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SOYBEAN PRODUCTION IN KANSAS

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SUMMARY

1. The soybean is adapted to the eastern three or four tiers of counties in Kansas. Drought and rabbits are the principal hindrances to growing it farther west.

2. It is adapted to about the same general conditions as corn, but will produce a fair crop on land which is too poor to raise good corn. It will also grow on soils that are too acid for alfalfa or sweet clover.

3. No other grain crop in Kansas will produce so much protein per acre as the soybean. The seed may be substituted for the expensive protein concentrates as cottonseed or linseed meal or it may be marketed as a cash crop.

4. Soybean hay compares favorably with alfalfa or clover in feeding value and may be used to supplement a shortage of alfalfa in the eastern third of the state.

5. When grown as a companion crop with corn and pastured off a better balanced feed is produced on which sheep or hogs make good gains with a saving of the cost of harvesting.

6. The seed should not be planted until the ground is thoroughly warm and the first two or three crops of germinating weed seed destroyed.

7. Choosing a variety that is adapted to the locality and suited to the purpose for which it is grown is essential to success.

8. Inoculation and clean cultivation are necessary for successful soybean production.

TABLE OF CONTENTS

SOYBEAN PRODUCTION IN KANSAS [1]

J. W. ZAHNLEY

Interest, in the soybean has been increasing rapidly for ten years or more in central and eastern states, mainly throughout the corn belt. While it constitutes a crop of only minor importance in Kansas at the present time, indications are that it will become more

FIG. 1.—A field of soybeans in 38-inch rows on the Agronomy Farm at Manhattan.

important within the next few years, especially in the eastern three or four tiers of counties. One reason for this is the constant need for protein feed on the farm and the high cost of commercial protein concentrates. Another is the recent establishment of soybean oil mills which provide a ready near-by market for the seed. Also difficulties in maintaining a normal acreage of alfalfa have directed attention to soybeans (fig. 1) as a possible substitute for alfalfa hay.

1. Contribution No. 193 from the Department of Agronomy.

UTILIZATION OF SOYBEANS

The soybean has certain characteristics and adaptations which make it suitable for growing in eastern Kansas. It will grow on a wide range of soils, fits well into short rotations, and may be substituted for part of the oat acreage to good advantage. Being planted later than corn and harvested after oats and wheat have been threshed, the soybean provides good distribution of labor. It may be grown as a hay crop, as a grain or feed crop to be fed to live stock, marketed as a cash crop, or grown in mixtures with corn for silage or for pasturing off. It is also a valuable crop for green manure.

Soybean seed has a very high feeding value because of the large protein and oil content. For this reason the seed can be substituted for the high-priced protein concentrates such as tankage, cottonseed meal, and linseed meal. A 15-bushel crop of soybeans will contain as much digestible protein as 850 pounds of prime cottonseed meal, which at $50 a ton gives an acre value of $21.25 for the soybeans, considering the protein alone. In addition the soybean seed contains approximately twice as much fat as cottonseed meal, which also adds to its feeding value.

Soybeans are frequently sold direct to mills for the oil which they contain. The meal left after extraction of the oil is equal to cottonseed or linseed meal as a feed for live stock. It is not equal to tankage as a feed for pigs, but may replace part of the tankage in the ration.

Experimental tests at the Illinois Agricultural Experiment Station show that, considered on the basis of the hay consumed, soybean hay is equal to alfalfa, red clover, or cowpeas for milk or butter production. Owing to the coarseness of the stems of soybeans there is more waste in feeding, usually amounting to from 10 to 15 per cent of the total weight of the hay.

Good results have been obtained from using soybean as a winter ration for young cattle, sheep, horses, and hogs. In limited tests at Manhattan soybean hay of good quality compared favorably with alfalfa for dairy cows. The alfalfa was only slightly superior on the basis of equal quantities of feed, the small difference probably being due to the wastage of soybeans because of the coarse stems.

Growing soybeans with corn for silage or pasturing off improves the quality of the feed. Pasturing off with sheep or hogs is probably the best means of utilizing such mixtures, as there is less loss

of feed and a considerable saving of labor in harvesting. An important advantage of the soybean is that when properly utilized it is good feed for all classes of live stock.

SOYBEANS AS A SOIL BUILDER

Soybeans are an excellent crop to plow under for green manure. In experiments at the Michigan and at the Connecticut Agricul-

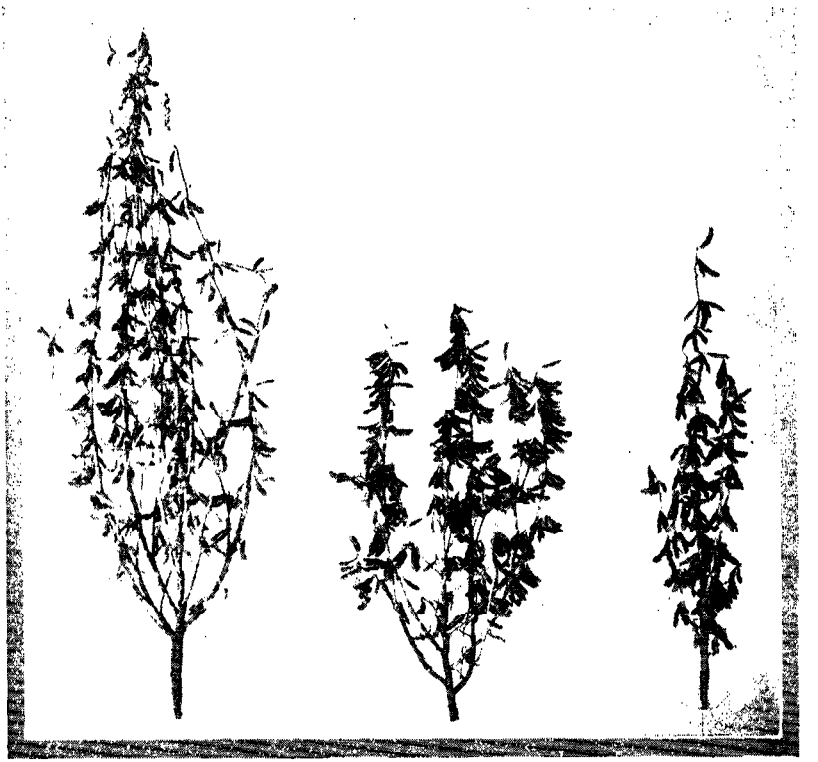


FIG. 2.—Typical plants of three good seed-producing varieties.

tural Experiment Stations they compared favorably with cowpeas and with clover for this purpose. The Arkansas Agricultural Experiment Station secured an increase in yield of corn of approximately 45 per cent from plowing under a crop of soybeans. Similarly the Mississippi Agricultural Experiment Station reports an increase of 48 per cent, in the yield of cotton following a soybean crop used as green manure. Generally speaking, soybeans are no better and possibly not so good as sweet clover for green manure

where the latter can be grown successfully. In Kansas this means that soybeans are the preferable crop only on acid soils.

