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The Soybean Crop in Missouri

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This picture shows a magnificent growth of Virginia soybeans on the Wabash heavy clay (gumbo) of the Mississippi River bottoms near Elsberry. Contrary to long established opinion, the soybean is not exclusively an upland crop. The Missouri Agricultural Experiment Station has discovered its adaptability to the heaviest and most intractable bottomland soils.

The soybean is successful on any farm land in Missouri. It is the most dependable and economical crop yet found for the production of nitrogenous hay on medium to poor uplands, where clover and alfalfa do not thrive. On such land this legume, because of its high capacity for the production of feed units, may even take the place of a part of the corn acreage. It is well adapted also to heavy clay bottomlands, where the production of most other legumes is attended by several special

difficulties.* The proper placement of soybeans in the crop rotation will lessen or even eliminate the expense of preparing any kind of land for fall sown grain. The manufacture of soybean oil and cake is increasing, and thereby a new market for soybean seed is being developed. Withal there is a sound prospect for the enlargement of this crop in Missouri, even though it is already being planted on a scale of 500,000 acres.

The method of growing and handling soybeans will largely determine the yield and quality of the crop, the benefits of the crop to the soil, and the reduction in the cost of growing the crop that follows soybeans in the rotation. This bulletin contains practical information on the essentials of soybean production.

THE BEST VARIETIES OF SOYBEANS

The leading varieties for Missouri are grouped according to the purpose for which they are best suited. It is seldom that a variety will excel in the production of both hay and seed, but some exceptions will be noted.

For Hay.—The best varieties for hay in Missouri are Virginia, Wilson and Laredo. Virginia is superior to Wilson and Laredo on all Missouri soils which are medium to low in fertility. On good land Wilson and Virginia make approximately the same yields, but Wilson produces a finer quality of hay and is slightly more resistant to lodging. Both of these varieties require approximately 100 days to mature hay and 130 days to mature seed, and can therefore be grown safely throughout the entire State without danger of frost injury. Laredo is a very late maturing variety and for this reason is adapted only to the southern third of the State. It is particularly adapted to the Southeast Missouri lowlands, and there will produce high yields of very fine-stemmed leafy hay; but the pronounced tendency of this variety to lodge and produce a long trailing growth of vines makes it difficult to cut and handle. Manchu and other short, erect kinds classed as seed varieties are suitable for hay on highly productive land where Virginia and Wilson make a heavy rank growth and lodge readily, but they should be sown at a very heavy rate to insure a good quality of hay.

For Seed.—Varieties is this group are distinguished by their short, erect, bushy growth and high yields of seed. Where the crop is grown for milling purposes a yellow-seeded variety is preferable, as yellow seed command a premium of 10 to 15 cents per bushel over brown or black seed.

Manchu, Illini, Morse and Midwest are the best seed varieties for Missouri. Virginia, which is classed as the leading hay variety for

*On the bottomland experiment field at Elsberry, Mo., conducted cooperatively by the Missouri Agricultural Experiment Station and the United States Department of Agriculture, soybeans on the Wabash heavy clay soil—often called "gumbo"—have produced extremely large crops of hay and seed.

Missouri, may also be included in the seed group, as it is the best variety yet discovered for seed production on poor land.

Manchu is very early, requiring only about 115 days to mature seed, and is well adapted to all fertile soils of the State. On medium to poor soils, particularly in dry seasons, the plants are likely to be too short to harvest with a binder. Illini is similar to Manchu in its general growth habits and time required to reach maturity. It is superior to Manchu on heavy bottomland, but is very poorly adapted to thin uplands.

Morse and Midwest yield well over a wide range of soil conditions, but each has one or more objectionable features. Midwest is very late maturing for a seed variety and produces coarse woody plants that are difficult to harvest and thresh. Morse if planted on good land is likely to lodge and produce side branches that settle to the ground with a considerable loss of seed. Harbinsoy, a yellow-seeded variety similar in general growth habits to Virginia, is suitable for seed production on soils of medium to low fertility. Under these conditions it will yield about the same quantity of seed to the acre as Virginia, but it is inferior to Virginia for hay.

For Planting in Corn.—In Southeast Missouri, large, late maturing varieties including Mammoth Brown, Mammoth Yellow, and Laredo are best suited for the popular practice of planting soybeans in corn. Mammoth Brown and Mammoth Yellow produce a relatively high yield of seed and are recommended where the crop is to be hogged off. Throughout the remainder of the State any adapted variety that produces a good yield of seed is satisfactory for growing in corn.

