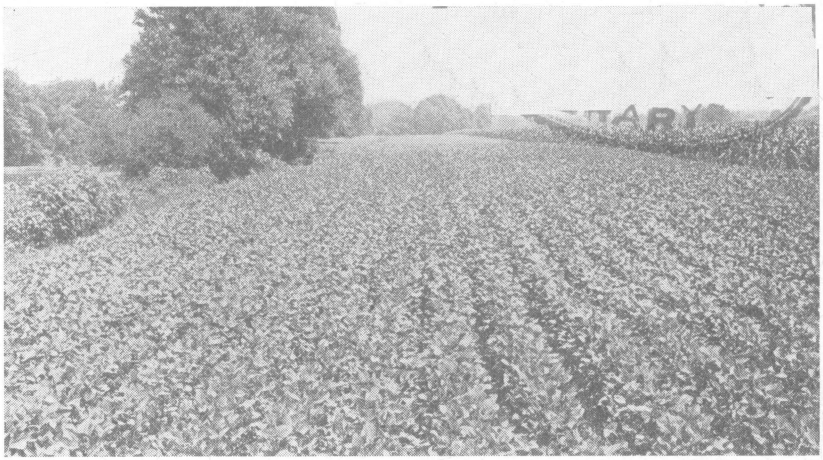

Farming with Soybeans

For Marketing
For Feeding
For Land Use

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To Be Successful in Producing Soybeans

• •

1. *Choose high-yielding, adapted varieties.*
   Maturity, yield, lodging-resistance, use, should be considered.

2. *Make certain that the seed is of high quality.*
   High germination, unbroken seed coats, freedom from variety mixtures and weed seeds.

3. *Prepare well worked seedbeds early.*
   Kill one or two crops of weeds before planting. Have seedbed firm underneath.

4. *Inoculate the seed.*

5. *Plant thickly, at a shallow* depth, as *early* as the soil warms up, and well worked, relatively weed-free seedbeds can be prepared. Plant later if drilled solid than if in rows to be cultivated.

6. *Control Weeds*—by tillage ahead of planting and by cultivation periodically until plants become 10 inches tall.

7. *Use timely and efficient harvesting methods.*

Farming with Soybeans

For Marketing • For Feeding • For Land Use

By

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Soybeans Become Popular. Recent years have brought a spectacular expansion of soybean production in Ohio. For each acre harvested for beans in 1934 there were 23 acres in 1940. In 1930, 69 per cent of the soybean acreage was harvested for hay, and not until 1938 were more acres harvested for beans than for hay. In 1940, Ohio farmers harvested 560,000 acres for beans, 363,000 for hay, and an additional 114,000 acres were grazed or plowed under for soil improvement, making a total of 1,037,000 acres planted to soybeans. Only corn and wheat occupied more acres.

Processing Plants Make a Ready Market. The great expansion of soybeans grown for the market was made possible by the building of soybean processing plants. At the present time there are twelve such plants well distributed over Ohio and growers anywhere can market their beans at any time through the regular grain buying channels. Processing capacity in Ohio is about double the present production of beans. This seems to insure a ready market for Ohio beans and is evidence that the processors have faith in the future of the industry.

Methods of Processing. The oil content of soybean seed ranges from 14 to 24 per cent, with an average in commercial beans of around 18 to 19 per cent. The protein content ranges from 30 to 50 per cent, with an average around 39 to 40 per cent.

Processes used for separating the oil from soybeans are (1) the expeller, (2) extraction with solvents, and (3) the hydraulic press. The expeller method is most commonly used by the mills in Ohio. In this process, hot crushed beans are fed continuously into a machine resembling a huge sausage grinder. Here the mass is subjected to high pressure by means of a powerful screw which propels the mass through a slotted steel cage under sufficient pressure to squeeze the oil out between the bars of the cage. By the expeller process a ton of beans yields 250 to 280 pounds of oil and approximately 1600 pounds of meal. Milling losses and moisture account for the remainder. The resulting meal has a pleasing toasted flavor and contains from 4 to 5.5 per cent of oil.

In the solvent process the beans are moisture conditioned, cracked, rolled into flakes, and passed continuously through an extractor

counter-current to the flow of solvent. Hexane is a commonly used solvent. The extracted meal is steamed to remove all trace of solvent, dried, ground, and bagged. In some cases it is roasted to improve the flavor and digestibility for livestock. When the solvent process is operated efficiently the meal contains no solvent and 1 per cent or less of oil.

