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THE SOYBEAN: Its Place in a Farming System

Soybeans acreage in the regular cropping system on Ohio farms increases.

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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, free of variety mixtures, weed seeds and corn.
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.
   (a) Plant later if drilled solid than if in rows to be cultivated.
   (b) May plant later for hay than for beans.
6. *Control weeds*—by tillage ahead of planting and cultivation during the early stages of growth.
7. *Use timely and efficient harvesting methods.*

THE SOYBEAN
Its Place in a Farming System

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The Increase in Production of Soybeans in Ohio.—Our soybean patch is grown to a respectable size. It has arrived by solid, purposeful expansion. In the 10-year period, 1927-1936, Ohio's average annual production was 879,000 bushels of soybeans. Of Ohio's one-half million acres devoted to soybean growing in 1938, 284,000[1] acres yielded approximately six million bushels. An additional 192,000 acres were harvested for hay. The average acre-yield of soybeans in Ohio for the 12-year period 1927-1938, was 17 bushels. The yield of corn for the same period was 37 bushels and of wheat, 19 bushels. Only Illinois, Indiana, and Iowa now exceed Ohio in total production of soybeans.

Capacity of Soybean Oil Mills Greater Than Soybean Production.—Soybeans are quoted daily on the Chicago grain market. At the present time, nine soybean oil mills located at six points in Ohio serve the state's growers. Soybeans may be sold directly at the mills or to local grain dealers at all times on the same basis as corn or wheat. Some mills will trade oilmeal for beans on a basis that is to the farmer's advantage. The present capacity of Ohio mills is much greater than the current production of soybeans in Ohio. As a result, soybeans are brought from other states to Ohio for processing.

What Determines the Price of Soybeans?—In both feed and industry, soybean products must compete with other materials. Thus, as a high protein feed, soybean meal competes with cottonseed and linseed meals. The volume of soybean meal produced is much less than that of cottonseed meal; hence, cottonseed meal dominates the price. Soybean meal is probably the most valuable of the vegetable protein concentrates and, therefore, should bear a little higher price, but essentially the different oilmeals are in direct competition.

Similarly, soybean oil competes with cottonseed, corn, and coconut oils in the edible field and with linseed, tung, and perilla oils in the paint and varnish industry. To a very large extent the manufacturer's choice of these oils is determined by the price. Cottonseed oil is produced in greatest quantity and it, together with the

[1] This figure is based on A.C.P. acreage records furnished by the County Agricultural Agents in the soybean producing areas.

price of lard, strongly influences the price of soybean oil. Being a many-purpose oil, soybean oil has an advantage over the others, in that it can go into either the edible or the paint field as price dictates.

The price of soybeans, therefore, is determined more by the prices of cottonseed and linseed products and oils imported from the tropics than by the size of the national soybean crop.

USE OF SOYBEANS

The soybean oil mill makes just two products, oilmeal and oil. By the expeller process, which is the one most commonly used, a ton of soybeans yields about 1600 pounds of oilmeal and 280 pounds of oil. There is a manufacturing loss of about 6 per cent. Accordingly, a 60-pound bushel of beans provides about 8.4 pounds of oil and 48 pounds of meal. Expeller meal contains from 4½ to 5½ per cent of oil. Meal made by the solvent extraction process contains less than one per cent of oil.

Ninety-five per cent of the oilmeal produced in the United States is used for feeding livestock. The remainder goes into manufacture of glue, fertilizer, plastics, and flour.

Industry Utilizes the Oil.—More than 85 per cent of the soybean oil now goes into edible products chiefly as salad oil, shortening, and margarine. The paint, varnish, linoleum, and soap industries are other users. Soybean oil is a semi-drying oil. By mixing it with linseed and other drying oils, including tung and perilla, and with suitable driers, manufacturers are making paints that have superior wearing quality. Research workers are steadily finding ways of improving soybean oil paint and varnish as well as new uses both for the oil and the meal.

Soybeans and Soybean Oilmeal as Feed.—Whole or ground soybeans have limited value 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 the above objection. 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.

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 green-crop manure may be plowed at this time, since there is no appreciable increase in nitrogen per acre after this.

EFFECTS OF SOYBEANS ON SOIL

The growing of any harvested crop does some damage to the soil. The soybean crop is no exception. In appraising its effects upon land, the following points may be noted:

A Small Root System.—The top growth of a normal soybean crop is equal to that of red clover, but its root material amounts to a bare one-tenth of its top, about 400 to 600 pounds of roots an acre in terms of dry weight. Roots of red clover weigh one-third to one-half as much as the tops. Consequently, the roots of the soybean contribute about one-third as much humus-making material as one may expect from clover roots.