GOOD METHODS OF PRODUCTION

Seedbed Preparation.—Land in ordinary condition will require about the same preparation for soybeans as for corn. Fall or early spring plowing is best but not essential, though the land should be plowed if possible at least three weeks before the crop is to be planted. Harrowing of the plowed land is beneficial. The final step in the preparation of the seedbed should be a thorough disking and harrowing immediately before planting to kill weeds and make the surface smooth and mellow. Land that is naturally loose and mellow and reasonably free from trash, need not be plowed, but can be put in good condition by deep thorough disking early in the spring and again just before planting. This will save some labor as compared with the job of preparation that includes plowing. After either plowing or disking the spring growth of weeds must be kept down.

Thorough preparation of the land for planting will greatly reduce the work of cultivating soybeans and will give a clean mellow seedbed for wheat or winter barley after the bean crop is harvested. Thus the

cost of producing both the soybeans and the grain crop is lessened through the efficiency of one good job.

Time of Planting.—Soybeans will stand considerable cold. In fact the young plants are not killed by light frost. But there are no advantages in very early planting, while the disadvantages are poor stands, greater labor and expense in keeping the crop clean, and reduced yields. Generally the crop should be planted between May 25 and June 15 in the northern third of the State; May 20 to June 10 in the central third; and May 15 to June 5 in the southern third.

The Manchu and other quick maturing varieties if planted as late as June 25 in the northern half of the State and July 5 in the southern half will usually mature a seed crop, but their yield is reduced 15 to 30 per cent by planting this late.

Soybeans planted anywhere in the State as late as July 15 will produce hay, green manure or pasture crop. The yields will not be large, but these late plantings are an efficient means of utilizing small grain stubble land that otherwise might grow up in weeds.

Methods of Planting.—The method of planting a crop of soybeans will depend on the fertility of the land, "foulness" of the land with weed seed, and the purpose for which the crop is to be grown. For seed production soybeans should be drilled solid on land capable of producing 30 or more bushels of corn in a normal season. On less productive land planting in cultivated rows is best. For hay the crop should be drilled solid except on very poor land, where it should be planted in rows. Some exceptions to these broad recommendations should be noted.

Planting in rows to permit thorough cultivation is advisable on foul land, particularly on rich bottomland heavily infested with the seed of morning glory, pigweed, cotton weed, and other rank growing weeds. However, soybeans can be satisfactorily produced by drilling even on very foul land, if the seedbed is so prepared that two or three crops of weeds are killed before the beans are planted. Drilling is always preferable to row planting on land subject to excessive erosion, although the latter method will result in the highest yields where the land is poor.

Soybean rows should be spaced only as far apart as is necessary to permit good cultivation with corn cultivators. A few growers space the rows 16 or 20 inches apart by "double rowing" with a corn planter or by stopping every other feed in the drill. This method, although satisfactory at times on clean land of moderate fertility, is not recommended, because the rows are too close together to permit intertillage and too far apart to keep weeds down.

Rates of Planting.—The minimum rate of planting under favorable soil and weather conditions is 60 to 75 pounds of good seed to the acre

for drilling solid, and 20 to 25 pounds for seeding in rows. These rates should be increased 20 to 50 per cent on fertile land foul with weeds, and on a rough, cloddy seedbed. When it is intended to cultivate broadcast with a harrow or rotary hoe there should be a similar increase. Heavy rates of seeding offset the loss of plants which results from this kind of cultivation, and also produce finer hay. The rate for large-seeded varieties is somewhat higher than for the small-seeded kinds. A much finer quality of hay is secured from heavier rates of seeding than is required for maximum seed production. There is very little danger of getting the plants too thick for hay, but excessive crowding and shading in a thick stand will tend to reduce the yield of seed.

INOCULATION

Soybeans, being a legume, can take nitrogen from the air, through the aid of bacteria that live on the roots. The presence of these organisms is indicated by nodules on the plant roots. They will not inoculate other legumes, nor will the bacteria found on other legumes inoculate soybeans. Where soybeans are grown on land for the first time inoculation should be practiced, otherwise the plants will be forced to draw all of their nitrogen from the soil, the same as corn, oats or other non-legume crops. As a result, the yield and percentage of nitrogen in the crop is lowered and the land made poorer in nitrogen.

