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SOYBEANS

THEIR USE AND CULTURE IN SOUTHERN MINNESOTA

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One of the greatest uses of soybeans in southeastern Minnesota seems likely to be as a home-grown high protein grain supplement, to take the place of oilmeal as a means of supplying the protein not provided in the ordinary dairy ration of corn silage, alfalfa hay, corn, and oats.

This is a conclusion drawn from experience with soybeans at the Southeast Demonstration Farm and Experiment Station at Waseca, and it throws light on the question as to the best use to make of a crop, which, by the seeding of adapted varieties, can be grown and matured in practically all parts of Minnesota.

Heretofore soybeans have been generally recommended for planting with corn for silage and for hogging off, and they have been used largely in these ways in the central and southern parts of the state.

Every experiment at the Waseca substation has shown that soybeans planted with corn will somewhat reduce the yield of corn. Whether soybeans will make a sufficient growth to equal or exceed this loss of tonnage is still a debatable question so far as the Waseca region is concerned.

The greatest danger lies in the fact that many farmers believe that by planting soybeans in their silage corn they have adequately provided for the protein needs of the stock, and that, when feeding a legume hay such as clover or alfalfa, they have no need of a protein supplement such as linseed meal. The soybeans in a field of corn and beans planted together vary from 10 to 20 per cent of the total tonnage. But even if the beans did produce as much as 10 to 20 per cent of the total tonnage, they would still come a long way from yielding enough protein for even the ordinary producing dairy cow.

Thirty pounds of straight corn silage contains 0.38 pound of digestible protein.¹ Silage containing 10 per cent of beans gives 0.4

¹ Haecker's Feeding Standards.

pound of protein, or an increase of 0.04 pound. A 1200-pound cow, producing 25 pounds of 4 per cent milk, requires 2.2 pounds of protein. Ten pounds of alfalfa hay provide 0.3 pound, clover hay less. Four pounds of corn and 4 of oats give 0.7 pound. It is easy to see, therefore, that with such a ration, including the soybeans in the silage, there is still need of one pound of protein.

It has been well established by experimental work at Iowa State College, Ames, Iowa, and at University Farm, St. Paul, that ground soybeans are equal to, or a trifle superior to, old process linseed oilmeal as a source of protein. At the Waseca substation, however, whole beans were fed to dairy cows with satisfactory results.

The question arose as to whether the beans could be fed successfully without threshing and grinding. If they give as good results when fed in this way, it would very materially reduce the cost of producing a high-protein grain feed. To answer this question, soybeans of the Habaro variety were allowed to mature in the field, were cut with a binder, and were shocked and stacked, like grain, beside the barn. These beans were fed in the bundle to the dairy cows. By threshing several bundles it was determined that each bundle contained on the average one pound of grain. The cows ate the beans readily, even the coarse, woody stalks, altho they left the coarser stalks of good alfalfa hay of the second cutting. Less beans than corn were lost in the manure, indicating that they were more easily digested than the ground corn which was fed.

This experience has led to the belief that the farmer who can not afford to buy oilmeal might profitably grow soybeans, and without the cost of threshing or grinding could furnish his cows a protein supplement equal to oilmeal. This method of feeding is worthy of an extended trial, and may prove to be one of the best uses that can be made of soybeans.

SOYBEANS AS HAY

Soybeans may also be used as an emergency hay crop. We do not believe that soybeans can compare, under present conditions at least, with either alfalfa or clover as a main hay crop, because it costs more to produce an acre of soybean hay than to produce an acre of clover or alfalfa. Soybeans yield about the same amount of hay per acre as red clover, but less than alfalfa. They are equal in feeding value to alfalfa hay and are no more difficult to cure. The estimated cost of producing and storing three cuttings from an acre of alfalfa is \$6.80, not including land rental. By combining the costs for similar operations with corn and hay, it is estimated that it will cost \$11 besides the land rental to raise an acre of soybeans. Assuming that the beans yield 2 tons per acre, the cost of hay will be \$5.50 per ton; while if alfalfa yields $3\frac{1}{2}$ tons the cost will be only \$1.95 per

CORRECTION

For Special Bulletin No. 82, "Soybeans"

The following should replace the next-to-the-last paragraph on page 1 and the paragraph beginning at the bottom of page 1 and ending at the top of page 2:

The greatest danger lies in the fact that many farmers believe that by planting soybeans in their silage corn they have adequately provided for the protein needs of their stock, and that when not feeding a legume hay such as clover or alfalfa, they may think they have no need of a protein supplement such as linseed meal. The soybeans in a field of corn and beans planted together vary from 10 to 20 per cent of the total tonnage. But even if the beans did produce as much as 10 to 20 per cent of the total tonnage, they would still come a long way from yielding enough protein for even the ordinary producing cow, without legume hay.