Soybean residues, if fairly mature, decompose slowly; the nitrogen and phosphoric acid, and to a lesser degree the potash, are not immediately released. Eventually, however, these nutrients do become available but the process is spread over a 2- or 3-year period. The immediate crop following the soybean shares little, if at all, in the benefit. Because soybeans are vigorous feeders, they draw heavily on the supply of available nutrients and moisture in the soil. Therefore, a crop planted immediately after removal of soybeans sometimes suffers. For these reasons, wheat following soybeans should be fertilized liberally.

An average crop of 4,500 pounds of soybean hay per acre contains about 120 pounds of nitrogen. The roots, stubble, and the few dropped leaves returned to the soil contain about 15 pounds of nitrogen. This makes a total of 135 pounds of nitrogen, a part of which came from the soil's stock of nitrogen.

When harvested as a hay crop or for beans without returning the straw, soybeans may leave the land slightly poorer in organic matter and nitrogen. Under these conditions, evidence and experience would rank the soybean crop about one-half as damaging to soil productivity as wheat.

If the crop is combine harvested, the beans will remove about 75 pounds of nitrogen. The straw, stubble, and roots contain about 60 pounds of nitrogen which is probably more than the growing crop took from the soil. The net effect is a small but positive addition of organic matter and nitrogen to the soil.

Soybean seed contains about the same amounts of phosphorus and potash as do comparable yields of corn and small grain. Soybean hay contains less potash and the same amount of phosphorus as comparable yields of clover and alfalfa.

An Aid to Tilth.—Few, if any, annual crops can match soybeans to loosen and mellow the upper surface of the soil. This may account in part for the better yields of crops following soybeans on some heavy types of soil. In this feature, the soybean is distinctly a restorative — a soil improving crop. The favorable tilth set up, though marked, proves less enduring and less deep than that associated with biennials and perennials which are our most potent agents in tilth-building.

Soil Suitable to Soybeans.—Soybeans do well on various types of soils and, if suitable varieties are used, they may be grown from Canada to Mexico. They are not sensitive to lack of lime and will often make a profitable crop on land that is too acid for clover or alfalfa. However, soybeans are benefited by lime and they yield better on lime-rich soil.

Soybeans seldom show a profitable response to fertilizers applied directly. It is best, therefore, to put all the fertilizer on other crops in the rotation that are known to make profitable use of it.

SOYBEANS TO BE A REGULAR MEMBER OF THE CROPPING SYSTEM

Soybeans in Rotation.—The soybean is no longer an odd, makeshift crop. If it is to contribute solidly to the farm program, good management requires that it be assigned a regular position in the farm's cropping pattern. That place should be at the expense of the corn or small grain acreage and never at the sacrifice of the sods. Among cropping patterns that accommodate soybeans are these.

3 year. — *Soybeans* — wheat (sweet clover) * — corn
4 year. — *Soybeans* — wheat — clover — corn
4 year. — *Soybeans* — wheat — sweet clover — corn
5 year. — *Soybeans* — wheat — alfalfa — alfalfa — corn
5 year. — *Soybeans* — rye pastured — alfalfa — corn — wheat — (sweet clover)

* Crop enclosed in parentheses, ( ), is utilized as green-crop manure.

All of these suggested rotations will maintain soil productivity, provided adequate amounts of fertilizers are used and good stands of other legumes are obtained.

When corn is to be followed by soybeans on sloping land, serious erosion will occur during the winter and spring. Rye seeded in the corn as a winter cover will reduce the damage.

Three Ways to Avoid a Conflict Between Soybeans and Wheat. —It is difficult to harvest soybeans with the combine early enough to sow wheat at the most favorable time. To overcome this difficulty, one may elect optional schemes:

Option 1 — Gain time for wheat by resort to both of two procedures (a) choice of an early-maturing variety; and (b) planting before or as early as corn planting time. This will mean some sacrifice in the yield of beans, since the early sorts yield less abundantly than good, later varieties.

Option 2 — Omit wheat but seed rye as early as practical following a medium-maturing but high-yielding variety of soybeans. In the spring, clover or alfalfa may be seeded and the rye utilized for pasturing or hogging off, or for grain harvest. See 5-year rotation.

Option 3 — In place of wheat, grow spring oats or barley, thus permitting use of a later maturing variety of soybeans. This arrangement comes at a price, however — that is, the cost in erosion occasioned by the bare, unprotected condition of the soil during the winter period. In instances of even mildly sloping land, the inevitable damage from erosion during the winter is so serious as to condemn this practice.