The most practical means of inoculation is by the use of artificial cultures. The material can be secured at the cost of its preparation from the Soils Department of the Missouri College of Agriculture, with complete directions as to its use.

CULTIVATION

Soybeans planted at the right time, on a clean, well prepared seedbed do not require a great deal of cultivation. A few timely and thorough cultivations are, however, very necessary to keep the land mellow, receptive to moisture, and free of weeds. Whether the crop is planted in rows or drilled solid, very shallow cultivation with a rotary hoe or a spike-tooth harrow is the most efficient method during early growth.

The first and frequently the most beneficial cultivation may be required before the very young beans have broken through the soil crust that usually forms where a rain follows planting. The rotary hoe is best for this purpose, although the spike-tooth harrow is satisfactory. A harrow should not be used when the plants are just breaking through the surface of the ground for they are tender and easily broken off at that stage. Harrowing after the plants are up to a good stand should be done during the late forenoon and afternoon when the plants have toughened under the sun.

Cultivation of soybeans seeded in rows should be continued after the plants are too large for cultivation with the rotary hoe or the harrow. Working twice with the corn cultivator equipped with sweeps for shallow level cultivation, will usually be sufficient to control weeds until the plants are ready to bloom. By this time the crop is shading the ground and making a heavy demand for moisture. Weed growth is thereby suppressed.

SOYBEANS IN MIXTURES

Soybeans are widely grown in combination with other crops. The principal advantages from these mixed plantings are (a) higher total yield, (b) better balanced feed, (c) easier curing where the mixture is utilized for hay, and (d) greater benefits to the soil.

Soybeans and Sudan Grass.—These crops when planted together make an excellent combination for hay. The best results are secured by first planting the beans in rows at the normal rate and keeping the land clean by level shallow cultivation until the plants are 4 to 6 inches tall. Sudan grass seed should then be drilled between the rows with a one-row drill, or broadcast at the rate of 20 to 25 pounds to the acre according to soil fertility, and worked into the soil by shallow cultivation. The mixture should be cut for hay when the Sudan is in full bloom. The Sudan grass may then produce another hay crop or furnish an abundance of pasture during the remainder of the growing season.

Soybeans and Small Grain.—Drilling soybeans in grain crops is a unique but nevertheless a practical method of growing soybeans in Southeast Missouri. Studies at Sikeston, by the Missouri Experiment Station, indicate that grain yields are not reduced by this practice. Hot dry weather shortly before and after grain harvest may cause a partial or total failure of the bean crop, but an average yield of 6 to 10 bushels on the lighter ridge lands and 10 to 15 bushels on the better soils can be secured over a period of years. The method has been tried in other sections of the State, but with little or no success. Wheat is mainly used as a companion crop with soybeans because it is generally more profitable than other grains. On poor sandy land rye is superior to wheat for this purpose, but land of this character is incapable of yielding a highly productive combination regardless of the grain crop used. Oats can be made a satisfactory companion crop by seeding early at a moderately low rate on a well prepared seedbed. But, since oats usually follow corn in the rotation, the seedbed preparation that is practical or even possible for the oats crop in most cases is not sufficient for a successful growth of soybeans.

The beans may be sown in wheat at any time in the spring after the soil is reasonably warm and until the grain begins to joint. Roughly this period extends from about March 15 to April 15.

Laredo, Virginia and Wilson are the best varieties yet discovered for growing in combination with grain in this State. Laredo plants make a slow early growth and will seldom interfere with the grain harvest. Virginia and Wilson make a comparatively rapid growth and should not be planted until shortly before the grain begins to joint.

The rate of planting the beans is governed by a number of factors. If planting is delayed until after about the first of April, 40 pounds of Laredo and 75 pounds of Virginia and Wilson to the acre are enough if the land is in good condition. For very early planting or for planting on a poor seedbed where the beans cannot be covered properly, these rates should be increased.

Soybeans and Corn.—Soybeans are grown with corn to a far greater extent than with other crops, 70 to 90 thousand acres in Missouri being used annually for this mixture. Tests conducted on upland soil of average fertility by the Missouri Experiment Station and other stations in the corn belt have shown that the yield of corn is invariably reduced by soybeans 5 to 25 per cent, according to the season, soil and rates of planting. The compensation for this loss by an increase in total yield, feeding value, and benefits to the soil has also been variable. In general, however, the yield of soybean seed has not equalled the loss of corn, bushel for bushel, but the mixed crop has produced more nitrogen than corn alone.

