen the danger of spoiling.

FEEDING VALUE OF SOY-BEAN HAY.

The chief value of soy-bean hay lies in its high content of digestible protein. In feeding value it is superior to red clover or cowpeas and, as indicated by comparative feeding tests, is equal to alfalfa for milk and butter production. Soy-bean hay makes an excellent winter ration for young cattle, sheep, and horses when fed in mixture with roughage or other hay and has been used to good advantage for hogs. The feeding of soy-bean hay alone is not to be advised, because on account of its high feeding value digestive troubles may result. Table VI shows that the amount of digestible nutrients in soy-bean hay compares very favorably with the hay of other important crops. The relative value of feeds is, however, best shown by comparative feeding tests.

TABLE VI.—*Average digestible nutrients in soy-bean hay compared with other important hay crops, air-dry basis.*[1]

Kind of hay.	Digestible nutrients, air dry (per cent).			
	Total.	Protein.	Carbohydrates.	Fat.
Soy bean	53.6	11.7	39.2	1.2
Cowpea	49.0	13.1	33.7	1.0
Alfalfa	51.6	10.6	39.0	.9
Red clover	50.9	7.6	39.3	1.8
Timothy	48.5	3.0	42.8	1.2

[1] Henry, W. A., and Morrison, F. B. Feeds and Feeding, ed. 17, 691 p. Madison, 1917.

The Tennessee Agricultural Experiment Station [1] conducted a feeding test with milch cows, comparing soy-bean and alfalfa hay in combination with corn ensilage and corn-and-cob meal. Each lot of cows consisted of four Jerseys, and the test lasted through three periods of 30 days each. At the conclusion of the test the results showed that the lot fed soy-bean hay produced 245 more pounds of milk and 20.5 more pounds of butter fat than the lot receiving alfalfa hay. In feeding tests with milch cows at the Ohio station [2] a ration of 8.7 pounds of soy-bean hay, 31.79 pounds of ensilage, 5.7 pounds of corn meal, and 1 pound of cottonseed meal gave as good results as a ration of 8.4 pounds of concentrates (equal parts by weight of wheat bran, cottonseed meal, and corn meal), 7 pounds of corn stover, and 32.8 pounds of ensilage. The feed cost of the butter fat, however, was 9.5 per cent lower in the soy-bean hay ration.

YIELDS OF SOY-BEAN HAY.

The soy bean will yield from 1 to 3 tons of hay to the acre, and occasionally 4 tons, depending upon the fertility of the soil and the season. Under favorable conditions soy beans should average at least 2 tons to the acre. Yields of hay of important varieties secured at various experiment stations are shown in Table VII.

TABLE VII.—*Yields per acre of soy-bean hay obtained at different agricultural experiment stations.*

Variety.	Arlington Farm, Va.	Connecticut.	Delaware.	Georgia.	Illinois.	Indiana.	Kansas.	Maryland.	Mississippi.	New Hampshire.	Ohio.	Tennessee.	Virginia.
Mammoth	1.8	.....	.....	1.9	2.1	1.6	.....	.....	2.2	2.1	1.9	2.8	2.9
Hollybrook	1.6	1.3	2.3	1.1	1.8	.....	.....	.....	1.8	2.4	.....	2.6	3.0
Guelph	1.8	1.6	2.2	.....	1.8	2.7	.....	.....	1.5	2.6	2.7	2.3	1.6
Medium Yellow	2.2	1.2	2.3	.....	2.1	.....	2.8	4.5	2.6	1.9	.....	2.3	2.3
Ito San	1.4	1.3	1.6	1.0	1.4	2.4	2.4	.....	2.4	2.4	2.4	2.2	2.6
Ebony	1.4	.....	1.9	.....	1.6	2.4	1.2	4.3	.....	1.9	2.4	.....	.....
Peking	2.1	1.6	2.4	1.4	.....	2.2	2.6	3.6	1.7	2.1	2.2	.....	.....
Haberlandt	1.9	.....	2.9	1.0	1.8	.....	.....	.....	1.1	2.6	.....	2.7	.....
Wilson	2.3	1.7	2.6	1.2	1.7	.....	.....	3.0	.....	2.3	.....	.....	.....
Arlington	1.8	1.6	2.3	.....	.....	.....	.....	3.1	1.8	.....	.....	.....	.....