Table 1. Yield of Beans by Soybean Varieties at Different Locations in Ohio

Variety	Wooster			Columbus		Holgate		Germantown
	7 Yrs.	4 Yrs.	2 Yrs.	9 Yrs.	4 Yrs.	10 Yrs.	4 Yrs.	5 Yrs.
Scioto	33.9	38.1	35.9	30.8	27.2	26.9	32.5	33.3
Illini	31.2	36.3	31.5	28.0	27.2	25.2	30.4	28.6
Dunfield	30.6	35.9	32.8	25.9	26.1	24.9	29.9	31.0
Mingo	31.2	36.0	31.8	26.7	25.1	24.9	30.0	32.0
Mandell		36.1	34.5		24.2		28.9	
Mukden	31.1	36.9	37.1		24.0		23.6	
Richland ...			29.8		18.7[1]		23.6[1]	
O.A.C. 211..			29.1					
Mandarin ..			29.3[1]		21.4[1]		22.3[1]	

[1] One year only.

ADAPTED HIGH-YIELDING VARIETIES

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

The following varieties are recommended for Ohio (See Tables 1 and 2).

Mingo is an early strain of Manchu. Introduced by the Ohio Station and until 1939 grown under the name Ohio Manchu No. 1, the strain is characterized by yellow seeds, slate black hilums or seed scars, purple flowers, moderately stiff stems, brown hairs. It is adapted to the northern half of Ohio. If planted early in May and with a good season it may be combine-harvested in time for wheat in north central and central Ohio.

Mandell is an early strain of Manchu (from the Indiana Experiment Station), in maturity and appearance similar to Mingo.

Illini, from the Illinois Experiment Station, is two to four days later than Mingo. The seeds are yellow and small, the hilums light brown, the flowers white and the hairs gray.

Dunfield matures two to three days after Illini. The seeds are yellow, hilums a light brown, and the hairs gray.

Manchu designates a group of strains that are similar in seed and plant characters, but unlike in size of plant and time of maturity. In general, the Manchus on the market average about the maturity of Dunfield. The seeds are yellow, the hilums a slate black, flowers purple, and the hairs brown.

Scioto is a late strain of Manchu developed and released by the Ohio Experiment Station in 1933. It is the highest yielding variety for grain in central and southern Ohio but is too late to precede wheat. Scioto is also a good hay variety.

Kingwa is an excellent hay variety, being high yielding and retentive of leaf. It performs well in central and southern Ohio and is superior to Wilson. It was developed by the West Virginia Experiment Station. The seeds are small and black, the flowers purple, and stems fine.

Richland is a new variety from the Indiana Experiment Station which has been observed in Ohio for three years. It seems to be only slightly earlier than Mingo and not dependably early enough to precede wheat in the northern quarter of Ohio. It is not adapted to thin land.

Mandarin has been observed in Ohio for only one year (1938). It is the earliest variety listed here and promises to be early enough to precede wheat in northern Ohio.

O. A. C. 211 from Ontario has been grown for three years at Wooster. It has not matured any earlier than Mingo and has yielded less. Its large seeds increase the amount required for planting.

For the northern third of Ohio, Illini, Dunfield, and the later strains of Manchu do not usually mature early enough to permit harvesting with the combine in time for seeding wheat on the same land at the proper time. Earlier varieties show a reduction in yield in approximate proportion to their earliness (See Tables 1 and 2).

Soybean varieties do not ripen in the same order in all years nor at all locations in the same year. This makes it difficult to state anything definite concerning the maturing of varieties.

For central Ohio, Mingo and Mandell ripen in time for seeding wheat; Illini and Dunfield are early enough for this in some seasons.

All the varieties listed above have stiff or moderately stiff stems and do not shatter their seeds upon ripening. All have yellow seed with the exception of Kingwa.

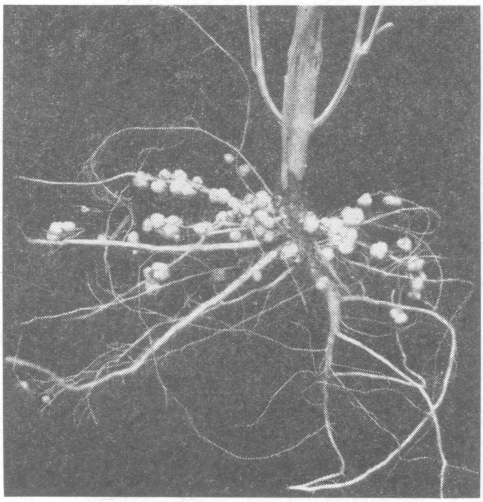

Fig. 1.—Root nodules on a well inoculated soybean plant—a source of low cost nitrogen.