Uses of Soybeans

Soybean Oil. This goes into a great many different products. At the present time more than 85 per cent of the total amount goes into edible products, including salad oil, vegetable shortening, and margarine. Other uses are in paint, varnish, linoleum, ink, soap, foundry core binder, and artificial rubber. Paints, varnishes, and enamels containing a percentage of soybean oil are finding increasing favor because of greater durability and superior elastic properties. Soybean oil is a highly competitive product in all its fields of use. It does have the advantage of being a many purpose oil and can go into any of several uses as price dictates.

Soybean Meal. Ninety-five per cent of the soybean oilmeal produced in the United States is used for feeding livestock. The remainder is used in manufacture of glue, fertilizer, plastics, and flour. With the exception of the glue industry, the volume of soybean meal used for industrial purposes other than feeds is negligible.

Although a newcomer among protein concentrate feeds, soybean oilmeal has become generally accepted as being fully equal to the other oilmeals, and superior for certain uses. When properly supplemented with minerals, it is one of the best vegetable concentrates available for fattening hogs. Likewise, for beef cattle, dairy cattle, sheep, and poultry, soybean oilmeal is very palatable, and in feeding trials has compared favorably with all competing products.

Whole or Ground Soybeans. These have limited use for feeding farm animals. Numerous experiment station tests have shown that ground soybeans are about equal to cottonseed and linseed oilmeals for dairy cows. Sheep also make good use of whole soybeans.

For fattening hogs, unprocessed soybeans are unsatisfactory. When fed in sufficient quantity to balance a corn ration they make a soft, flabby carcass and the gains are relatively costly. Soybean oilmeal, on the other hand, is free from this objection.

Hay. Soybeans make an excellent legume hay, with a yield equal or superior to red clover. Well cured soybean hay is equal in feeding value to good alfalfa, although the coarse stems, which make up 10 to 15 per cent of the soybean hay, are refused by animals.

Green Manure. The maximum amount of nitrogen per acre in a crop of soybeans is usually reached by September 1 to 15, depending

on location and variety. At this time, the seeds of the so-called grain varieties are two-thirds to fully formed and the lower leaves are beginning to turn yellow. Soybeans intended for a green-crop manure may well be plowed at this time, since there is no appreciable increase in nitrogen per acre after this.

The Soybean and Soil Productivity

The growing of a biennial legume does some damage — but much good — to the soil. All effects of a grain crop are degrading. Between these stand the annual legume. Being one of the latter, the soybean exerts a soil effect, part of which is good and part bad. A full appraisal of what the soybean does to land very properly includes four features, namely:

1. Volume of organic material added;
2. In-put and out-go of nitrogen;
3. Renewal of tilth by its root action;
4. Out-go of phosphorus and potash.

Humus-making Material Varies with Crop Use. Of a normal crop of soybeans, the root material amounts to from 400 to 700 pounds; the top, to 4,500 pounds in terms of dry weight. In comparison, a better than normal crop of red clover contains about 1,200 to 1,500 pounds of root and 4,000 pounds of top. Utilizing the soybean for hay obviously adds to the soil a meager amount of humus-making material — not more than a fourth to a third as much as could be had in the clover roots. From what is known of the rate at which organic matter content of tilled land is dissipated (700 to 1,500 pounds yearly), the material contributed by the soybean root system would fall far short of replacing that destroyed incident to growing the crop.

Harvesting mature beans with a combine instead of for hay reverses the balance; about 2,500 pounds of leaves, stems, and pods are then left on the field. This mass of residue incorporated with its complement of 400 to 700 pounds of roots, restocks the soil with three to four times as much humus-making material as the soil lost in growing the crop, although some of this is lost during the winter.

In-put and Out-go of Nitrogen. Full nodulation enables the soybean to obtain the major share of its large nitrogen needs from the air. A 30-bushel crop of beans contains 90 pounds of nitrogen in the seed and the corresponding straw, roots, and stubble contain about 60 pounds. According to Sears' data at the Illinois Experiment Station, the nitrogen left on the ground by these crop residues safely exceeds the amount removed from the soil by the crop.

The case for hay is different. The roots and stubble of a 4,500-pound hay crop contain about 15 pounds of nitrogen — an amount believed to be substantially less than that drawn from the soil by the

crop. Clearly, the growing of soybean hay exhausts the soil of nitrogen — but less rapidly than it is done by corn.