[1] Price, J. N. Home-grown rations in economical production of milk and butter. Tenn. Agr. Exp. Sta. Bul. 80, p. 31–50. 1908.

[2] Caldwell, R. E. The value of soy-bean and alfalfa hay in milk-production. Ohio Agr. Exp. Sta. Bul. 267, p. 125–145, 2 fig. 1913.

SOY BEANS FOR SOILING.

The soy bean has an important place among soiling crops. Having a high protein value, the crop may be fed to good advantage with less nitrogenous crops, such as corn, sorghum, Sudan grass, and millet. The great variation in the time of maturity of the different varieties of soy beans or the planting of the same variety at different dates will make it possible to have a succession of green forage throughout the greater part of the summer and fall. When the crop has become well established, it grows well during drought and often succeeds when other crops fail.

SOY BEANS FOR PASTURE.

The soy bean can be utilized to advantage as pasture for all kinds of stock, the most profitable method, perhaps, being to pasture with hogs, supplementing the corn ration. This is especially desirable when the harvesting is interfered with by bad weather, lack of labor, or other causes, and when the crop is grown for soil improvement. In this way the crop is profitable not only from the standpoint of feeding value, but also in the increase of soil fertility due to the manure and refuse vines. Hogs greatly relish the bean plant, especially the ripening pods and seed, and a considerable part of the growth of young hogs may be made with soy-bean pasture. Animals ready for fattening may be fitted for market much more rapidly if soy beans are used to supplement the corn ration. In pasturage experiments conducted at the Alabama Agricultural Experiment Station [1] soy beans, peanuts, chufas, and sorghum were compared as pasturage for hogs. It was found that when corn alone was fed, 100 pounds of pork cost $7.63; when fed a two-thirds ration of corn and pastured on chufas in addition, 100 pounds of pork cost $8.89; on sorghum, $7.79; on peanuts, $3.20; and on soy beans, $2.74. The average gain of the pigs each day on the soy-bean pasture was 1.02 pounds, on the peanut pasture 1.01 pounds, on the chufa pasture 0.72 pound, and on the sorghum pasture 0.37 pound. The same station [2] reports three years' work in feeding 105 hogs to determine the value of soy-bean pasture as compared with other feeds, the most profitable quantity of corn as a supplement, and the effect of the soy-bean forage on the quality of the pork. It was found that when corn was used alone the average daily gain for each hog was 0.375 pound, at a cost of 7.61 cents. When soy-bean pasture was grazed with a one-fourth, one-half, and three-fourths ration of corn the average daily gains were raised to 1.102, 1.006, and 1.329 pounds, respectively, and

[1] Gray, D. T., Duggar, J. F., and Ridgeway, J. W. Feeds supplementary to corn for southern pork production. Ala. Agr. Exp. Sta. Bul. 143, p. 27–77. 1908.

[2] Gray, D. T., Ridgeway, J. W., and Eudaly, E. R. Corn, soy-bean pastures, tankage, cottonseed meal for fattening hogs. Ala. Agr. Exp. Sta. Bul. 154, p 43–87, 9 fig. 1911.

the cost of pork reduced to 2.59, 3.36, and 3.17 cents, respectively. One acre of soy-bean pasture afforded grazing for 10 hogs for 32 days with a one-fourth ration of corn, 48 days with a one-half ration, and 62 days with a three-fourths ration of corn. The total value of pork produced on each acre of soy-bean pasture varied from $25.84 to $39.13. The Kentucky Agricultural Experiment Station,[1] in a series of experiments with soy-bean pasture for hogs, found that it was not profitable to hog down soy beans (grain) unless a supplementary feed is given. The results showed, however, that it was highly profitable to hog down soy beans if a supplementary feed, such as corn, is given. The lot of hogs receiving 2 per cent of its weight in corn meal daily produced 825 pounds of pork to the acre, at a cost of $4.54 per hundred pounds of gain. An acre of soy beans hogged off with a supplementary feed of corn produced feed for 10 hogs for 21 days and for 20 hogs for an additional 21 days. An acre of soy beans with no corn fed the hogs produced feed for 10 hogs for 21 days and for 15 hogs for an additional 14 days.

