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# SOYBEANS FOR MINNESOTA



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# Soybeans for Minnesota

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**I**N MINNESOTA the soybean crop has been grown largely as an emergency hay crop when there are shortages of alfalfa or clover. Well grown crops of soybeans approach alfalfa and clover fairly closely in yields of hay per acre. Soybean hay may be substituted for alfalfa and clover in most livestock rations.

In a number of states in recent years, soybeans have replaced oats to a considerable extent as a cash seed crop. In Minnesota during the last two years, the acreage of soybeans grown for seed has been increasing. With the establishment of processing plants in the state, a ready market has developed for soybean seed. Many elevators, particularly in the southern part of the state, now purchase soybean seed regularly. Soybean seed yields per acre in the southern and central parts of the state have been high enough to make it practical to grow this crop instead of wheat, oats, or barley to the extent that prices warrant.

## Extensively Grown in Foreign Countries

The soybean is an annual leguminous plant, native to Asia. It has been grown in China, India, and Japan for more than 5,000 years. Manchuria

produced a total acreage of soybeans in 1921 estimated at 7,000,000 and the yield per acre at 22 bushels. This was more than was produced by all the other countries together. In these countries the bean is used extensively as food and the oil for lubrication and for lighting purposes. They export large amounts of soybeans and soybean products.

The tariff act of 1930 placed an import duty of 3.5 cents per pound but not less than 45 per cent of the value on soybean oil, 2 cents per pound on seed, and \$6 per ton on cake brought into the United States. Very small amounts of soybean oil and seed and only moderate amounts of cake have been imported during the last few years.

## Acreage Is Increasing in the United States

Soybean seed was introduced into the United States in 1804. After 1900, seed of a large number of varieties was brought in, but the crop was not important, except in limited areas, until about 1912. With the introduction and development of varieties maturing in from 90 to 160 days, production of soybeans became practicable over a large area of the United States. The soybean crop requires about the same climate and soil as corn.

At first the crop was grown largely for seed, hay, and, in combination with

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corn, for silage. During the last few years, the growing of soybeans with corn as a silage crop has decreased materially, whereas production for hay and for seed from which oil is extracted has increased. In 1939, preliminary reports give the acreages devoted to soybeans in the United States as follows: for hay, 4,423,000; for grazing or plowing under, 1,357,000, and for seed production, 4,226,000. The states leading in soybean-seed production, with acre yields, December prices per bushel, together with the same data for Minnesota and Wisconsin are given in table 1.

Soybean oil is relatively low in drying quality and consequently can be substituted for linseed oil in paints only to the extent of about 25 per cent. It is satisfactory for the manufacture of enamels, linoleums, printer's ink, and soaps. In refined form it is suitable for human consumption. The cake is a valuable feed for livestock and numerous products, including glue, plastic materials, and rubber substitutes are manufactured from it.

### Use of Crop Can Be Changed as Season Progresses

Soybeans planted in the spring for hay purposes may be utilized otherwise, if needs change as the season progresses. The soybean crop may be pastured off or used as green manure in exceptional cases where that may appear desirable. If not needed for hay or pasture, the crop may be harvested at maturity and either fed in the bundle to cattle or sheep or threshed and the seed fed or sold for planting or crushing. As indicated in table 1, the acreage planted specifically for seed production is increasing.

### Soybeans Leave Soil in Good Condition for Other Crops

Although the soybean is a leguminous crop, it does not improve the soil to the extent that biennial and perennial legumes do. Being annual, the soybean plants do not develop as extensive root systems as are developed by biennial and perennial legume

Table 1. Acreage of Soybeans Produced for Seed, Yields per Acre, and December 1 Farm Price for the Period 1935-39 in the States Leading in Production and in Minnesota and Wisconsin for the Period 1938-39

Year	1,000 acres	Yield per acre, bushels	Farm price per bushel	1,000 acres	Yield per acre, bushels	Farm price per bushel
		Illinois			Indiana	
1935	1,334	18.0	\$0.74	410	17.0	\$0.78
1936	1,076	16.0	1.08	282	14.0	1.08
1937	1,140	20.0	0.81	341	17.0	0.81
1938	1,452	23.5	0.64	477	20.0	0.64
1939	1,854	24.5	0.75	716	19.5	0.75
		Iowa			Ohio	
1935	400	16.5	0.74	124	21.0	0.74
1936	191	13.0	1.06	135	15.5	1.08
1937	229	18.5	0.82	171	19.0	0.82
1938	321	16.0	0.67	274	16.8	0.66
1939	487	21.0	0.75	461	21.0	0.75
		Minnesota			Wisconsin	
1938	12	15.0	0.85	7	16.0	0.85
1939	25	16.0	0.90	20	16.0	0.85

plants. Thorough tillage each year to prepare the land for planting, cultivation of the crop with the harrow when drilled solid, and intertillage where the rows are spaced to permit cultivation bring about as rapid reduction in the organic content of the soil as when corn is grown. For these reasons, the soybean is not considered a soil-building crop.