It is a question then of how to utilize the increase in nitrogen in order to derive a benefit from the mixture. If the beans are turned back into the soil in the same manner as a green manure crop, the increase in yields of succeeding crops will not offset the loss in corn yields. If the mixture is pastured off with hogs, the gain in animal weight resulting from a better balanced feed, and the increase in organic matter and nitrogen from the manure and plant residue left on the land, may be expected to overbalance the reduction in corn yields. But regardless of the apparent merits of the corn-soybean combination the acreage of this mixture in the State as a whole is steadily declining. However, on some of the sandy and sandy loam soils in Southeast Missouri, the planting of beans in corn continues as a very popular practice. There the mixture produces an average value far in excess of that from corn alone.

There are several reasons for this more favorable showing. (1) Late varieties, including Mammoth Brown and Laredo, that require 150 to 170 days to mature, are well adapted to the long growing season of Southeast Missouri. The slow growth of these varieties where planted in corn and a slightly higher rainfall in that section tend to minimize the destructive effect of competition between the beans and corn. (2) When the mixture is planted at the usual corn planting time the corn crop matures 30 to 40 days ahead of the beans, which continue growth

until fall. The resources of the soil are thus fully utilized in nearly the entire growing season with the result that the total yield is much greater than could be secured from either of the crops alone. (3) The sandy soils now principally used for growing the mixture are low in organic matter and nitrogen. They show marked improvement from each small increment of these components. Where the mixture of corn and beans is pastured, or the corn harvested and the beans later pastured or turned under, there is a pronounced beneficial effect on the succeeding crop, particularly if that crop is cotton.

The most effective method of planting a mixture of soybeans and corn is to use a special bean attachment on the corn planter. Mixing the corn and beans in the same hopper will result in an uneven stand, but the method may be used with fair success if the seed is stirred frequently. Drilling is preferable to checking except where cross cultivation is required to control weeds. The rate of planting in pounds of seed to the acre will vary widely, but 2 to 4 bean plants for each corn plant in Southeast Missouri, and 1 to 2 plants on the uplands of the State, are about the right proportions.

HARVESTING SOYBEANS FOR HAY

Stage for Harvesting.—The best stage at which to harvest soybeans for hay could be exactly determined only by feeding tests with hay cut at different stages. There are, however, certain well known facts that can be used in calculating the proper stage. Briefly they are:

(1) The weight of the crop increases until the pods are filled with seed and the leaves on the lower fourth of the plant are yellowing from maturity, but before the leaves have shed.

(2) The leaves are at their maximum weight when the pods are well formed and first begin to fill.

(3) The stems remain practically constant in weight after the pods are well formed.

(4) The protein content of soybean hay harvested at any stage from "pods well formed" until the pods are filled and the leaves are showing signs of maturity, is nearly constant.

(5) Hay cut before the pods are full is more palatable, more easily digested, and easier to cure than when cut at a later stage.

From these facts it is evident that soybeans should not be cut for hay until the pods are formed and begin to fill, for earlier cutting results in a low yield of leaves, the most valuable part of the plant for hay, as well as a reduction in total yield. The most advanced stage of growth that might be considered for hay is when the pods are full and the leaves are maturing. There are three to five weeks between these extreme limits

of the hay stage, during which the yield is gradually increasing. The weight of leaves is then decreasing, but there is a compensating increase in the weight of pods and seeds that gives a net gain, even over the declining weight of the leaves. The weight of stems is nearly constant during this period.

It is therefore clear that in deciding on the stage to cut soybeans, the maximum yield of hay and protein on the one hand should be measured against palatability, ease of digestion, and ease of curing on the other. A balance between these desirable conditions is logical. Since good feeding qualities are the first requirement of a hay crop, the balance should be in the direction of the early hay stage.

This means that the soybean hay crop should be cut when the pods are one-fourth to one-half filled.