Soils already enriched with nitrogen from clover in the rotation are able to digest raw soybean residue promptly and with benefit to a fall-seeded cereal crop. But ill results may attend the process on soil poor in nitrogen, since the decay organisms are obliged to use up a goodly share of the scant stock of available soil nitrogen, thus leaving too little for the current demands of a fall grain. This situation may be corrected by:

1. Applying at wheat seeding, 300 pounds to the acre of fertilizer analyzing 2 to 4 per cent of nitrogen

or 2. Incorporating with the soybean residue 75 to 100 pounds to the acre of a nitrogen carrier (such as sulfate of ammonia)

or 3. Waiting until spring and seeding a spring cereal, since the unbalanced condition will correct itself by then. Hence, oats on soybean residue land yields more than on cornstalk land.

Renewal of Tilth by Soybeans. Few, if any, annual crops can match the power of soybeans to loosen and mellow the soil body. In this attribute the soybean is distinctly a restorative (a soil improving) crop. Its tilthing action proves quite intense in the upper part of the plow layer, but feeble beneath. The looseness of soil set up by soybeans proves less durable than that created by biennial legumes or grasses.

Due largely to its physical action on the stubborn Paulding clay, a soybean crop definitely raised the yield of corn and oats when added to a rotation of corn, oats, and sweet clover. Heavy soils — clays, clay loams, and silty clay loams — succumb to this action. It makes better seedbeds for drilled crops and results in a saving in cost of tillage. Soils prone to looseness may show excessive looseness after a crop of soybeans. For such situations, a weighted cultipacker or roller may be used to firm the soil over the seed. Because of its favorable tilth, stubble ground following a soybean hay crop cut before August 1 affords an excellent site for seeding alfalfa in summer.

Out-go of Phosphorus and Potash. Heavy inroads on soil phosphorus and potash are made by the soybean plant. Seed of a 25-bushel crop of beans removes as much phosphorus as the grain of a 55-bushel corn crop; and three times more potash. Selling soybean hay depletes the farm by one-half more phosphorus and three-fifths more potash than does the marketing of beans. Comparable annual hay crops of soybean and alfalfa consume like amounts of phosphorus, but the up-take of potash by soybeans lags three-fifths behind that by alfalfa.

In practice, therefore, small grain seeded on soybean hay stubble ground would best receive 300 pounds of a fertilizer carrying at least 12 per cent of phosphoric acid plus 12 per cent of potash; on land from which only beans were harvested, the potash may be dropped to about

half that of phosphoric acid but the rate unchanged. (At the same time, the nitrogen needs should be met as outlined above.)

Soil Productivity Factor. Combining the four effects just discussed into a single all-over appraisal, the evidence would seem to place the soybean crop as mildly degrading. Its "soil productivity factor" — or index for the collective influence on soil organic matter, tilth, nitrogen, and mineral nutrients — is a numerical value of −0.5 in a scale where corn rates −2.0, wheat −1.0, common clover +2.0. Modifying the factor according to the use made of the crop, we have:

Use of Crop	*Productivity Factor*
Soybeans harvested for hay	−0.5 degrading
Soybeans harvested for beans (straw removed)	−0.5 degrading
Soybeans harvested for beans (straw left on field)	−0.25 degrading
Soybeans green-crop manure	+1.5 restorative

Use of Lime and Fertilizer. Liming acid soils is beneficial to soybeans, although they make fairly good yields of both hay and beans on soils that are too acid for red clover.

Soybeans respond very little to direct applications of commercial fertilizer. It seems best, therefore, to apply the fertilizer on other crops in the rotation.

Carry-over Effect of Soybean on Other Crops. What of the after-effect of the soybean on other crops that immediately follow it in the cropping scheme? Under a progressive soil program, the effect is wholesome. But on land weakened by bad soil practices of long standing, a crop following the soybean may fall short of expectations.

Significant evidence of the wholesome after-effect of the soybean is offered by the 17-year findings of the Indiana Agricultural Experiment Station. These data seem especially meaningful to Ohio inasmuch as the cropping was done on Brookston, Miami, and Crosby soils — identical with those of the Corn Belt region of Ohio, where 82 per cent of our beans are being grown. Corn after soybeans outyielded corn after oats and wheat. Better yields of wheat were obtained after soybeans (beans and straw removed) than after oats or corn. Oats after soybeans excelled (20 per cent) oats after itself, or after wheat, and almost matched oats after clover. This performance refutes the idea of the soybean plant being toxic to other crops.