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

Variety	Wooster	Van Wert		Columbus	
	2 Yrs.	1938	1937	1938	5-Yr. Average
Scioto	148	135	123	128	132
Dunfield	148	130	133	127	132
Illini	143	135	123	128	132
Mandell	134	130	123	129	130
Mingo	134	130	130	128	130
O.A.C. 211	128				
Richland	130	121	130	127	
Mukden	130	130		128	130
Mandarin	129[1]	114[1]		125[1]	

[1] One year only.

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.

On good soil in a favorable season, soybean yields of as much as 40 bushels an acre have been obtained on large fields. Some growers have maintained a 25-bushel average for a period of several years.

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.

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. The directions on the package should be followed. Soil from around the roots of well inoculated plants usually give satisfactory results as an inoculating material. About one quart of soil is needed for each bushel of seed. Dry, sifted soil may be mixed with dampened seed, or the soil mixed with water may be stirred with the beans. A minimum of water should be used and the seed should be dry enough to drill when the mixing is completed. An excess of water causes loosening of seed coats, swelling of the beans, and trouble in drilling. Drilling should take place within half a day after inoculating the seed.

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. 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 guaranteed germination of recent date.

A Seedbed Like That 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.

Early Planting; Earlier Ripening; Higher Yields.—Shallow planting, preferably not more than 1 inch deep, brings about quick

emergence of the seedlings and easier weed control. It also reduces the danger of soil crusting before the seedlings are above ground.

By "early" we mean at or just before corn planting time; the first half of May. Early planting makes weed control more difficult but it also makes earlier maturity and slightly higher yields of

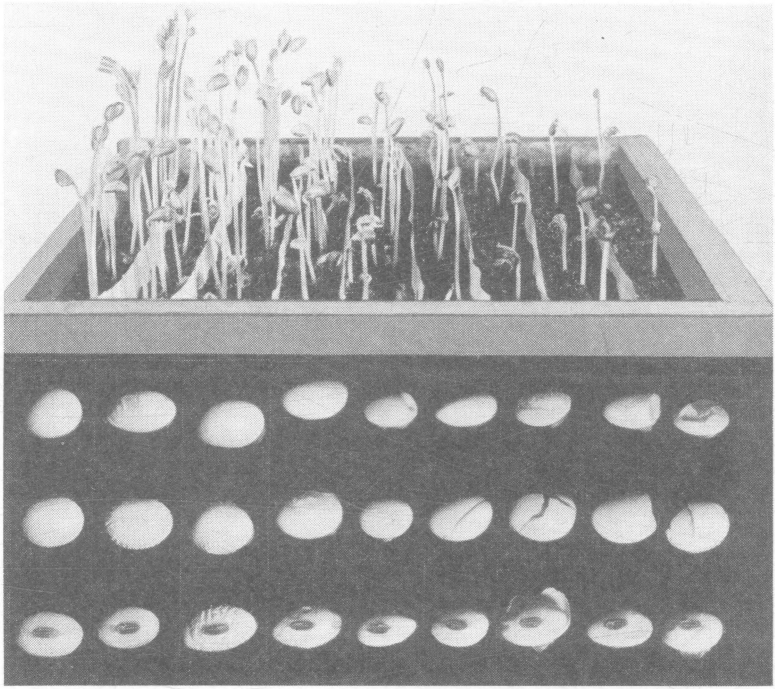

Fig. 2.—Shriveled and broken seed coats and broken beans reduce germination of soybeans. The beans on the left are of first quality. Those to the right are progressingly less desirable. Note the corresponding germination shown immediately above.

beans, if the weeds are controlled. Some experienced growers, however, believe they get better results from planting in late May. 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 each three days later planting results in one day later maturity.

Thick Planting Desirable.—Two methods of planting are commonly used: (1) drilling solid, using all spouts of a grain drill, and (2) spacing the rows wide enough to permit the use of a corn or beet cultivator.

Experiments at Wooster show that for 28 inch rows, 3 pecks of seed give the best yield. For solid drilling, 2 bushels of seed appear best. Solid drilling gave the same yields as 24 inch rows. Spacing seeds 1 inch in rows gave best yields at the Iowa Station.

Rows versus Drills.—The choice between solid drilling and cultivated rows is chiefly a question of weed control. Solid drilling requires more seed. It receives less cultivation and often the weeds are not well controlled. In a thick planting, the seedlings can push through a crusted soil much better than in a thin planting. A thick stand provides for some loss of plants in cultivating and helps to control weeds by smothering.