Soybeans apparently bring about some improvement in the soil when grown for seed in rotation with grain crops. Thus at Manhattan an increase of 14 bushels of corn per acre has been obtained where corn followed soybeans in alternate years as compared with corn grown continuously.

It should be borne in mind that even though the soybean is a legume it will not increase the nitrogen content of the soil appreciably if all of the crop is removed. Investigations at the Ohio Agricultural Experiment Station indicate that perhaps not more than one-fifth of the crop is left on the soil as roots and stubble. Since approximately one-third of the nitrogen used by the plant comes from the soil it is evident that when only roots and stubble are left no more nitrogen is returned to the soil than was removed in the growth of the crop.

When the crop is grown for seed (fig. 2) most of the leaves are shed before harvesting; thus more plant food is returned to the soil than when cut for hay.

ADAPTATIONS

Soybeans are adapted to about the same general conditions as corn. Any soil which will produce good corn will grow good soybeans. They will grow on nearly all types of soil in eastern Kansas and will produce fair crops on soils which are too poor for growing good corn. They will stand more wet weather than corn and are not so seriously injured by hot, dry weather during the period of flowering. They will grow on land that is too acid for alfalfa and sweet clover, but better yields are obtained on soils well supplied with lime. A crop of soybeans can be plowed under for green manure or harvested for hay in approximately 100 days after planting. Most of the best seed-producing varieties in Kansas require about 120 days to produce ripe seed.

When grown on fertile soil there is a tendency for most varieties to lodge, making harvesting difficult and causing loss of a large amount of seed which is not gathered by the ordinary harvesting methods. Consequently a better yield of seed is often obtained when the crop is grown on soil of medium fertility.

PRODUCTION METHODS

PREPARATION OF THE GROUND

Preparation of the ground for soybeans does not differ materially from that for corn which is to be surface planted. It is especially important that the land be cultivated thoroughly to destroy all weeds before planting as the young soybean plants start slowly and do not compete well with weeds. The practice of fall or early spring

Courtesy of International Harvester Company.

FIG. 3.—A well-inoculated soybean plant.

plowing and cultivating several times during April and May to provide a smooth, well-settled seed bed free from weeds is essential even though this may necessitate some delay in seeding. Cultivation to destroy weeds can be done more effectively and economically before the crop is planted.

INOCULATION

The soybean, like other legumes, is able to secure a large part of its nitrogen from the air through the action of bacteria that live on the roots. (Fig. 3) In order to do this, however, it must be provided with the proper kind of bacteria. The particular kind neces-

sary for the soybean is seldom, if ever, present in Kansas soils except where this crop has recently been grown. Such bacteria will not inoculate any of the other commonly grown legumes, nor will the bacteria found in the nodules of other legumes inoculate soybeans. Hence inoculation usually is necessary.

Inoculation is most easily accomplished on soils that are neutral or slightly alkaline. Although soybean bacteria will thrive in soils more acid than will those of most other legumes, special attention will be required to obtain thorough inoculation on soils that are distinctly acid.

There are several methods of inoculating the soybean any of which will be effective if good material is used and the work carefully done. Specially prepared pure cultures may be purchased from commercial seed firms, direct from companies that produce them, and from many state agricultural experiment stations. County agricultural agents usually obtain a supply for farmers of their respective counties. Directions for using these cultures are printed on the packages. The method of applying is very simple, consisting usually of mixing with a little water and moistening the seed just before planting. It is essential that such inoculating materials be fresh when used.

The soil-transfer method may be used. This consists of spreading 250 to 500 pounds of thoroughly inoculated soil per acre evenly over the field to be planted and harrowing in. While this method is effective it is expensive because of the labor involved. A more economical method is to apply finely-sifted inoculated soil directly to the seed. The soil should be taken from the spot where well-inoculated plants grew. Two quarts of such soil is sufficient for one bushel of seed, provided the seed is first moistened with a solution consisting of three ounces of glue or sugar and one quart of water. If the glue or sugar is not used a gallon of the soil per bushel of seed should be used; or this soil may be mixed with water to make a thin mud and applied to the seed. In all cases planting should be done as soon as convenient after inoculation.

It is frequently advisable to inoculate the first two or three crops of soybeans that are grown in a field. While soybean bacteria may live in the soil for many years the number usually decreases rapidly when other crops are grown and this decrease is more rapid in an acid than in a neutral or alkaline soil. Therefore if the soil is acid it may be necessary to reinoculate the field before planting soybeans if that crop has not been grown for three or four years.

On fertile soil the soybean will produce a fairly good crop without inoculation. Under such conditions all of the nitrogen used by the plant is taken from the soil, thus leaving the soil poorer in nitrogen than if soybeans were not grown. Inoculation not only enables the plant to function as a soil builder but both the hay and seed are richer in protein and the yield is usually higher than when grown without inoculation. Inoculation produces more marked increases in yield and quality of the crop on poor soil than on fertile soil. At the Michigan Agricultural Experiment Station the protein content of the crop was increased by inoculation on fertile soils where no increase in yield was obtained. Increases resulting from inoculation at the Illinois station amounted to 42 per cent in yield of hay and 24 per cent in yield of seed, with increases in protein content of 1.19 per cent, for the hay and 4.2 per cent for the seed.