The tillage in preparing the seedbed for soybeans and cultivation of the crop with the harrow or with the cultivator where the crop is planted in rows help clean the land of weeds. In addition, the soybean plants have a mellowing action on the soil. The cleaning and mellowing effect of the soybean crop leaves the soil in ideal condition for corn or sugar beets. Both fall- and spring-sown small grains and flax do remarkably well following soybeans, but the soil should be cultivated or rolled after seeding. On fields with enough slope to make soil washing a serious factor, the growing of soybeans is not recommended.

### Soybeans Provide High-Protein Feed

Adequate amounts of protein are essential in the rations of livestock, particularly in the feeds of young and growing animals, those producing milk, and those bearing young or doing hard work. A large proportion of the necessary protein can be supplied at lowest cost during the growing season by good pastures and throughout the rest of the year by the use of high-protein roughages.

As the soybean plant is a legume, the hay, seed, and by-products in the form of cake or meal are high in protein content. In table 2 are given the digestible nutrients in 100 pounds of various high-protein hays and concentrates.

**Table 2. Comparison of Pounds of Digestible Crude Protein and Total Digestible Nutrients in 100 Lbs. of High-Protein Roughages and Concentrates**

Feed	Digestible nutrients	
	Crude protein	Total
Roughages		
	pounds	pounds
Soybean hay .....	7.9	50.0
Alfalfa hay .....	10.4	51.5
Red clover hay .....	7.4	49.6
Sweet clover hay .....	10.9	50.7
Concentrates		
Ground soybean .....	33.7	92.3
Soybean oil meal .....	37.8	82.3
Linseed meal .....	32.5	75.3
Cottonseed meal .....	33.5	73.6

The data given in the table are taken from Minn. Expt. Sta. Bul. 218, by T. W. Gullickson and J. B. Fitch.

**Hay**—As shown in the table, soybean hay is similar to alfalfa hay in both digestible crude protein and total digestible nutrients per hundred-weight. Experience at the Southeast Experiment Station at Waseca indicates that good soybean hay is equal to the same grade of alfalfa hay as a dairy feed. Harvested and fed in this form, the crop provides forage from the leaves and stems and concentrate from the seed.

In a trial at University Farm, St. Paul, feeding soybean hay to dairy cows reduced the expenditure for mill feed by 93.6 per cent compared to feeding timothy hay.

At the Indiana Experiment Station, based on feeds consumed, soybean hay proved somewhat less valuable than alfalfa hay for milk production.

Under most conditions in the state, alfalfa and clover can be grown at lower cost per ton than soybean hay. Therefore, soybeans are recommended for hay only in emergencies.

**Seed**—At the Minnesota Experiment Station, ground soybeans proved for all practical purposes equal pound for pound to linseed meal in the dairy



Fig. 1. Soybeans for Silage Growing Alongside Corn

This is the preferable way to plant soybeans for mixed silage.

ration. Butterfat in the milk of the group of cows fed linseed meal averaged 3.82 per cent, and of the group fed ground soybeans, 4.01 per cent. At the Waseca branch of the Minnesota Experiment Station, mature bean crops cut with the binder and fed in the bundle to cows eliminates threshing and grinding costs. The average weight of seed per bundle was ascertained and the quantity fed per cow was judged accordingly. When eaten with the pods, the beans were chewed thoroughly enough to be digested. Threshed beans fed without grinding passed through the digestive tract in considerable numbers without being utilized. Coarse stems refused by the cattle were readily eaten by horses. Cows consuming considerable hay utilized 2 to 3 pounds of whole beans daily without unfavorable effects. In a trial completed in 1940, steers on full feed with soybean oil meal as a high protein supplement put on a

better finish than those fed ground soybeans as a supplement. However, the steers receiving the ground soybeans made cheaper gains than those fed soybean oil meal as a supplement.