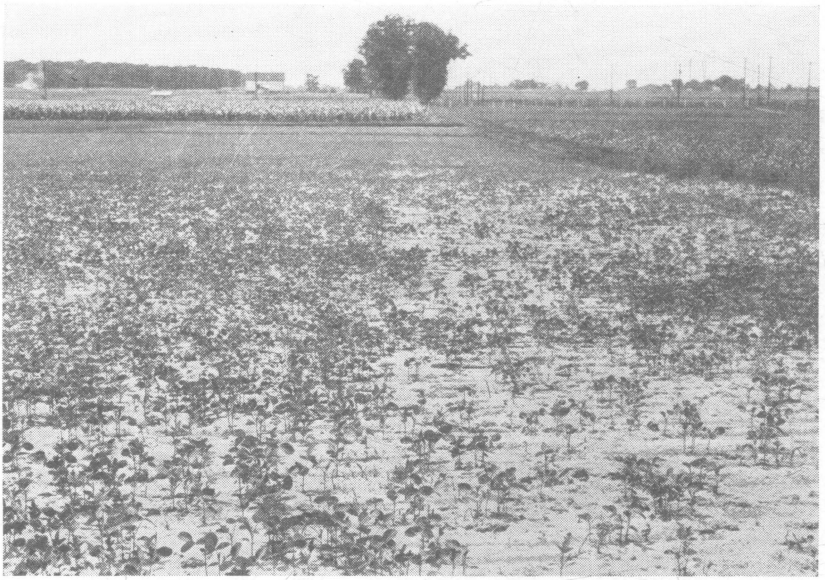

Fig. 3.—A rotary hoe helps soybeans break through a crusted soil. Left of center the crust was broken with rotary hoe, right of center line, no cultivation.

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 weeder is adapted only to use on loose 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 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 may be used to advantage and, at times, going once over with the row cultivator may prove sufficient.

On weedy soils and those that compact quickly, the only sure method of weed control is cultivated rows. A beet planter and cultivator are very satisfactory. Lacking this, the grain drill and corn cultivator can be used for 28- to 30-inch rows by stopping some of the drill spouts. Some tractor cultivators can be adapted to 28-inch rows by removing certain shovels.

HARVESTING OF SOYBEANS

Harvesting for Grain (Market Beans).—The combined harvester-thresher is by far the easiest and most econominal 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

Table 3. Grade Requirements for Yellow, Green, Brown, Black, and Mixed Soybeans

U S Grade	Condition and General Appearance	Minimum Test Weight per Bushel (pounds)	Maximum Limits of (per cent)			
			Moisture	Splits	Damaged Beans	Foreign Material
Extra No. 1[1]	Shall be cool and of natural odor, plump, well screened, and of good color.	56	15	0.5	1.0	0.2
No. 1	Shall be cool and of natural odor and good color.	56	15	1.0	2.0	0.5
No. 2	Shall be cool and of natural odor and may be slightly stained or mottled.	54	16	10.0	3.0	2.0
No. 3	Shall be cool and of natural odor and may be stained or mottled.	52	17	20.0	5.0	5.0
No. 4	Shall be cool and may be badly stained or mottled and may be slightly frosted or immature.	50	18	30.0	8.0	10.0
Sample Grade	Shall be soybeans which do not comply with the requirements of any of the above grades or which have any commercially objectionable foreign odor or are sour, heating, hot, moldy, infested with live weevils or other insects injurious to stored soybeans, or are of otherwise distinctly low quality.					

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

and the leaves turning yellow; the crop shocked in rows and the wheat sown at once. The soybeans will then be hauled and threshed when they are dry enough. Soybeans are not safe from heating in bulk storage until the moisture is down to 15 per cent. Beans carrying more moisture than this should be spread on the floor and stirred frequently, or they may be cross piled in open mesh bags until dry.

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

May 1 May 15 June 1 June 15

Fig. 4.—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.

To move harvesting forward, some soybean growers have used seed corn driers for their beans. This aids with wheat seeding after soybeans, and by moving the harvesting season ahead, it reduces the danger of encountering bad weather late in the season.

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.

Market Grades for Soybeans.—Standards for market grading of soybeans have been established by the United States Department of Agriculture.

Requirements for the several grades are shown on page 13.

Common causes lowering the grade of soybeans are high moisture content, excessive amounts of splits, moldy beans, and foreign materials (usually weed seeds and corn).

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

soybean 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. When harvested in August, the grain 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 any 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 seasonable curing days 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. 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 Emergency 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.