Does the Soybean Render Soil Vulnerable to Erosion? Not included in the above productivity effect of soybeans is the matter of erosion. Exposure of the soil surface in the period preparatory to, during, and immediately after planting of the soybean renders the soil neither more nor less vulnerable to erosion than like conditions attending the planting of other crops. The almost continuous canopy over the soil afforded by solid planting of the soybean crop protects against

puddling caused by the impact of rain drops and this sustains the rain water intake capacity of the soil.

Row planting, on the contrary, fails to protect, and permits a larger volume of surface run-off together with greater erosion. In rows, the soybean leads to essentially as much erosion as row planting of any crop. According to findings by the Missouri Experiment Station, soybeans drilled solidly up and down a 3.7 per cent slope allowed about 45 per cent as much erosion as did corn in rows up and down the same slope; in rows of corn planter width soybeans occasioned 95 per cent as much soil loss as corn.

To avoid unnecessary washing, the drill rows ought to be on the contour. After-season protection may be had (a) by planting a winter cover crop, or (b) by leaving the straw residue uniformly spread over the surface. The latter device triples the water intake capacity of the soil, and sloping fields so protected over winter are observed to be much less subject to erosion.

Make a Regular Member in Cropping Pattern

Up to now, the soybean crop has been somewhat a makeshift, being grown outside the regular crop rotation. Large scale production, however, demands that it be made a regular member of the cropping system.

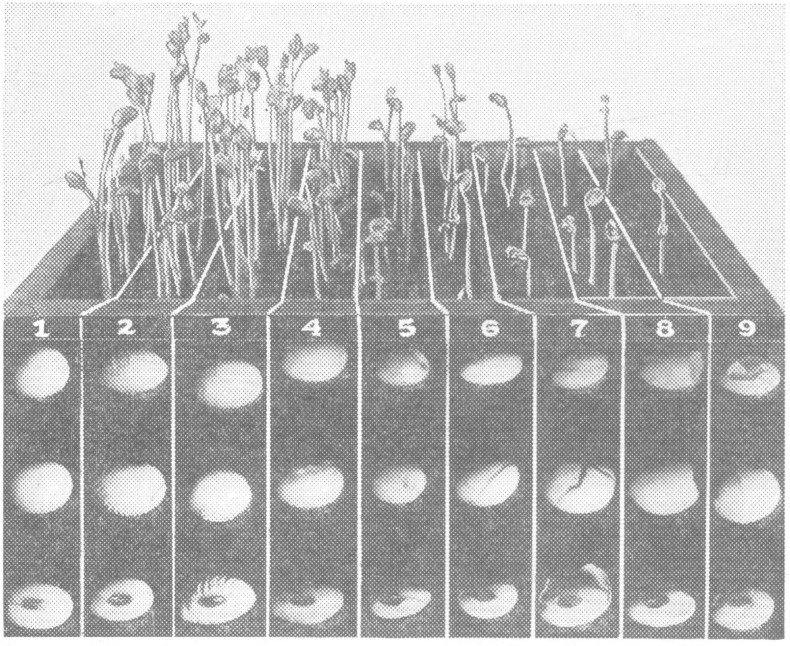


Fig. 1.—Shriveled and broken seed coats and broken beans reduce germination of soybeans. The beans on the left are of first quality. Left to right the seeds are progressively less desirable. Note the corresponding germination shown by the stand of seedlings.
(For discussion of seed quality, see paragraph 2, page 13.)

Broadly considered, the grower may look to four or five patterns for one that fits or can be made to fit his circumstances. These key schemes appear in the box below:

Some Crop Sequences That Accommodate the Soybean

1. Sod, Corn, SOYBEANS, Wheat
2. Sod, SOYBEANS, Corn, Wheat
3. Sod, Corn, SOYBEANS, Oats
4. Sod, SOYBEANS, Oats or Wheat
5. Sod, Corn, SOYBEANS
6. Corn, SOYBEANS, Oats (Sweet clover)

In each instance the Sod should be kept long enough (as much as two years) to maintain productivity and control erosion.

Scheme 1. To attempt a rotation that includes both soybeans and wheat necessitates erasing the overlap, of one to three weeks, in the harvesting of beans and the seeding of wheat. There are two ways around this difficulty for the grower who wishes to hold to wheat: (1) He may adopt an early variety of soybeans (see discussion of varieties); (2) he may adopt scheme 2 as follows:

Scheme 2. The soybean crop follows the sod and in turn is followed by corn, permitting wheat to be seeded on corn land as usual. Very limited experience by farmers thus far indicates little if any disadvantage to corn through this procedure.

Scheme 3. If one is willing to omit wheat he may keep the bean crop in its usual place after corn and substitute oats for wheat.