Various methods of seeding are used when the soy bean is to be utilized for pasture purposes. In the Southern States, especially North Carolina, where a considerable acreage is used for hog pasture, from 1½ to 2 bushels of seed are sown broadcast at the last working of the corn. The hogs are turned in when the seed is fully mature. Corn and soy beans are sometimes grown together and pastured down, as is often done with corn, or the two crops may be planted in alternate rows. For young hogs the beans are often planted alone. Soy-bean pasture may be supplied for a period of several weeks by planting early, medium, and late varieties. Early-maturing varieties may be sown after small grains and make sufficient growth to supply considerable feed in the fall. Soy beans may be pastured at any time from the stage when the pods are one-half filled until the beans are mature. The usual practice is to turn the hogs into the beans when the seeds are about full grown, although in some sections this is not done until the seeds are mature.

When hogs have been pastured on soy beans alone there is a tendency for the lard to become soft. This may be overcome very materially by feeding the hogs on a grain ration after taking them from the pasture. The feeding of corn alone for four or five weeks has produced firm lard, while corn and cottonseed meal used in the proportion of 3 parts of corn to 1 part of cottonseed meal has given the best results.

SOY BEANS FOR ENSILAGE.

The use of soy beans alone for ensilage is not to be recommended, as shown by the results obtained by various experiment stations. The

[1] Good, E. S. Hogging down soy beans and cowpeas. Ky. Agr. Exp. Sta. Bul. 201, p. 139–149, 2 fig. 1916.

Wisconsin station[1] found that soy-bean ensilage alone was not readily eaten by stock, had a rank unpleasant odor, and produced a bad effect in the quality of the milk, butter, and cheese. Somewhat similar results were obtained at the Michigan station.

The soy bean, however, forms a valuable supplement to corn for ensilage, and the growing of the crop for this purpose has increased extensively throughout the Northern States and in some of the Southern States. The high content of protein and rather low content of carbohydrates in soy beans tend to produce strong-smelling objectionable ensilage, while their dilution with corn—about two or three parts corn and one part soy beans—reduces the danger of strong odors, makes a well-balanced ensilage that keeps well, is readily eaten by stock, and produces no bad effects in the quality of milk and its products. Corn in itself makes rather a wide ration, and should be supplemented with feeds richer in protein to balance the ration. The Maine Agricultural Experiment Station,[2] in an experiment with six cows, comparing soy-bean and corn ensilage with corn ensilage alone, found that the cows on soy-bean and corn ensilage with 1 pound less grain did practically as well as on corn ensilage. In all feeding tests with soy-bean and corn ensilage the animals showed good gains in flesh and milk production.

Various methods are employed in growing and working the two crops in the silo. The easiest, least expensive, and perhaps the commonest way is to mix two-thirds corn and one-third soy-bean seed and plant it the same as corn. With this method the planting is all done at one operation and the crop cared for in accordance with the common practice for corn. Another method of mixing the seed is to add to the regular seeding of ensilage corn 8 pounds of soy-bean seed to the acre. The growing of the two crops together is advisable only where the soil and climatic conditions are suitable.

Under conditions where corn grows tall and leafy much larger yields of soy beans will be obtained by growing the crop in a separate field. Results secured by the Cornell Agricultural Experiment Station[3] do not favor the two crops together, as the beans are likely to be crowded out in competition with the corn. It would also appear that the harvesting and maintaining of the desired proportions of beans and corn can be more certainly accomplished by growing the two crops separately. In filling the silo from separate fields of soy beans and corn, the ratio usually runs one load of beans to two loads of corn, though in some sections three loads of corn are used.

[1] Woll, F. W., and Humphrey, G. C. Soy-bean silage as a food for dairy cows. *In* Wis. Agr. Exp. Sta., 21st Ann. Rpt. [1903]/04, p. 67–74. 1904.

[2] Woods, C. D., and Bartlett, J. M. Soy beans in Maine. *In* Maine Agr. Exp. Sta. Bul. 106, p. 113–121. 1904.

[3] Minns, E. R. Soy beans as a supplementary silage crop. N. Y. Cornell Agr. Exp. Sta. Bul. 310, p. 259–274, fig. 53–58. 1912.