IMPORTANCE OF GOOD SEED

Good seed is important for successful soybean production. The seed loses its vitality much more rapidly than is the case with most other legumes, and it is seldom advisable to plant seed which is more than one year old if it can be avoided. The seed is often chipped, cracked, or broken in threshing, making it unsafe for planting. It is advisable always to have it tested for germination before planting time. Good seed should be pure as to variety, free from cracked or broken seed, and of strong vitality.

TIME AND METHODS OF PLANTING

Soybeans may be planted toward the latter part of the corn-planting season, although it is desirable to plant them two or three weeks later. There is little to be gained by early planting as the young plants grow more slowly and much more trouble results from weeds. It is better to delay planting until the first part of June than to plant in weedy ground or in a poorly prepared seed bed. Experiments have shown that soybeans planted as late as the tenth of June at Manhattan matured only three or four days later than the same varieties planted three weeks earlier. If the crop is to be used for either hay or seed June 1 to 10 is sufficiently early in this section. In tests at the Missouri Agricultural Experiment Station seeding from June 1 to 15 was more favorable than any other period both for the production of seed and of hay. Planting should be done at a time when moisture conditions are favorable for quick germination of the seed.

The method of planting will depend mainly upon the purpose for

which the crop is grown, i. e., whether it is primarily for seed, hay, silage, pasturing off, or for green manure. The various methods are described in the following pages.

SEED PRODUCTION

PLANTING

For seed production the crop should be planted in rows and given sufficient cultivation to keep down weeds. The ordinary corn planter with furrow-opener attachment is generally used in this section. The furrow openers need not be used, but if used they should be set to open a furrow only two or three inches deep. Planting the seed in deeper furrows is likely to result in loss of the stand from becoming covered too deep by heavy rains. Planting with a lister is seldom if ever advisable. A grain drill may be used by stopping part of the holes.

In most cases the rows may be closer than the usual distance for corn. This may be three feet or less. If planted closer than three feet the cultivator must also be adjusted to prevent the wheels running over the row on one side or the other. On the Agronomy Farm at Manhattan 38 inches has proved to be a satisfactory width between rows.

Poor stands frequently result from planting too deep. A depth of from one to one and one-half inches is usually sufficient and in no case should the depth exceed two inches except on sandy soil.

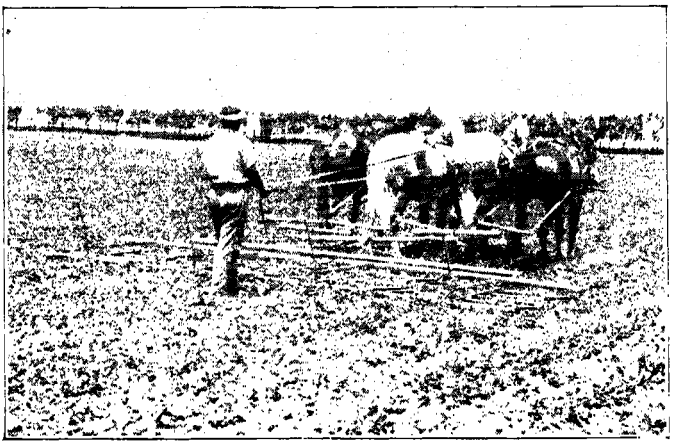
The rate of planting varies somewhat with the kind of soil and especially with the size of seed. The latter varies widely with different varieties. For example the Peking contains approximately 6,300 seeds per pound while the Manchu, Morse, and A. K. contain from 2,500 to 2,800 per pound. Most of the varieties commonly grown for seed in this state have seed of medium size and should be planted at the rate of 20 to 25 pounds per acre when the rows are from 36 to 40 inches apart.

CULTIVATION

Great care should be given to cultivation during the early growth of the crop. As stated before, as many weeds should be destroyed as possible before planting. If weed seeds germinate or if a crust forms before the young plants come through the ground the first cultivation should be given at once with a weeder, rotary hoe or spike-tooth harrow. (Figs. 4 and 5) This type of cultivation may be repeated until the plants are six or eight inches high. Such implements may destroy many plants if used immediately after they

Courtesy of International Harvester Company.

FIG. 4.—Cultivating soybeans with a rotary hoe.



Courtesy of International Harvester Company.

FIG. 5.—The spike-tooth harrow destroys very few soybean plants if properly used.

break through the soil, as they are brittle and tender at that stage. After they get three or four inches high little damage will be done, especially if cultivated in the middle of the day when the plants are somewhat wilted. The rotary hoe and weeder destroy fewer plants than the harrow, but the harrow is more effective in killing weeds. Less damage will be done to the crop if harrowed crosswise of the rows or at an angle of about 45 degrees. Succeeding cultivations with the ordinary corn cultivator should be given as often as necessary to keep down weeds until the plants begin to bloom.

FIG. 6.—Harvesting soybeans with a grain binder.

HARVESTING

For seed production soybeans should be cut when fully ripe and just before the first pods begin to shatter. At this stage most varieties will have lost practically all of their leaves. Cutting before the pods are fully mature will cause the seed to wrinkle on drying and increase the difficulty of keeping in storage. Delay in harvesting will almost certainly result in serious losses from shattering.

Various methods of harvesting for seed are used. The mower, grain binder, self-rake reaper, special bean harvesters, and the combine are used for this purpose.

The Grain Binder.—The taller and more erect varieties may be harvested successfully with the grain binder (fig. 6), the bundles being shocked and handled in every way similar to wheat or oats.

Extension guards on the binder may be necessary when the

plants are spreading or lodged. The bundles should be small and loosely bound and set up into small shocks. Rain will do little damage to small shocks standing in the field as the bundles contain very few leaves and dry out readily. Threshing must be done as soon as the pods are dry enough. Close attention should be given to the crop as shattering is hastened by wetting and drying and by sudden changes in temperature. Heavy dew or frost followed by warm sunshine make the pods open as soon as they are dry enough to thresh. If threshing cannot be done promptly stacking may be necessary to save the seed. Stacking is very desirable, also, where the ground is to be planted to a fall crop soon after harvesting.