Scheme 4. On thin land, too weak for row crop production, some like to use a combination of soybeans, small grain, and sod crop harvested for seed. This permits harvesting all crops with the combine in a grain system. This scheme may be used for all of the cropland of a farm or it may be used parallel with a sequence of sod, corn, and wheat on the farm, in which instance the acreage formerly devoted to the corn crop is divided between soybeans and corn.

Scheme 5. The year following soybeans is given entirely to soil improvement. In the spring a legume-grass mixture is seeded alone or with a light seeding of oats. No crop is harvested. Weeds may need to be clipped to prevent seeding and smothering the legumes.

Scheme 6. This is an intensive grain system that depends on obtaining a good stand and growth of sweet clover to plow down for corn.

The above schemes are not rotations; they merely indicate the order in which types of crops may be grown and they show the position of the soybean crop in sequences of other crops. Each combination has advantages peculiar to itself.

USE ADAPTED HIGH-YIELDING VARIETIES

Oil mill operators prefer yellow beans, and it happens that the higher yielding varieties have yellow seeds. Fortunately, these same

Table 1. Yields of Soybean Varieties at Six Locations in Ohio.
Bushels per Acre.

Variety	Columbus		Holgate (Henry Co.)		Wooster		Van Wert 3 yrs '38-40	Clarksburg, Ross Co. 2 yrs. '39-40	Sandusky, Erie Co 2 yrs. '39-40
	11 yrs. '30-40	2 yrs. '39-40	12 yrs. '29-40	2 yrs. '39-40	11 yrs. '30-40	5 yrs '36-40			
Scioto	31.8	22.8	27.9	34.5	32.2	33.3	30.6	23.3	32.7
Illini	26.8	22.1	25.6	29.5	28.6	29.3	32.5	22.4	30.4
Dunfield	24.4	20.9	25.4	30.6	27.6	28.0	29.7	22.0	29.4
Mingo	26.1		25.5	30.5	26.9	29.6	31.9	21.7	31.6
Mandell						31.1	31.9		
Mukden		19.9		28.0			30.3	19.0	31.6
Richland				27.8		25.8	29.2	19.1	29.0
Mandarin				24.0			25.2	12.6	20.2
Wisconsin No. 3				26.8			25.5*		26 5
McClave		16.3		24.8			25.5*		25.5

* Two years only. 1939-40.

The following farmers cooperated with State and Federal agencies in conducting these tests: Mr. W. G. Weigel of Marsh Foundation, Van Wert; Mr. Ross Ransom, Sandusky; Mr. C. A. Gearhart, Clarksburg.

varieties are satisfactory also for hay. In northern and central Ohio, the yellow-seeded grain varieties are better suited for hay than the dark-seeded Wilson and Virginia that have long been popular. In central and southern Ohio, an exception to this rule is the new variety Kingwa, a black-seeded variety that is outstanding in yield of hay and in retention of leaves.

Varieties widely adapted in Ohio are Illini, Dunfield, and Mingo, the last being a medium early selection from Manchu. Scioto is a late selection from Manchu that has a high yield record over most of Ohio. It is too late to precede wheat except in southern Ohio. In northwestern Ohio Scioto has matured, but it makes late harvesting with the accompanying weather hazards.

Table 2. Days from Planting to Maturity of Soybean Varieties in Ohio.

Variety	Holgate 2 yrs. '39-40	Van Wert 3 yrs. '38-40	Sandusky	Ross Co.	Columbus*
Scioto	140	141	145	130	126
Illini	134	134	138	127	122
Dunfield	133	132	137	128	123
Mingo	131	129	131	122	121
Mukden	132	130	134	121	118
Richland	125	122	126	117	116
Mandarin	115	114	118	114	109
Wisconsin No. 3	124	119**	122	117	114
McClave	144	143**	149	135*	128

** 2 years. * 1940 only.

The need for early varieties is most acute in northern Ohio. Observations covering one to three years indicate that the best early varieties available are Mandarin, Richland, and Wisconsin No. 3. Data on maturity and yield are given in Tables 1 and 2. Recommendations of varieties for Ohio by climatic zones are given in Table 3.

The yields of soybean varieties are roughly in proportion to the lengths of their growing seasons, provided maturity is reached. For that reason the necessity of using an early variety in a wheat rotation involves some loss in yield of soybeans compared to other rotations in which a later variety might be used.

Table 3. Soybean Variety Recommendations for Ohio

All but two varieties listed below have yellow seeds and are acceptable to the oil mill trade. The exceptions are the two hay varieties—Kingwa, which has black seeds, and Virginia, which has brown seeds.