At the Iowa Experiment Station, cracked soybeans were found to be worth \$60 per ton, as compared with \$45 per ton for linseed meal, when fed to dairy cows. In a trial at the South Dakota Experiment Station, ground soybeans, used as a high-protein supplement for dairy cows, produced 20 per cent more milk and 18 per cent more butterfat than linseed meal.

The Ohio Experiment Station found ground soybeans as efficient as linseed meal as a supplement along with tankage in feeding hogs having access to green forage. In dry-lot feeding the ground soybeans were somewhat less efficient than the linseed meal.

While ground soybeans make an excellent feed for other classes of animals, this feed should not make up

more than 10 per cent of the total ration of fattening pigs. Soft or oily pork results from feeding higher proportions than this.

**Meal**—Soybean meal made by the methods of oil extraction in common use at present is much higher in protein than the ground seed. This meal contains 4.5 to 8 per cent of oil compared with 15 to 23 per cent in the beans. By a recently improved method of extraction by solvents, 4 to 5 per cent additional oil is removed from the meal. Removal of the additional oil leaves the meal still higher in protein content. The meal from which the oil is extracted by the new process retains no odor of the solvent. It is brown instead of light yellow in color.

Soybean meal makes a highly satisfactory high-protein supplement in the rations of all classes of livestock, including growing and fattening pigs.

**Straw**—Soybean straw makes good feed for sheep. At the Waseca station, the breeding flocks of registered Shropshire ewes have been wintered on a ration of two pounds of corn silage per head a day and such an amount of soybean straw as could be consumed. Horses relish soybean straw and consume it more completely than do sheep.

### Choice of Variety

Of the large number of soybean varieties tested in Minnesota, only a few can be recommended for seed production. Well matured seed is essential for commercial use of the grain. When mature crops of soybeans are desired, the planting of northern-grown seed of the recommended varieties is advised. For hay production, soybeans do not need to come to full maturity. Therefore, when northern-grown seed is

scarce, soybeans of the varieties recommended for seed production farther south or varieties somewhat too late for seed production may be used successfully for hay.

### Varieties for Southern Minnesota

For seed production, the varieties Habaro, Minn. No. 209, and well acclimated strains of Manchu are recommended. These varieties average 30 to 35 inches in height and mature in from 110 to 115 days. The seeds of Habaro are yellow with hilums of the same color. The seeds of Manchu are yellow with black hilums. The number of seeds per pound of these varieties varies from 2,600 to 2,800. Yields of seed have varied from 14 to 25 bushels per acre. Mukden, a popular variety in northern Iowa, has been grown long enough in the state to show that it is well adapted in the southern counties. The seeds of this variety are yellow with light brown hilums.

For hay production, Habaro, Manchu, and Mukden have produced as high yields per acre as later varieties, and the quality of the hay produced by them has been superior because a large proportion of the total yields has been made up of seed. Illini, a variety maturing too late to produce high yields of mature seed consistently in southern Minnesota, has produced satisfactory hay yields. This variety has yellow seeds with brown hilums. Seeds of this variety average around 4,000 per pound. Other varieties similar to Illini in habit of growth and maturity will give satisfactory yields of hay. Varieties maturing considerably later than Illini and producing few or no seeds have not proved desirable. Yields of hay have varied from 1.6 to 2.8 tons per acre.

### Varieties for Central Minnesota

For seed production, Habaro and the earliest strains of Manchu are satisfactory in southern and central counties. Earlier varieties, such as Wisconsin Black and Minsoy, are safer in the northern counties of this section of the state.

Seed yields have varied from 14 to 18 bushels per acre on the loam soils and from 7 to 9 bushels on the very sandy soils. On peat, the yields have varied from 10 to 25 bushels per acre. On peat early maturing varieties are preferable in order to minimize danger of frost injury.

For hay production, Habaro, Manchu, and Mukden are satisfactory in the central part of the state. Illini can be used to advantage in the southern counties of this area, if seed of the other varieties is scarce. Average yields of hay on the loam soils have been about two tons per acre and on the light sandy soils one ton per acre.

### Varieties for Northern Minnesota

In the northern part of the state only the earliest varieties, such as Wisconsin Black and Minsoy, are at all suitable for seed production. Early strains of Mandarin are suitable also. Wisconsin Black has black seeds averaging 3100 per pound. The seeds of Minsoy are yellow with brown hilums. They average 3900 per pound. Mandarin seeds are yellow and average 3200 per pound. In this section of the state, seed crops have not matured every year. Seed yields have averaged from 6 to 8 bushels per acre.