Harvesting with the Mower.—A mower may be used when the plants are short and the branches low and spreading or when the crop is lodged. In that case extension guards on the mower may be used to good advantage. A side delivery attachment is desirable to move the cut swath aside so that the beans will not be tramped out when the team comes around the second time. If cut with a mower without such an attachment cutting should be done when the crop is damp or the swath should be moved out of the way of the team at every round. After cutting with a mower the crop should be raked as soon as possible and placed into small cocks. From five to ten days of good drying weather will allow the pods to become dry enough to thresh. If the piles become wet through with rain they should be turned frequently to avoid damage to the seed.

Special Soybean Harvesters.—Special harvesters which gather the beans from the standing stalks are being used in some states. The most common type is a boxlike machine mounted on two wheels and provided with a cylinder with long teeth or fingers. As the machine passes over the row the beans are beaten from the stalk and thrown into the body of the machine by the rapidly revolving cylinder. The machine is drawn by two horses, and usually two men are necessary to operate it. Under favorable conditions two men can harvest five or six acres a day. There is some loss of seed when this type of machine is used and it is not altogether satisfactory with vining varieties or where the crop is lodged. Harvesters of this kind, of which there are several types, cost from $150 to $250.

Combine Harvesters.—The combine is being used extensively for harvesting soybean seed. (Fig. 7.) These machines are of the same type as those used for harvesting wheat. To prevent cracking the beans the speed of the cylinder should be reduced to ap-

proximately one-half that required for wheat, but the remaining parts of the machine should run at the usual speed. The concave teeth may all be removed if the crop is well matured. Among the advantages of the combine over other methods of harvesting are: (1) A great saving of time in harvesting. This shortening of the harvesting period enables the grower to wait until the crop is fully mature and then to harvest it quickly before shattering occurs. (2)

Courtesy of Indiana Agricultural Experiment Station.

FIG. 7.—Harvesting soybeans with a combine.

There is less loss of beans than when the binder, mower, or soybean harvester is used. The greatest loss is due to low branches and lodged plants which are not picked up by the cutter bar. (3) The straw is spread on the ground where it grew.

Owing to the high cost of the machine the combine is economical only when a comparatively large acreage of beans is to be harvested each year or when it can be also used for harvesting small grain.

THRESHING

The ordinary grain thresher can be adjusted to thresh soybeans successfully by reducing the speed of the cylinder to approximately one-half without changing the speed of the fan or separator. This may be done by doubling the size of the pulley on both ends of the

cylinder shaft. If the beans are dry all of the concave teeth should be removed. A special set of thin concaves may be used to good advantage when the beans are tough, or most of the teeth of the standard concave removed. Soybean seed is often badly cracked in the threshing, which seriously reduces its value for seed and increases the danger from heating in storage. With proper adjustment of the ordinary separator cracking the seed may be almost eliminated. Some manufacturers have special pea- and bean-hulling attachments, which are very satisfactory and which may be added to the ordinary separator at small cost.

HANDLING THE THRESHED SEED

Threshed soybean seed does not keep well in storage unless thoroughly dry. Losses from molding and heating can be prevented by exercising care to dry the seed thoroughly before storing it in bulk. Ordinarily seed containing over 15 per cent moisture should not be stored in quantity in a tight bin. Seed containing immature beans high in moisture, a high per cent of cracked or otherwise damaged beans, or that is to be used for planting, should receive special care to avoid heating or molding. In some cases it is necessary to spread it out in a layer a foot or two in depth on the floor of a well-ventilated room and stir frequently if it begins to heat. Usually little difficulty will be experienced if the seed is placed in sacks as soon as threshed and stored by standing the sacks upright in rows in an open shed, leaving plenty of room between the rows for the free circulation of air. Piling the sacks in twos crosswise, leaving a little space between them, will also afford some ventilation. It is always advisable to watch the seed closely for some time after threshing and if heating starts, to stir and dry it immediately.

SOYBEAN HAY PRODUCTION

PLANTING SOYBEANS FOR HAY

On ground which is fairly free from weeds soybeans may be drilled solid with a grain drill, using about 90 to 110 pounds of seed per acre. The heavier rates of seeding allow for the destruction of some plants by cultivation with the harrow, weeder, or rotary hoe, and produce a finer quality of hay. (Fig. 8.) A thicker stand also affords more competition for weeds in the early stages of growth.

On weedy land it is better to plant in rows three to three and one-half feet apart and cultivate in the same manner as for seed production. Spacing the rows 18 to 21 inches apart by double planting with a corn planter is also satisfactory for hay production. Tests

conducted by the Agricultural Experiment Station at Manhattan, as shown in Table I, indicate a somewhat greater yield from planting with a grain drill in row seven inches apart,. These tests were on clean land and plats Nos. 2 and 3 were cultivated with a harrow or rotary hoe or both. The ordinary six-shovel corn cultivator was used on plat No. 1.

TABLE I.—YIELD OF HAY BY DIFFERENT METHODS OF PLANTING.

PLAT NO.	Width of rows.	Seed per acre.	Yield of hay per acre.			
			1927.	1928.	1929.	Average.
	Inches.	*Pounds.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1	38	22	2.54	2.25	2.08	2.29
2	19	44	2.18	2.80	1.70	2.23
3	7	90	2.58	2.97	2.24	2.60

On weedy land where the crop is planted in wide rows to allow thorough cultivation thirty pounds per acre will produce a better quality of hay and fully as much.

HARVESTING FOR HAY

Soybeans should be cut for hay when the seeds are about half developed. At this stage the oldest pods will be well filled while the younger pods will be nearly full length but will contain no seed. The crop may be cut any time from the formation of pods until the leaves begin to fall and a good quality of hay produced. The earlier cut plants contain a higher per cent of protein but the yield is less and the crop is difficult to cure. If left too long the plants rapidly become woody and there is more waste in feeding because of the hard stems. A good rule is to cut soon after the first pods are full grown and beginning to bulge with seed, provided weather is favorable for curing the hay.