Methods of Cutting and Curing.—Soybeans are more difficult to cut and cure than alfalfa, timothy, and other fine-stemmed plants, but with a little skill and care they can nearly always be made into high quality hay. There is no one best method to follow in making soybean hay, but certain points should be observed under a wide range of conditions. The crop should never be cut when wet with dew or rain. The surface of the ground should be dry when the beans are cut, especially if they are mowed; otherwise the plants on the upper side of the swath may become dry and bleached before those underneath are ready to rake.

A mowing machine is generally the most satisfactory implement to use in cutting soybeans for hay. A grain binder also can be used successfully if the crop is not too heavy, if it stands up well, and if it is free from vines that cause difficulty in elevating and binding. Less labor is required for the whole job of cutting, curing and handling if the binder is used. On the other hand, there is considerable danger of loss from molding and rotting in the center of the bundle, although this can be partly overcome by making small, loosely bound bundles and placing them in small shocks to promote rapid curing.

If the crop is mowed it should be left in the swath until thoroughly wilted regardless of the time required. It should then be raked into windrows before the leaves are bleached and made brittle by excessive drying. Curing may be completed in the windrow, but as a safeguard against rainy weather it is better to cure in tall narrow shocks rather than in the windrow.

The hay should be thoroughly cured before it is housed or stacked. Practical experience is the safest guide in determining when the hay is ready to store, but when plants from the center or underside of a shock have become so dry that no sap can be twisted out of the stems and pods, the hay is ready for storage.

More thorough field curing is required before hay can be safely baled from the shock or windrow than is required for storing loose in a barn or for stacking. Indeed it is seldom safe to bale from the shocks except after unusually long periods of favorable curing weather. It is best first to place the hay in tall narrow stacks or ricks and allow it to pass through the "sweating process", after which there is no danger of damage in the bale.

HARVESTING SOYBEANS FOR SEED

Stage for Harvesting.—In general soybeans should not be harvested for seed until approximately one-half of the pods are ripe and three-fourths of the leaves have shed. These two stages are usually reached at about the same time in varieties adapted to Missouri, but not in all cases. If harvested before most of the leaves have shed, the plants and seed dry slowly, thus delaying threshing, and in prolonged rainy spells any considerable amount of leaves bound into the bundle will hold enough water to cause molding of the beans. If the crop is cut before a large percentage of the pods are ripe, seed yield and germination is lowered. On the other hand, if it is allowed to stand until the pods are thoroughly dry there will be some loss from shattering. Where a combine is to be used it is necessary for the crop to reach this advanced stage of maturity to obtain the best results. Varieties which do not shatter and lodge readily are best suited for combine harvesting. Those adapted to Missouri that meet these requirements include Virginia, Wilson, and Manchu.

Methods of Harvesting.—Various kinds of machines are available for harvesting beans for seed. Small combines may become practical on large tracts of level land if commercial seed production is entered on a large scale, but under present conditions the grain binder should be used. The bundles should be made comparatively small, placed in small, well formed shocks, and allowed to cure in the field. It is sometimes necessary to cut a badly lodged seed crop with a mower.

Threshing.—Special bean and pea threshing machines are manufactured that are very efficient for threshing soybeans. The ordinary grain separator can be used with equal success if it is adjusted to prevent cracking of the beans. The principal cause of this damage is the high speed of the cylinder, but some of the beans are actually crushed between the cylinder teeth and concaves. The damage from high speed is easily eliminated by reducing the cylinder speed to about one-half the normal operating rate. At the same time, however, the other parts of the machine must be maintained at a normal rate to clean out the chaff.

This is accomplished by doubling the size of both cylinder pulleys. Damage from crushing the beans between the cylinder and concave teeth is reduced or eliminated by removing part or all of the concave teeth. If the pods are dry and brittle no concave teeth are necessary, but if they are tough, one or two rows of teeth are required to prevent unthreshed pods from passing through the machine.

Soybeans threshed before the seed are thoroughly dry should be handled carefully to prevent heating and molding. Damage from these sources is almost certain to result if a large quantity is s ored loose in a bin. The best method of conditioning beans for storage, under farm conditions, is to spread them in a thin layer on the floor of a well ventilated barn, and stir them from time to time until they are dry.