The varieties Habaro, Manchu, and Wisconsin Black are satisfactory for hay production. Minsoy is a low-growing variety not well suited to hay production.

### Use High Germinating, Well Inoculated Seed

The germinating power of soybean seed may be relatively low even though the sample may be of excellent appearance. After the seed is one year old, germination frequently decreases fairly rapidly, depending somewhat on variety. Testing seed for germination during late winter or early spring before planting is always advisable.

Unless the proper bacteria are present in nodules on their roots, soybean plants will not do well usually, because then they must obtain all their nitrogen from the soil. The bacteria in the nodules are able to use the free nitrogen in the air, and this becomes available to the soybean plants. An abundance of nodules on the roots of plants indicates the presence of adequate numbers of the proper bacteria. The root of a well inoculated soybean plant is shown in Figure 2.

Until such time as the soybean crop is grown regularly in rotations on farms in the state, it is always necessary to inoculate the seed before planting it. The clovers, alfalfa, and other legumes require different kinds of bacteria and do not supply the bacterial requirement of soybeans. Commercial inoculants may be purchased from seed houses and have been found to be satisfactory if the directions on the container are carefully followed. Soil from a field that has produced well inoculated soybean plants the previous year, sifted and mixed with moistened seed in about equal quantities, usually brings about satisfactory inoculation.

### Good Corn Land Suitable for Soybeans

Well drained soils that produce good yields of clover and corn are satisfactory for soybeans. Loam, clay, and

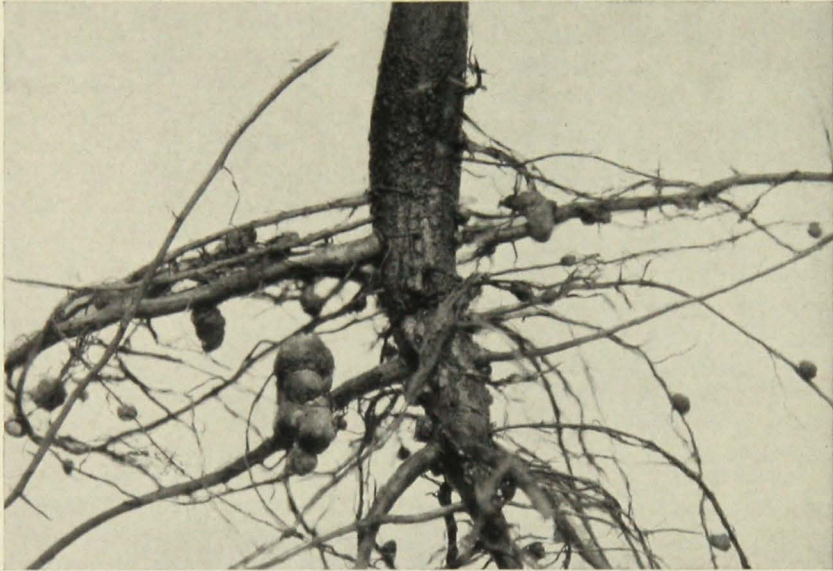


Fig. 2. Root of a Well Inoculated Soybean Plant

Numerous large nodules occur either grouped around the upper part of the tap root or well distributed over the entire root system of well inoculated plants. The nodules shown are approximately one-fourth actual size.

peat soils produce higher yields of soybeans than light sandy soils. Application of lime to acid soils intended for soybeans is not necessary. The moisture supply in light sandy soils is usually too uncertain for good yields of soybeans.

#### Control of Weeds before Planting Important

A mellow seedbed free from weeds at planting time is one of the most important considerations in producing good crops of soybeans. Cultivation before the crop is planted lessens the amount of cultivation necessary to keep the crop reasonably free from weeds. Fall-plowed land, harrowed or disked early to start weed seeds germinating and at 7- to 10-day intervals

up to corn planting time to kill the weed seedlings, provides the best seedbed. Early and frequent working of the soil to free it of weeds and weed seeds is particularly necessary when the beans are to be sown in 6-inch rows with the grain drill.

#### Sow at Corn Planting Time

Both for hay and seed production, planting early gives best results. Early planting is particularly important for commercial beans which must be mature in order to command the highest prices.