The hay crop is ordinarily cut with a mower, although the binder is sometimes used. Hay cut with a mower is handled in about the same manner as alfalfa. Usually it is left in the swath until thoroughly wilted and then raked into light windrows before the leaves become dry enough to shatter. It may be left in this condition for a day or two and then placed in cocks and left until fully cured. A brighter hay is produced by putting it in cocks and in case of rain there is less loss as the cocks, if carefully made, shed rain very well. The cocks should be opened a few hours before hauling to dry out thoroughly.

The hay is sometimes almost completely cured in the swath. When this practice is followed a side-delivery rake can be used to good advantage. The windrows may be turned once or twice as is often done with alfalfa to bring about more uniform and thorough curing.

If the crop is cut with a binder the bundles must be small and loosely bound. Even then they may mold unless the weather is very favorable for curing.

FIG. 8.—A good hay crop of Virginia soybeans.

Soybean hay molds readily in stack or mow unless it is thoroughly cured and free from dew or rain when stored. Layers of a grass hay or straw alternating with layers of the soybean hay will help prevent heating or molding.

SOYBEANS AND COWPEAS COMPARED AS HAY CROPS

In Kansas soybeans are more desirable for hay than are cowpeas for the following reasons: They grow more erect, are more easily harvested, and the hay is much more readily cured. The leaves of cowpeas shatter more easily in handling, leaving a more stemmy hay. Soybean hay is not so quickly injured by wet weather and the yield is consistently higher than that of cowpeas.

The average yield of soybean hay produced by the A. K. variety at Manhattan for the years 1920 to 1929 was 2.4 tons per acre as compared with 1.66 tons produced by the Whippoorwill cowpea. During the last three years the Victor cowpea has outyielded the Whippoorwill. The average yield of this variety for the three years, 1927 to 1929, was 1.65 tons compared with 2.43 tons for the A. K. soybeans for the same period.

FIG. 9.—Soybeans in corn for silage or pasturing off.

GROWING SOYBEANS WITH CORN

Planting soybeans with corn for pasturing or hogging off is practiced extensively in some sections. (Fig. 9.) This combination is also used for silage. The two crops may be planted in the same row at the time the corn is planted by using a bean and pea attachment, on the corn planter. The corn is planted at the usual rate and the beans from four to eight pounds per acre. Another method is to first plant the corn and then follow as nearly as possible in the same row, planting the soybeans shallower to avoid disturbing the corn. A third method consists in mixing the two in the planter box, using equal parts by weight and adjusting the planter to plant about twice the usual rate for corn alone. This is probably the least satisfactory

method because the soybeans tend to work to the bottom and plant out first. Fairly satisfactory distribution can be obtained by filling the boxes only about half full and stirring the mixture frequently.

The usual result when such a mixture is grown is a reduction in the yield of corn, especially of the grain, the decrease depending upon the thickness of stand of the two crops. The increase in feeding value will in most cases compensate for the smaller yield of corn. The yield of soybeans grown in the corn will rarely equal the loss in yield of corn, but on the average as much or more protein per acre will be produced. Where the crop can be harvested by hogging off the saving of labor in harvesting and larger gains on the stock from a better-balanced ration than corn alone, make this practice, in many instances, a desirable one.

Seeding soybeans in corn for silage has not been a satisfactory practice according to experiments carried on at Manhattan. When the soybeans make sufficient growth to add materially to the feeding value of the silage the yield of corn is seriously reduced. In dry-seasons the soybeans make little growth and are largely lost in harvesting due to the failure of the binder to gather and hold them in the bundle.

Results of three-year tests with the two crops grown together and separately are shown in Table II. One plant of corn every twenty inches and one plant of soybeans every three to four inches was regarded as a full stand. Pride of Saline corn and A. K. and Virginia soybeans were used.

TABLE II.—YIELDS OF SOYBEANS AND CORN GROWN TOGETHER AND SEPARATELY FOR SILAGE.

(Three-year average, 1924 to 1926.)

Stand of—		Method of planting.	Silage produced.		Protein per acre.
Soybeans.	Corn.		Total weight of both crops.	Per cent soybeans.	
			Tons.		*Pounds.*
Full.....	Full.....	Grown in same row.....	13.23	19.5	378
Half.....	Half.....	Grown in same row.....	10.72	24.0	328
One-fourth....	Full.....	Grown in same row.....	14.34	10.0	344
Half.....	Full.....	Grown in same row.....	13.68	15.5	367
Full.....	Full.....	Grown separately, ½ plat of each,	11.59	26.0	365
.....	Full.....	Corn alone.....	17.14	.....	343

In no case was the combined yield of the two crops when grown together equal to the yield of corn grown alone. The yield was materially reduced when only 10 per cent of the total crop consisted of soybeans. The inconvenience of planting, cultivating, and harvesting the two crops together should also be considered. Since the green soybeans contain approximately three times as much protein pound for pound as the corn the total amount of protein produced is slightly greater where the two crops are grown together. The results of these tests should not be regarded as final on account of the short period of time during which the work has been carried on, but with the information at hand, growing soybeans and corn together for silage cannot be recommended for Kansas. Results in some states farther east, e.g., Iowa, Pennsylvania, Connecticut, and Virginia, have been somewhat more in favor of growing the two crops together.

When mixtures of soybeans and corn are desired for silage, such mixtures may be made by growing the two crops separately and mixing them at the ensilage cutter. It is often practicable to cure the soybeans as hay and feed a ration of soybean hay and silage.

VARIETIES

IMPORTANCE OF CHOOSING A GOOD VARIETY

Success with soybeans depends largely upon choosing a variety which is adapted to the locality and suited to the purpose for which it is grown. There are hundreds of varieties of soybeans, some of which are very early, late-growing, and unproductive, while others are extremely late rank-growing plants which will scarcely begin to bloom before frost in this state. Already there are too many varieties being grown in Kansas. This is due to the lack of information regarding the adaptation and relative value of varieties for Kansas conditions.

More than sixty varieties have been tested by the Kansas Agricultural Experiment Station at Manhattan since 1915. (Fig. 10.) Some of the best of these have also been grown in cooperative experiments with farmers in the eastern part of the state. Yields of about thirty varieties are given in tables which follow.