SOYBEANS IN THE CROP ROTATION

Soybeans can be made to fit perfectly into any standard Missouri rotation, either as a substitute for oats, or other annual crops, or simply by lengthening the rotation cycle one year. Generally they should follow corn, or if oats are grown, soybeans may follow the oats crop, thus giving a rotation of corn, soybeans, wheat, clover, or a rotation of corn, oats, soybeans, wheat and clover. Fall sown grain, preferably wheat, in most cases should follow soybeans because little or no seedbed preparation is required for the grain crop. On level prairie or bottomland, where there is no soil erosion during the winter, fall sown grain may be omitted and the soybean land used the following season for corn or oats. Corn after soybeans has been found an excellent sequence on heavy clay "gumbo." In experiments on such soil, near Elsberry, corn on double-disked soybean land in a three-year period produced a higher average yield than corn on spring plowed corn land or on alsike clover sod.

One of the most frequent objections raised by farmers to bringing soybeans into the rotation is that they cause erosion on rolling land. Serious erosion is sure to result if the crop is grown in cultivated rows or the land left bare over winter. If the beans are close-drilled, however, and the land seeded to wheat or winter barley, very little erosion will occur even on land that is usually subject to excessive erosion. The best results are obtained by harvesting the bean crop early and seeding winter barley during the first ten days of September.

EFFECT OF SOYBEANS UPON THE YIELD OF WHEAT

Reports have come from farmers that wheat yields are at times reduced below normal where wheat follows soybeans in the rotation. Some of the most probable causes of this reduction are explained briefly in the following paragraphs, and means of overcoming them are suggested.

1. A crop of soybeans usually leaves the ground very loose. This condition in itself is not unfavorable to the wheat crop that is to follow, but if the land is then prepared for wheat by deep disking shortly before seeding, a marked reduction in yield may result. Late, deep disking of land for wheat already made loose by soybeans is equivalent to late plowing—it produces an extremely loose and very dry seedbed on which the crop is subject to injury from three separate causes—erosion, freezing, and winter drought. The disk should seldom be used at all on soybean ground, but if it is necessary for working out an unusually rough field, it should be set for a shallow depth. The land should then be harrowed. These operations will tend to make the seedbed smooth and mellow at the surface and firm underneath. Rolling is an effective means of overcoming in a small way the loosening effect of soybeans, but the advantages gained will not as a rule pay for the cost of the treatment. Indeed it may be said that any preparation of soybean stubble land other than that which may be necessary to make the land smooth will seldom be beneficial. Soybeans naturally leave the land in good condition as a seedbed for wheat, and as a rule any preparation of the soybean ground will lessen rather than improve this condition.

2. A heavy crop of soybeans which grows until near wheat seeding time, will leave the soil reduced in available plant food, and so may cause a loss in the wheat yield. Furthermore, during the first few weeks following soybean harvest, bacterial action is greatly stimulated by the presence of the soybean roots. The bacteria require nitrogen as a food and draw heavily on this essential material, which may already have been decreased below normal by the bean crop. It should be emphasized in this connection that the use of the nitrogen by bacteria is only a temporary depletion. Eventually the nitrogen tied up in the bodies of these minute organisms will become available to the wheat crop.

Practical means of overcoming or minimizing the harmful effects of a crop of soybeans on wheat caused by a temporary shortage of plant food are (1) providing the soybeans with thorough inoculation from the air, (2) harvesting the bean crop early, so as to hasten the accumulation of available plant food for the wheat, and (3) applying nitrogenous fertilizer to the wheat.

3. In seasons of moderate or low rainfall a late crop of soybeans will leave the land low in moisture which in turn may cause poor germination and slow growth of the wheat in its early stages of development. Early harvesting of the bean crop in order that the soil moisture may be restored to normal before wheat seeding time is the best way out of this difficulty.

SOYBEANS FOR SOIL IMPROVEMENT

One of the primary reasons for growing soybeans is to improve the land. The physical condition of a hard, compact soil is certain to be improved through the loosening effect of the roots and the increase in organic matter, and there may be an addition of nitrogen. The total benefit will depend partly upon the quantity of nitrogen added, which in turn depends on the yield and method of utilizing the crop. The maximum gain in nitrogen will result from turning the crop under as green manure, but it is seldom practical to utilize a full season crop in this manner. Approximately 50 pounds of nitrogen is added to the soil for each ton of dry weight in the soybean crop that is turned under. The roots of the plants required to produce this amount of material contain about 6 pounds of nitrogen. Therefore for each ton of soybean tops plowed under, about 56 pounds of nitrogen are added to the soil, of which slightly more than one-half has been taken from the air, if the crop was thoroughly inoculated.