Soy beans may be used for ensilage at any time from the appearance of the first bloom until the seeds are full grown. The best results, however, are obtained if the plants are cut when the seed is about half grown. The crop may be harvested with a side-delivery reaper or with a binder. The latter implement is, perhaps, most satisfactory, as the beans can be handled in bundles and without waste.

SOY BEANS FOR SOIL IMPROVEMENT.

The value of a crop of soy beans for soil improvement depends upon the amount of available plant food which it adds to the soil and the effect which the roots have upon the mechanical condition of the soil. Leguminous plants, through the aid of the root-tubercle organisms, are able to add to the available nitrogen of the soil and therefore are extensively used in restoring soils that are deficient in that element. The fertilizing value of a crop of soy beans compares favorably with that of other legumes commonly grown for green manure.

Some rather extensive experiments were carried on by the Michigan Agricultural Experiment Station[1] to compare soy beans and other legumes as green-manuring crops. Taking the approximate yields of the legumes as a basis and adding to the fertilizing constituents in the forage the amounts that would be found in the weight of roots going with that amount of forage, the total amounts of the fertilizing constituents are shown in Table VIII.

TABLE VIII.—*Fertilizing constituents in different legumes grown at the Michigan Agricultural Experiment Station.*

Legume.	Fertilizing constituents (pounds).			
	Hay.	Nitrogen.	Phosphoric acid.	Potash.
Soy beans	5,860	152.29	27.38	100.89
Cowpeas	3,575	61.90	15.45	77.20
Vetch	3,000	77.10	18.58	63.12
Clover (second crop)	2,000	51.47	12.05	36.18
Clover (new seeding)	2,170	49.06	11.61	63.55

The Kansas Agricultural Experiment Station[2] reports an increase of 14 bushels of corn to the acre where corn followed soy beans in alternate years as compared with corn grown continuously. At the Arkansas station[3] soy beans used as green manure gave nearly as good results as cowpeas, as determined by subsequent crops of wheat, oats, cotton, and corn. Soy-bean vines produced a larger yield of cotton than cowpea vines, but the cowpea stubble gave a larger yield than

[1] Smith, C. D. Legumes other than alfalfa. Mich. Agr. Exp. Sta. Bul. 227, p. 167–184. 1905.

[2] Ten Eyck, A. M., and Call, L. E. Cowpeas. Kans. Agr. Exp. Sta. Bul. 160, p. 179–209, 10 fig. 1909.

[3] Newman, C. L. Oat experiments. Ark. Agr. Exp. Sta. Bul. 66, 23 p. 1901.

the soy-bean stubble. With corn, cowpea stubble and soy-bean stubble gave about the same results, while the soy-bean vines gave better results than the cowpea vines. The results with oats were slightly in favor of cowpeas.

It is hardly practicable to grow soy beans for green manure alone, as it is too valuable a crop to plow under for soil improvement except under certain conditions. The soy beans may follow wheat or oats and make sufficient growth to add considerable organic matter to the soil for wheat or other fall-sown crop. Soy beans should not be allowed to mature before plowing them under. When the plant has reached the blossoming stage, most of the nitrogen has been gathered.

ENEMIES OF THE SOY BEAN.

As yet the soy bean is troubled by few serious enemies. In general, it may be said that no insect or fungous pest has assumed any great economic importance in connection with the culture of this crop.

Rabbits are most troublesome, as they are very fond of the soy-bean plant and have been known to destroy considerable areas. Where rabbits are abundant, soy-bean culture in small areas is practically impossible unless the field can be inclosed with rabbit-proof fencing. In some of the Northern States, woodchucks have caused considerable damage to small plantings of the soy bean.

Root-knot caused by a nematode often causes considerable injury to soy beans in many sections of the Southern States where this pest is prevalent. In sections where the pest has become well established in the soil, soy beans should not be planted. To plant them is a dangerous practice, not only because the bean crop will be reduced, but also because the pest can propagate freely and greatly damage any susceptible crop which follows the soy beans.

Cowpea wilt, due to a Fusarium, causes considerable damage to the soy bean. One variety, unnamed as yet, is highly resistant to this disease and has given quite good results on soils infested with wilt.

Caterpillars sometimes eat the soy-bean foliage, but the damage from such insects is seldom serious. The black blister beetle has been reported in a few cases to have done considerable damage to soy-bean fields, but in general this insect can not be considered a serious pest.

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