CHARACTERISTICS OF A DESIRABLE VARIETY

Yield is not the only criterion to be considered in the choice of a variety for either hay or seed. For example, some varieties which produce very heavy yields of forage are so late that the plants do not reach the proper stage of maturity to make a good quality of

FIG. 10.—Varieties of soybeans grown for comparative yields of hay and seed.

hay. Likewise a variety may produce heavy yields of seed but because of its tendency to lodge or to shatter is not a desirable one to grow. The most important characters to be considered in choosing a variety to grow for seed in addition to yield are:

1. Uprightness of growth.
2. Freedom from lodging.
3. Freedom from shattering of seed.
4. Color of seed.

A variety which is upright in growth, which stands up well on fertile soils and in seasons of abundant rainfall, and which does not shatter readily is more desirable even though the yield is somewhat less than that of one which does not possess these characteristics. For seed production varieties with light-colored seed are usually preferred as such seed is in better demand on the market and is more readily eaten by certain kinds of live stock.

For hay production the color of the seed is not important, but freedom from lodging, fineness of stems, leafiness, and adherence of leaves before cutting and during curing and handling are essential characteristics of a desirable hay variety. The rate and hence the cost of seeding can be reduced with varieties like the Peking and Laredo which have small seed.

RESULTS OF VARIETY TESTS AT MANHATTAN

Yields of seed of varieties which have been tested for ten years, 1920 to 1929, and the average number of days required to mature are given in Table III. Yields of two varieties of cowpeas are shown in this table for comparison with soybeans.

The first five varieties named in the above table have yellow or greenish yellow seed and are well suited for seed production. The Peking bears black seed while seed of the Virginia is brown. Both of these varieties are more suitable for hay production than for seed. The Pinpu, Aksarben, and Manchu are regarded as good medium-early varieties. A. K. and Austin are medium late but mature satisfactorily before frost in this section. The Wea is a very early, low-growing variety. Because of its low spreading habit of growth it is difficult to harvest.

Table IV shows the yields of hay of the same eight varieties for the same ten-year period.

The medium-late varieties give higher yields of hay than those which mature earlier.

New varieties are continually being included in tests and the less desirable ones are being omitted. For this reason only a relatively small number of varieties have been grown continuously throughout the ten-year period. Within the past four years several varieties which have not been tested here before have been grown, some of which have given promise of being superior to those which have been tested over a longer period. A record of the yields of these is given in Tables V and VI.

One variety, the Hongkong, introduced recently into tests here has given promise of being desirable for seed production. Final conclusions cannot be drawn, however, because of the short duration of the test. The years covered in this period were characterized by abundant rainfall during the growing season. This condition favored certain varieties more than others. The A. K. variety tends to lodge under such conditions, which probably accounts for the yield for the three-year period falling below the ten-year average for that variety while the yield of other varieties is higher. The higher rainfall and lower average temperatures delayed maturity, as will be seen by comparing Tables III and V.

The yields of hay for the same three-year period are given in Table VI.

TABLE III.—YIELD OF SEED OF SOYBEAN VARIETIES AND AVERAGE TIME FOR MATURITY.

(Ten-year period, 1920 to 1929.) (Cowpea yields given for comparison.)

VARIETY.	Average days to mature.	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	Average.
A. K.	125	40.6	18.6	16.8	23.3	24.6	28.0	13.6	25.1	21.8	20.0	(a) 23.24
Pinpu	113	16.9	26.3	17.5	27.2	29.1	28.9	12.2	25.3	24.6	20.8	22.88
Aksarben	112	23.4	23.8	17.4	22.3	21.5	28.3	12.1	25.0	26.1	16.4	21.63
Manchu	111	19.4	22.3	18.1	22.7	18.5	22.6	11.6	24.4	26.3	19.0	20.49
Austin	126	20.5	21.2	13.3	22.9	21.2	20.6	11.5	21.0	28.6	18.7	19.95
Wea	105	19.3	20.5	13.8	.....	16.5	26.6	11.3	26.8	25.3	17.0	(a) 19.68
Peking	120	.....	17.5	15.2	22.0	15.5	12.5	10.0	22.7	19.7	18.9	(a) 17.11
Virginia	123	.....	21.0	11.8	21.8	16.9	15.0	8.8	13.9	23.0	15.1	(a) 16.36
Cowpeas.												
New Era	(b) 109	12.2	22.1	10.3	.....	11.6	8.9	4.1	1.8	12.9	2.2	(a) 9.57
Whippoorwill	(b) 114	3.3	14.0	2.8	.....	5.5	3.3	1.3	3.2	12.8	5.8	(a) 5.78

(a) Nine-year average. Yield of A. K. for same years that Wea and the cowpea varieties were grown was 23.2 bushels and for the nine years that Peking and Virginia were grown was 21.3 bushels.
(b) To date of first picking of pods.

TABLE IV.—YIELD OF HAY OF SOYBEAN VARIETIES.

(Ten-year period, 1920 to 1929.) (Cowpea yields given for comparison.)

VARIETY.	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	Average.
A. K.	4.36	2.85	1.67	1.90	2.36	3.34	1.10	2.05	2.51	1.86	2.40
Austin	3.92	3.33	1.65	1.97	1.96	2.25	0.82	2.23	2.67	2.66	2.35
Virginia	.....	3.44	1.64	1.77	2.03	2.23	0.82	1.97	2.44	1.75	(a) 2.01
Peking	.....	3.23	1.58	1.84	1.92	1.41	1.05	2.14	2.06	1.89	(a) 1.90
Aksarben	1.79	1.72	1.37	1.51	2.03	2.02	0.94	2.28	2.82	1.95	1.84
Manchu	1.67	1.54	1.50	1.72	1.87	2.06	0.94	2.08	2.09	1.95	1.74
Pinpu	1.50	1.67	1.41	1.84	2.06	1.73	0.98	1.63	2.19	1.53	1.65
Wea	2.01	1.46	0.90	0.73	Lost	1.60	0.82	1.74	1.84	1.72	1.42
Cowpeas.											
Whippoorwill	2.18	1.67	1.57	2.11	2.22	1.90	0.72	1.42	1.76	1.10	1.66
New Era	1.67	1.15	1.35	1.92	2.20	2.25	0.72	1.93	1.84	1.39	1.64

(a) Nine-year period. The yield of A. K. for the same nine-year period was 2.18 tons.