The usual practice is to plant the soybeans a few days after corn in order to be able to cultivate the soybean land once more to kill additional weeds. Depth of planting depends upon the kind and condition of the soil. On



clay and clay loams, on which a crust usually forms after rains, shallow planting is more essential than on lighter soils. It is important that conditions be as favorable as possible for germination of the seed and growth of the plants. The seed should be planted as shallow as possible and still be properly covered and in contact with moist soil. Planting at a depth of from one to one and one-half inches is usually satisfactory. Planting deeper than necessary results in delayed emergence of the seedlings. This gives a longer time during which crusts may form, and makes it more difficult for the seedlings to break through. Rolling with a cultipacker after planting results in more rapid and even germination.

### Thick Planting Gives Highest Yields

Highest yields of soybean hay and seed result from thick planting. This is due in part to the better competition thick stands offer to weeds.

In the eastern part of the state, where the average rainfall is higher than in the western part, the rate of planting per acre should be 90 pounds of seed for wide spaced single rows and 120 pounds for wide spaced double rows, narrow spaced rows and for drilling solid. In the western part of the state, 60 to 90 pounds of seed per acre is preferable to the higher rate, except for years when rainfall is heavier than usual. The rates given are for beans of medium size. For large or small beans the rates should be adjusted.

### Method of Planting

Planting in rows so that the crop may be cultivated is the best method whenever weeds are likely to be plentiful. Results of trials in the state



Fig. 3. Planting Two Rows Six Inches Apart Every 42 Inches Provides the Same Number of Rows per Acre as Single Rows Spaced 21 Inches Apart

indicate that planting in rows 20 to 24 inches apart results in high yields. Only those who have sugar beet cultivators are equipped to cultivate beans on a field scale with rows of this width. Planting two rows six inches apart every 42 inches with the grain drill or corn planter provides the same number of rows on a given area and the same amount of seed may be planted as when the rows are 21 inches apart. Double rows six inches apart every 42 inches may be cultivated with the regular corn cultivator without any difficulty.

The other method of obtaining high yields of soybeans under favorable moisture conditions on fields fairly free from weeds is to drill solid at the rate of 120 pounds of seed per acre. This method is not recommended for the western part of the state. Five varieties of soybeans in 8 trials in the southern

and central part of the state in 1935 yielded higher when drilled solid at the rate of 90 pounds per acre than when planted in 36-inch rows at 60 pounds per acre. Moisture conditions were favorable. In 1936, under severe drouth conditions, the beans that were drilled solid yielded materially less than those planted in cultivated rows. In 1937 with moisture conditions favorable the results were similar to those obtained in 1935.

### Adjusting Drill to Plant Soybeans

Corn planters may be adjusted to drill 60 to 90 pounds of soybeans per acre in rows 36 to 42 inches apart. Beet drills are convenient for planting in 24-inch or narrower rows. Dropping the seeds one inch apart in the row will plant about 100 pounds per acre. With a 20-row grain drill, it is possible, by stopping up intervening cups, to sow five 24-inch rows, four 36-inch rows, or three 42-inch single or double

rows at one time. With this size of drill for seeding in 42-inch double rows, it is found convenient to allow cups 3, 4, 10, 11, 17, and 18 to seed, blocking up the remaining cups. It is thus necessary to increase the rate of seeding in the 6 cups to compensate for the 14 blocked up. When used for planting rows of the width mentioned, setting the grain drills to sow 3.5 to 4 bushels of oats will result in planting about 90 to 100 pounds of soybeans per acre. Grain drills are used to plant soybeans in six-inch rows. Ordinarily, setting grain drills to sow 2 bushels of field peas per acre will be satisfactory for planting soybeans at the rate of 120 pounds per acre in six-inch rows.

### Cultivation of Soybeans

If, after soybeans have been planted, heavy rains occur and a crust forms on the surface of the soil, light harrowing will break the crust and let the seedlings through. The seedlings are

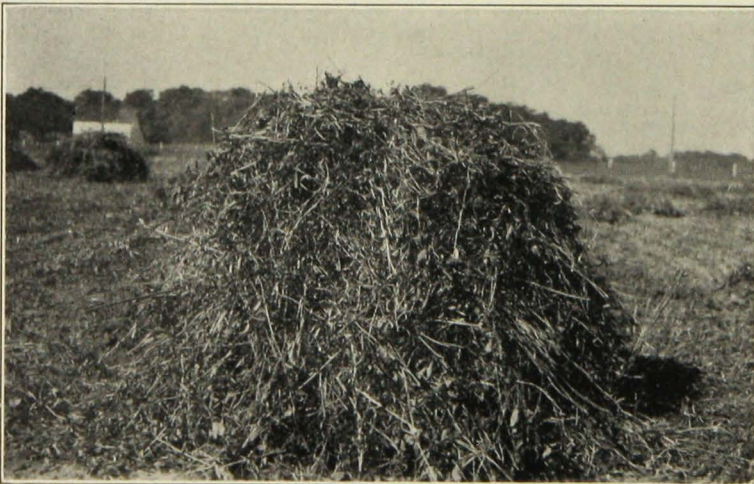


Fig. 4. Soybean Hay Cut with the Binder and Shocked to Dry



Fig. 5. Soybean Hay Built into Narrow Cocks as Soon as the Leaves Are Wilted Settles and Dries Out Gradually and Will Shed Considerable Rain