Sections of the State	For Grain		For Hay
	When winter wheat or rye is to follow the soybean crop	When no fall sown crop is to follow the soybeans	
For Northern Ohio	Mandarin Wisconsin No. 3 Richland	Richland Mingo Dunfield (plant early) Illini (plant early) Scioto (plant early)	Mingo Dunfield Illini Scioto Kingwa
For Central Ohio	Wisconsin No. 3 Richland Mingo (plant early)	Mingo Dunfield Illini Scioto	Mingo Dunfield Illini Scioto Kingwa
For Southern Ohio	Richland (for late plantings) Mingo Dunfield (plant early) Illini (plant early)	Mingo Dunfield Illini Scioto	Scioto Kingwa Virginia

Manchu, as such, is not recommended because a wide range of maturity is represented by different strains of this variety. For example, Wisconsin No. 3 is a very early selection of Manchu; Mingo a medium maturing selection, and Scioto a late selection from the original, highly mixed Manchu introduction. Furthermore, some beans are called "Manchu" simply because their correct names are unknown.

Mandarin is the earliest one suggested for Ohio. It yields less than the others, and is needed only in the shortest season areas of extreme northwestern and northeastern Ohio. Hilum or seed scar pale yellow, flowers purple, hairs gray.

Wisconsin No. 3, an early selection from Manchu, matures between Mandarin and Richland. Hilum black, flowers purple, hairs brown.

Richland is medium early and stiff stemmed, adapted only to productive soils, and especially to the productive black soils of the northern half of Ohio. Hilum dark gray, flowers purple, hairs gray.

Mingo, a selection from Manchu, of medium maturity, and a good yielder in its maturity class; widely recommended. Hilum black, flowers purple, hairs gray.

Dunfield is a few days later than Mingo. It and Scioto probably have the highest oil content of the recommended varieties. Hilum brown, flowers white, hairs gray.

Illini matures about the same time as Dunfield, has slightly higher yield, but slightly lower oil content. Seed small, hilum brown, flowers purple, hairs gray.

Scioto, a late selection from Manchu, is superior to all others in yield in all except the most northern tier of counties. It is too late to precede wheat even in southern Ohio. Its content and quality of oil are highly satisfactory. Hilum black, flowers purple, hairs brown.

Growing the Soybean Crop

Soybeans are not difficult to grow and crop failures are not frequent. When failures occur, the chief causes are poor stands and poor control of weeds.

Inoculation is Indispensable. The soybean requires its own special kind of inoculation and does not cross-inoculate with any other legume. A well inoculated crop yields substantially more than one devoid of nodulation. Presence of inoculation is indicated by dark green, healthy plants, and by an abundance of grayish-white nodules on the roots. Uninoculated plants are yellowish unless growing on a soil rich in nitrogen. Uninoculated plants do not use nitrogen from the air, and, therefore, use soil nitrogen, just as non-legumes do. In a 3-year test at the Indiana Station, uninoculated soybeans yielded 27.5 bushels and inoculated yielded 32.9 bushels.

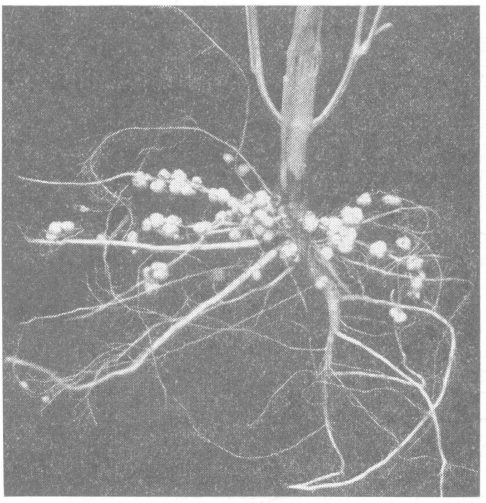
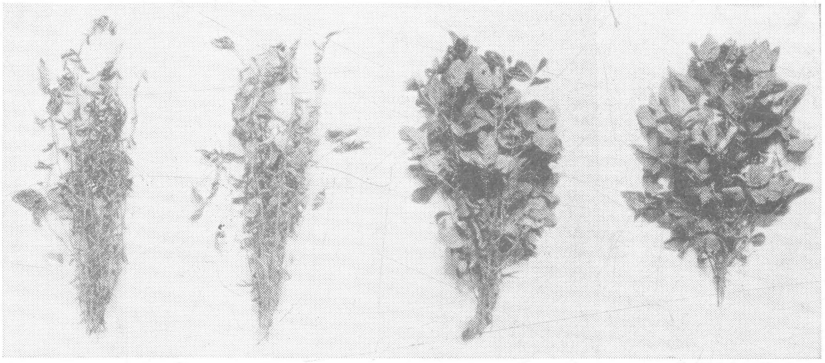


Fig. 2.—Root nodules on a well inoculated soybean plant—a source of low cost nitrogen.