TABLE V.—YIELD OF SEED OF SOYBEAN VARIETIES.

(Three-year period, 1927 to 1929.) (Cowpea yields given for comparison.)

VARIETY.	Days to mature.	Bushels per acre.			
	Average.	1927.	1928.	1929.	Average.
Hongkong	135	27.8	25.4	20.8	24.7
Pinpu	122	25.3	24.6	20.8	23.6
Manchu	120	24.4	26.3	19.0	23.2
Wea	125	26.8	25.3	16.9	23.0
Austin	134	21.0	28.6	18.7	22.8
Aksarben	120	25.0	26.1	16.4	22.5
A. K	132	25.1	21.8	20.0	22.3
Pine Dell Perfection	140	33.0	17.8	15.3	22.0
Morse	140	20.9	27.2	17.8	22.0
Southern Prolific	140	20.9	21.4	22.8	21.7
Hoosier	129	22.9	21.2	21.1	21.7
Dunfield	120	23.8	24.0	15.4	21.1
Illini	126	26.5	19.0	17.6	21.0
Peking	129	22.7	19.7	18.9	20.4
Blacker	136	21.1	21.0	19.1	20.4
Hamilton	136	20.2	20.7	18.8	19.9
Easy Cook	138	21.2	18.0	.....	(a) 19.6
Mikado	144	19.6	20.6	18.1	19.4
Columbia	126	21.0	19.0	17.6	19.2
Laredo	147	19.8	18.0	17.8	18.5
Ilsoy	143	22.1	19.0	13.3	18.1
Elton	126	17.0	20.9	15.1	17.7
Herman	146	16.7	23.8	12.4	17.6
Lexington	131	19.9	16.8	15.8	17.5
Virginia	138	13.9	23.0	15.1	17.3
Jet	128	17.8	18.8	15.3	17.3
Midwest	135	18.2	15.9	.....	(a) 17.0
Ebony	129	18.2	17.3	14.7	16.7
Chiquita	149	17.4	16.7	15.7	16.6
Merko	130	16.5	18.0	12.7	15.7
Yokoten	138	13.0	12.9	16.7	14.2
Tarheel Black	160	14.9	10.6	11.4	12.3
Mung bean	117	16.6	4.4	12.2	11.1
Arlington	147	11.8	10.8	10.1	10.9
Cowpeas.					
Victor	124	10.0	14.2	7.3	10.5
Whippoorwill	124	3.2	12.8	5.8	7.3
New Era	124	1.8	12.9	2.2	5.6

(a) Two-year average. Yield of A. K. for same two year period was 23.4 bushels.

Varieties which have produced the highest yields of hay at Manhattan are those which mature very late and are not among the highest in seed production. Late-yielding varieties will not always become fully mature in the north half of Kansas in seasons when frost comes before October 15. A seed crop is therefore uncertain and the hay crop cut late is slow of curing. For these reasons such earlier varieties as A. K., Austin, Peking, and Virginia may be more suitable for hay in the northern part of the state, while in the southeastern counties such later varieties as Chiquita and Laredo are well adapted for forage purposes. For green manure, tonnage is the only important consideration, hence the late, rank-growing varieties should be used in all sections of the state where soybeans are grown for this purpose.

TABLE VI.—YIELD OF HAY OF SOYBEAN VARIETIES.

(Three-year period, 1927 to 1929.) (Cowpea yields given for comparison.)

VARIETY.	Days to mature.	Tons per acre.			
	Average.	1927.	1928.	1929.	Average.
Chiquita	126	2.60	3.18	2.64	2.81
Laredo	125	2.68	3.13	2.43	2.75
Tarheel Black	127	3.40	2.68	2.14	2.74
Easy Cook	116	2.19	2.99	.....	(a) 2.59
Pine Dell Perfection	119	3.04	2.29	2.13	2.49
Jet	107	2.12	2.87	2.34	2.44
Hongkong	111	2.34	2.78	2.11	2.41
Southern Prolific	120	2.39	2.81	1.95	2.38
Morse	112	2.28	2.65	2.19	2.37
Hamilton	108	2.34	2.67	2.10	2.37
Austin	110	2.23	2.67	2.16	2.35
Aksarben	88	2.28	2.82	1.95	2.35
Lexington	110	2.85	2.28	1.90	2.34
Herman	112	2.40	2.74	1.71	2.28
Mung bean	105	2.62	2.65	1.51	2.26
Blacker	111	1.82	2.61	2.20	2.21
Columbia	102	1.89	2.85	1.88	2.21
A. K.	107	2.05	2.51	1.86	2.14
Arlington	119	2.34	2.22	1.78	2.11
Midwest	114	1.98	2.20	.....	(a) 2.09
Ilsoy	100	2.15	2.45	1.59	2.06
Virginia	109	1.97	2.44	1.75	2.05
Manchu	93	2.08	2.09	1.95	2.04
Peking	109	2.14	2.06	1.89	2.03
Ebony	109	2.03	2.13	1.82	1.99
Hoosier	97	1.99	2.21	1.77	1.99
Mikado	112	2.05	2.17	1.72	1.98
Dunfield	93	1.47	2.55	1.63	1.88
Merko	100	2.01	2.10	1.52	1.88
Yokoten	107	2.14	1.82	1.63	1.86
Illini	95	1.72	2.23	1.60	1.85
Elton	95	1.61	2.14	1.66	1.80
Pinpu	88	1.63	2.19	1.53	1.78
Wea	88	1.74	1.84	1.72	1.77
Cowpeas.					
New Era	109	1.93	1.84	1.39	1.72
Victor	109	1.25	1.99	1.74	1.66
Whippoorwill	109	1.42	1.75	1.10	1.42

(a) Two-year average. Yield of A. K. for the same two-year period was 2.28 tons.