brittle at this stage of development, so the work must be done carefully.

The purpose of cultivation is to get rid of weeds which, if permitted to develop, reduce the soybean yields. The amount of cultivation necessary depends on how thoroughly the soil was freed from weed seeds and seedlings before the soybean crop was planted.

Weeds are killed most easily when they are in the young seedling stages. Therefore, cultivation should be given as often as any number of weed seedlings appear above ground. After the soybean plants have their first pair of true leaves and up to the time they are four to five inches tall, weed seedlings among them may be destroyed by harrowing crosswise of the rows on sunny afternoons. The plants are not so brittle then as in the forenoon and may be treated as roughly as necessary to destroy the weed seedlings. The rotary hoe run rapidly may be used in place of the harrow. Neither the harrow nor the rotary hoe will kill weeds after they have become established. If weeds become established in soybeans planted in rows spaced 20 inches

or more apart, it is advisable to use the cultivator promptly. This is a more expensive method of cultivation than harrowing.

#### Harvesting Hay—Time Affects Yields

Highest yields of hay per acre and highest feeding values are obtained if the crop is cut at the time the pods are well filled with beans. This is due to the fact that, in the soybean hay crop, a large part of the total possible yield per acre is seed. Therefore, if the crop is cut for hay before the seed is well formed in the pods, comparatively low yields result. Care should be exercised to cut before too many of the leaves have turned yellow or fallen off. When medium-maturing varieties such as Habaro and Manchu are grown  $3\frac{1}{2}$  or 4 months are required for the crop to reach the best hay stage.

A good method of harvesting and drying soybean hay is to cut with the binder and set in small shocks to dry. The bundles should be medium to small in size and bound as loosely as is practicable to minimize molding

under the bands. Where this method proves satisfactory, the cost of the twine is offset by the greater convenience in handling the crop of hay.

Another method is to cut with the mower in the morning after the dew is off. Leaving the crop in the swath in sunny weather until the leaves are well wilted, but not brittle, hastens the drying. Raking and cocking should be done before the leaves become brittle. Cocks made before the leaves become brittle will shed light rains after they have settled, and, if the cocks are not torn apart, few leaves need be lost. If wet weather prevails for some time, the cocks should be moved to dry ground to avoid mold on the bottom.

Large acreages may be handled for hay the same as alfalfa, curing in small windrows, but allowing more time for drying. This is necessary since the soybean stems are much thicker than alfalfa stems. Turning when the leaves are dry and brittle will cause considerable loss, but the windrows may be moved when the leaves are somewhat tough with dew.

### Harvesting Seed—Dry Well before Storage

Most of the soybeans harvested for seed in Minnesota are cut with the binder after the seed is hard and the leaves have fallen. The bundles are

set in pairs in medium-sized shocks to permit further drying out of the beans.

The ordinary grain separator is used for threshing the crop, slowing down the cylinder to 300 to 400 revolutions per minute without checking the speed of the other parts. Ordinarily it is not necessary to use any concaves. These precautions are necessary in order to minimize cracking of the beans. Cracked beans are undesirable in seed or commercial beans.

When the bundles are thoroughly dry but the pods are damp from dew, the seed seems to thresh out better. At the Waseca station all available wagons are loaded early in the morning and threshing continues until they are empty.

In the states where large acreages are grown, soybeans are usually threshed with combines. When this method is used, the beans must be left standing longer in the field than when they are harvested with the binder to allow the drying that ordinarily takes place in the shock. The straw is left in the field ready to pasture off or plow under.

The threshed seed should be spread less than four inches deep on the floor of a well ventilated room and shoveled over when necessary, to prevent any heating or molding. It usually takes several weeks of favorable drying weather for the seed to reach the air-dry condition. Under no circumstances should the seed be stored in sacks until it has become air-dry.

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#### UNIVERSITY FARM, ST. PAUL

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