When soybeans are to be grown on a field for the first time the seed should be inoculated. Most commercial inoculators now on the market are dependable. Directions on the package should be followed.

Plant Only High-Quality Seed. Soybean seed should be carefully inspected before buying. Seeds with broken, and especially with loosened seed coats are likely to be weak or dead (see Fig. 1, page 8). Buying certified seed is the best guarantee that the seed obtained will be true to variety name and in good seed condition. Each bag of seed should carry a statement of guaranteed germination.

A Firmer Seedbed Than for Corn. A good seedbed for soybeans is firm below with enough loose soil on the top to permit shallow planting and good covering. This is best accomplished by early plowing, which allows time for settling of the soil and for several diskings. Such procedure also permits killing several crops of weeds before planting the soybeans.



May 1 May 15 June 1 June 15

Fig. 3.—Dates of planting and stage of maturity of soybeans on September 21. Early planting insures early maturity—three days delay in planting makes one day later maturity.

Early Planting Makes Earlier Ripening. Soybeans are more resistant to late spring frosts than corn. Since early-sown beans grow slowly until early June, the weeds may get ahead. However, they mature earlier and make slightly higher yields of beans, if the weeds are controlled. Some experienced growers believe they get better results from planting in late May. One grower expressed it this way: "Plow soybean land before corn land, and plant corn first." Planting May 19 to 25 gave the best yields in a test at Wooster. At Columbus, Manchu, planted May 1, yielded 1.8 bushels more than when planted May 15. Borst, of the Ohio Station, determined that three days' delay in planting results in one day later maturity.

For hay, or when drilled solid for mature bean harvest, it is desirable to plant around June 1. Rows for cultivation may well be planted earlier because weeds can be controlled.

Plant Shallow. A good seedbed permits shallow planting, preferably not more than 1 inch deep, which brings about quick emergence of the seedlings and easier weed control. It also reduces the danger of the soil crusting before the seedlings are above ground.

Thick Planting Is Desirable. Within wide limits the thickness of planting soybeans makes little difference in yield provided that large gaps do not occur in the stand. Spacing the seeds an average of about 1 inch in the row gives plants enough for maximum yield and allows for some loss of plants in cultivation. The number of pounds needed for planting depends on the size of the seed. For solid drilling, about

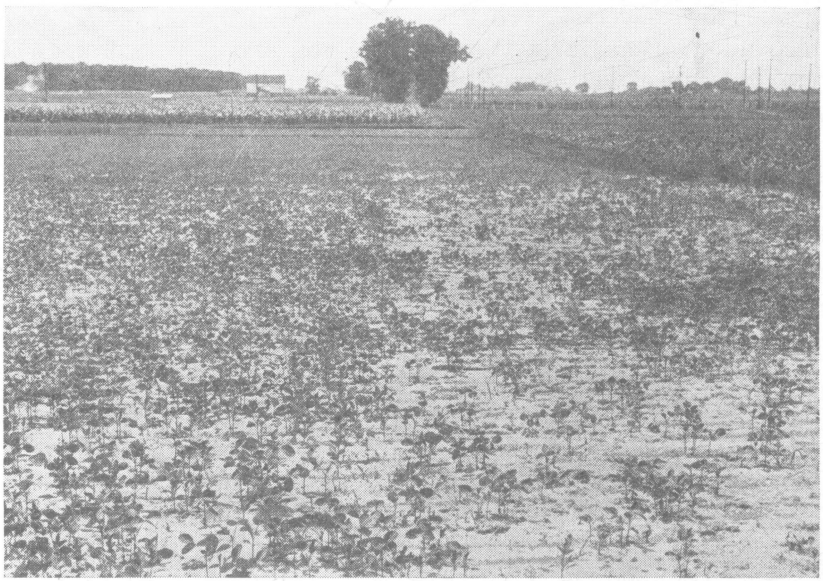


Fig. 4.—A rotary hoe helps soybeans break through a crusted soil. Left of center the crust was broken with rotary hoe; right of center line, no cultivation.