YIELDS IN COÖPERATIVE TESTS WITH FARRIERS

In cooperative tests A. K. has given the highest average yield of seed over an eight-year period. Peking has given the highest yield of hay over the same period, with A. K. second. These tests were widely distributed over the eastern part of the state with a majority in the southeast corner. Results of these tests are given in Table VII.

During the last four years the Laredo has given higher yields of hay than any other variety in a limited number of tests in the southeastern part of the state. It has averaged approximately 2.4 tons of hay for the four-year period from 1926 to 1929.

TABLE VII.—YIELD OF SOYBEAN VARIETIES IN COÖPERATIVE TESTS.
(Eight-year period, 1922 to 1929.)

VARIETY.	Seed.		Hay.	
	Number of comparisons.	Yield in bushels per acre.	Number of comparisons.	Yield in tons per acre.
A. K.	98	12.5	80	1.36
Austin	82	11.6	64	1.25
Peking	91	11.2	68	1.53
Morse	98	10.5	79	1.32
Virginia	96	10.4	76	1.26
Manchu	89	10.4	64	1.22

DESCRIPTION OF VARIETIES

Of more than sixty varieties tested at Manhattan only about a dozen have given results which were sufficiently satisfactory to attract special attention. Brief description of some of the varieties which appear to be best adapted to Kansas conditions are given here. Plants of the same variety vary somewhat when grown under different conditions. This is especially true of the time required to reach maturity. The descriptions here given are based on the growth of plants at Manhattan. The number of seeds per pound is given to aid somewhat in determining the rate of planting as well as for identification. The number given aproximates an average for the variety but varies with the conditions under which the seed is grown and whether it has been cleaned and graded, and the closeness of the grading.

A. K.—Plants of this variety are erect and fairly bushy with medium-size stems and branches. The variety lacks uniformity in growth and maturity. Pubescence or hairs over the entire plant may be either tawny or gray. Flowers are both white and purple; pods range from gray to brown. Seeds of medium size (2,800 per lb.), straw-yellow with hilum (seed scar) varying from light, to dark brown, sometimes surrounded by an irregular brown splotch on the seed coat. Plants have a tendency to lodge on fertile soils in seasons of abundant rainfall. This is an excellent variety for both hay and seed. Matures in 120 to 125 days.

Hongkong.— Plants similar to those of A. K. but somewhat more uniform in growth and maturity. Pubescence both tawny and gray. Flowers both purple and white Seeds medium small (3,100 per Ib.)

and of dark cream color with light brown hilum. An excellent all-purpose variety, with apparently somewhat more resistance to lodging than A. K. Matures in 120 to 125 days.

Austin. — This is an erect bushy type suitable for both seed and hay. Flowers both purple and white; pubescence gray; seed yellowish green with brown hilum, slightly larger than A. K. (2,900 per lb.) and more nearly spherical. Plants stand up well. Matures in 120 to 130 days.

Morse. — The Morse is a medium rank-growing variety and slightly later than A. K. and Hongkong. While adapted mainly for seed production it is also a good hay variety. The leaves remain green longer than in most other varieties and the seed does not shatter readily. It is a good variety for poor soil but has a greater tendency to lodge than the Hongkong or Austin on fertile soil. Pubescence gray; flowers both purple and white; pods gray; seeds medium size (2,700 per lb.), yellowish green with tawny hilum. Matures in 125 to 130 days.

Manchu. — This is a medium-early variety maturing about two weeks earlier than A. K. or Hongkong. It is especially suitable for seed production. The stems and leaves are somewhat coarse and the yield of hay is relatively low compared with other adapted varieties. Pubescence tawny; flowers both purple and white; pods brown; seeds straw-yellow with black hilum; medium size (2,700 per lb.). The branches are rather erect and pods are well distributed over the plant. The plants stand up well and the seed does not shatter readily. Matures in about 110 days.

Aksarben. — This is a good medium-early variety for seed production, being similar to the Manchu in earliness and yield. It is easily distinguished from the latter by the gray pubescence or hairs over the entire plant, those of Manchu being tawny or brown. Flowers both purple and white; seeds medium-large (about 2,400 per lb.), straw-yellow with light yellow to buff hilum.

Pinpu. — This is distinctly a seed variety similar to the Aksarben and Manchu in earliness, but slightly shorter and the branches more spreading at maturity. Pubescence gray; flowers purple; seeds of medium size (about 2,700 per lb.), straw-yellow with brown blotches prominent in some seasons; hilum brown varying from light to slatey-brown. One of the best yielders among the early seed varieties, its chief defect being its short spreading growth habit, which makes harvesting inconvenient.

Virginia. — This is mainly a hay variety. It is one of the best for poor soils but lodges badly on fertile soil. The plants are tall and slender with twining tips. Pubescence tawny; flowers purple; pods brown and distributed along the full length of the stem and branches; seeds medium small (3,600 per lb.), oblong, much flattened, olive-brown with inconspicuous hilum of nearly the same color. Matures in 120 to 125 days.

Peking (Sable). — This is a compact, erect bushy variety with fine branches and very leafy. It is very resistant to lodging and makes a good quality of hay. Pubescence tawny; flowers both purple and white; pods brown; seeds glossy black, oblong, flattened and very small (6,000 per lb.), little more than half as large as that of Virginia. Matures in about 120 days. The fineness of branches, leafiness, good yield, and small size of seed, which permits a lighter rate of planting, thus reducing the cost of seeding, make this one of the best medium-maturing hay varieties.

Laredo. — This is a late rank-growing variety which produces heavy yields of hay where the season is sufficiently long. The plants are slender, erect, and have a tendency to lodge on fertile soils. Pubescence tawny; flowers both purple and white; seeds very small (7,000 per lb.), only two-fifths the size of those of A. K., oblong, much flattened and black with black hilum. Matures in 140 to 145 days. It is well suited for growing in southeastern Kansas for hay or green manure. Its late maturity and size, color, and low oil content of seed discriminate against it as a variety for seed production.

Chiquita. — This variety is similar to Laredo in growth habits and time of maturity, but with larger seed (4,000 per Ib.) of a straw yellow color. It produces high yields of hay but the yield of seed is relatively low.