If the crop is utilized for hay or pasture and all manure returned to the land, approximately 80 per cent of the nitrogen, or about 45 pounds—of which about 22½ pounds came from the air—is added to the soil. The remainder is retained by the animals which consumed the crop. If no manure from the hay crop is added to the land, however, there will be a loss rather than a gain in nitrogen, from the growth of the beans. When the crop is cut and handled for seed by the usual methods employed in Missouri, only its roots and leaves are returned to the soil. Roughly one-half of the nitrogen in the entire crop is contained in these two parts of the crop. Assuming again that one-half of the nitrogen in the crop came from the air, practically no gain or loss has resulted. It should be said in this connection, however, that a crop of oats, corn or other non-legume crop leaves the land poorer in nitrogen, whereas the nitrogen level is maintained by a soybean seed crop.

COST OF PRODUCING SOYBEANS

The cost of producing soybeans is variable with the efficiency of the methods employed, with the yields per acre, with the character of the soil, and with weather conditions from plowing to harvesting. It is variable finally with the purpose of the crop—whether the crop is grown and harvested for hay or for seed. The total cost of the hay crop is less variable than that of the seed crop, because it does not include threshing charges, which are an important item of cost for the seed crop, and differ widely from one locality to another.

Because more than three-fourths of the soybean crop in Missouri is harvested for hay, we are generally interested in soybeans as a hay crop,

and particularly interested in comparing the cost of bean hay with the cost of corn on similar land. Land yielding an average of 1½ tons of soybean hay per acre is capable of producing an average yield of 30 bushels of corn. These figures are very close to the average production of medium upland, but perhaps they favor the corn rather than the beans. On such land, if work stock power is used, the 30-bushel corn crop will cost about 20 hours of man labor and about 49 hours of horse labor, assuming the crop is harvested by husking the corn and pasturing the stalks. Under similar conditions of land and work-stock power, the production, harvesting, and stacking of 1½ tons of soybean hay will cost about 19 hours of man labor and 38 hours of horse labor. The difference in cost here is slightly in favor of the soybeans.

If the corn crop is harvested by cutting, shocking, and husking, and the fodder is hauled away, an additional cost of about $2.50 per acre may be charged against the corn. In this case the cost of the corn may exceed the cost of the soybean hay by as much as $3.00 an acre.

Finally the comparative costs of producing these crops should take into account their effects upon soil fertility. The crop of soybean hay by removing less fertility than corn will leave more in the soil. Here is a difference in natural expenditure which is difficult to figure out for the farm ledger, but nevertheless enters surely into the long run cost of crop production—and in this case makes a substantial point in favor of the soybeans.

FEED VALUE OF SOYBEAN HAY

The total digestible nutrients in 1½ tons of soybean hay are estimated at 1608 pounds, and in 30 bushels of shelled corn at 1372 pounds, with about 300 pounds to be added if the stalks of the 30-bushel crop are pastured or the fodder is fed. There will be much variation in the total feed value of the stalks or fodder because of the fluctuating degree of waste in these remnants. Still, there may be estimated a small margin of total digestible nutrients, in favor of the total crop of corn. But this difference is over-balanced by the fact that in the soybean hay there is much more protein per acre than in the corn. Protein is the most expensive constituent in feed—especially when it is bought in the form of commercial concentrates—and there is sound economy in its home production by such easily grown legumes as soybeans.

SUMMARY OF COST AND VALUE

1. On the basis of labor and power charges, soybean hay costs somewhat less than an equivalent yield of corn. On the best corn land, the highest yield of corn will give this crop an advantage over soybeans

in the low cost per unit of feed produced. On land that is medium or less in fertility the advantage in cost of the feed unit will pass to the beans.

2. On the basis of cost to the land—the removal of soil fertility—the soybean crop is much cheaper than corn.

3. On land that is medium in fertility, a crop of soybean hay will produce feed per acre that will approximately equal the acre value of feed there produced by corn. On poor land the soybeans will outyield corn in feed units by a wide margin.

4. It is therefore clear that on land ranging from medium to poor in fertility, the substitution of soybeans for a part of the corn crop is a reasonable procedure in the production of feed. Only on land above medium in fertility can corn be expected to produce a larger yield than soybeans, in terms of total digestible nutrients.