2 bushels of average sized beans are needed for an acre, and for 22-inch rows about 4 pecks.

Cultivated Rows or Solid Drilling. Experiments comparing 8-inch drilling with cultivated rows at various distances apart do not show any consistent relation of space between rows to yield. In most cases, the differences in yield are small. Apparently most varieties will make maximum yields when planted in 20- to 24-inch rows and for the larger-growing varieties 36 inches between rows is probably not too wide. Some experienced growers say they get satisfactory yields by using a corn planter with rows up to 40 inches apart. Solid drilling requires more seed but less labor in cultivating. Cultivated rows require more labor but permit better control of weeds.

A sugar beet drill and cultivator are excellent equipment for soybeans.

Cultivation and Weed Control. With solid drilling, the only methods of cultivation are the rotary hoe, the harrow, and the weeder. The rotary hoe breaks a crust better; the harrow kills more weeds and more soybeans. The spring-tooth weeder is the best on heavy soil. On weedy land and on heavy soil, especially in a wet season, these methods are not adequate for good control of weeds. Control is aided by plowing early, disking several times, and planting in late May, but this makes for later maturity. On soils that do not get hard quickly, and if rains are not excessive, the rotary hoe and harrow will control most of the weeds at small labor cost.

Cultivations should take place whenever weed seeds sprout and before they become established, and should continue until the bean plants are 6 inches tall. Even with widely spaced rows the rotary hoe and harrow may be used to advantage, and then going once over with the row cultivator may prove sufficient.

Harvesting of Soybeans

Harvesting for Grain (Market Beans).—The combined harvester-thresher is by far the easiest and most economical method of harvesting soybeans. Many experienced growers say it is not practical to grow soybeans unless a combine is available for the harvesting. Fewer beans are wasted with a well adjusted combine than with any other method of harvesting.

In the interests of timely wheat seeding, the soybeans may be harvested with a grain binder when most of the pods are brown and the leaves turning yellow; the crop shocked in rows and the wheat sown at once. The soybeans will then be threshed when they are dry enough. Soybeans are not safe from heating in bulk storage until the moisture is down to 15 per cent. For deep bin storage the moisture should be down to 13 per cent. Beans carrying more moisture than this should be spread on a dry floor 12 to 18 inches deep and left until dry. They should be stirred if heating occurs.

To avoid splitting beans in threshing, the cylinder should run at about one-half normal speed and the concaves should be reduced or removed entirely. The separator must maintain normal speed.

With combines that have the cutter bar offset at the side of the separator, it is possible to follow immediately behind the cutter bar with a wheat drill or with a disk harrow and drill, if disking is necessary. The straw then falls on drilled land and the job is all done.

Soybeans for Hay. The same varieties that are used for grain production are suitable also for hay. Since the chief objection to soy-

bean hay is the difficulty of curing, it is best to make hay in late August when the weather is better adapted to the curing operation than later. When harvested in August, the early varieties make higher yields of hay than later varieties. Only when hay harvest is delayed until late in the season do the late varieties make higher yields. Although the greatest yield is obtained when the seeds are from three-fourths to full size, and the lower leaves are just beginning to turn yellow, curing is easier at an earlier stage. Lack of favorable curing weather after August almost prohibits waiting for this stage of development in the soybean plant. To aid in overcoming the difficulty, the grower may resort to early planting.

After curing in the swath for one or two days, the hay should be raked into small windrows, preferably with a side delivery rake. These should be turned for drying but handled as little as possible to avoid loss of leaves. After a heavy rain, the windrows should be turned for quicker drying. For details on growing and harvesting soybean hay see Ohio Agricultural Extension Bulletin 151, "Sudan Grass, Soybeans, and Other Supplementary Hay and Pasture Crops."

Although some varieties of soybeans tend to have finer stems than others, the proportion of stems in the hay is not materially different among varieties. Thick planting produces smaller stems but does not reduce the percentage of stems in the hay. More of the small stems are eaten by animals although their nutritive value is very low.

Market Grades for Soybeans

The Federal grade requirements for market soybeans that have been in use for several years are in process of revision as this bulletin goes to press. When the new grade requirements are ready, printed copies may be obtained from grain buyers, soybean processors, or from the Agricultural Extension Service.

High quality market soybeans should be yellow, dry enough to keep safely in storage, and as free as possible from damaged beans, splits, and foreign material. One of the commonest foreign materials is shelled corn, which cleaning machinery will not entirely remove. The result is a lower grade and a lower price for the market beans.