A 1200-pound cow, producing 25 pounds of 4 per cent milk a day requires 2.2 pounds of protein daily. Thirty pounds of straight corn silage contains 0.38 of a pound of digestible protein.¹ Silage containing from 10 to 20 per cent of beans provides 0.4 of a pound of protein or an increase of 0.02 of a pound. Ten pounds of prairie hay contain 0.3 of a pound of protein, or an increase of 0.02 of a pound. Ten pounds of prairie hay contain 0.3 of a pound of protein, and 4 pounds of corn and 4 of oats contain 0.74 of a pound of protein. Such a ration, therefore, contains a total of 1.44 pounds of protein, or three-quarters of a pound less than the amount required. If, however, 10 pounds of alfalfa hay, containing 1.17 pounds of protein, is substituted for the 10 pounds of prairie hay, the total of protein is brought to 2.3 pounds, or a slight fraction more than the amount required.

¹. Haecker's Feeding Standards.

ton. This would make soybean hay more expensive than alfalfa, largely because of the lower yield, the higher cost of seed, and the greater amount of labor needed. On farms where enough alfalfa is not yet established or where red clover winter kills, cattle feeders and dairymen will undoubtedly find it profitable to grow soybeans for hay.

Trials at Waseca indicate that for cows soybean hay is far superior to a mixture of oats and Canada field peas. It is easier to handle, apparently much more palatable to the cattle, and certainly of much higher feeding value, especially in protein. Cattle have left bright second-cutting clover for soybean hay which has been out almost a week during rainy weather. The bean hay was not moldy, but was badly discolored. The cattle ate all the coarse stalks and stems of the soybeans but left some of the clover and alfalfa stems. This odd habit has been observed for three successive years.

SOYBEANS FOR HOGS

Soybeans may be used to balance a ration for fattening hogs if minerals also form a part of the ration. This has been proved by numerous experiments in which the beans were fed either whole or ground. However, the beans have the same value if eaten from the plant in the field. It has become a common practice in some parts of the country to plant beans with corn for hogging off. At the Waseca substation this plan has not been given an extended trial as the spring pigs are usually marketed before the corn is ripe. Attempts to grow the later maturing tall varieties with corn have not been very successful on this soil. It is possible that some of the earlier maturing low-growing varieties such as Minsoy, which gives practically the same yield of seed as our best varieties, Manchu and Habaro, may be better adapted to this purpose. It is probable that more satisfactory results will be obtained by planting the beans alone and the corn alone in the same field. In hogging off corn it is customary to feed from 5 to 10 per cent tankage. About six pounds of beans, then, should balance a bushel of corn. Assuming a yield of 50 bushels of corn and 20 bushels of beans, about $2\frac{1}{4}$ acres of beans would be needed to furnish a protein supplement for 10 acres of corn.

SOYBEANS FOR SEED

At present the demand for Minnesota grown soybean seed is very active, and all indications point to a continued demand for seed of adapted varieties for some time to come. Seed of good quality has been bringing from \$3.50 to \$4.50 per bushel. In 1923, the demand far exceeded the supply. Even if the price per bushel were as low as \$2.50, soybeans would be a profitable crop to grow under present

conditions. If beans should become cheap enough to make it practical, there is always the possibility of using them as a source of oil. The oil is extracted from soybeans in much the same way as from flax and can be used for the same purposes. There are a few soybean oil mills in the United States, but in most localities beans are so high in price as to make the production of oil impractical. The oilcake formed as a by-product is equal to linseed oilmeal for feeding purposes. Milk substitutes, flour, and other manufactured products can be made from soybeans, so there is little possibility of an over-production. In China and Japan soybeans are largely used as human food.

When growing soybeans for seed, the broken and split beans can be separated and used as stock feed. Fed whole to fattening steers they have given very good results and seem to be very palatable. Steers on a full feed of corn have been observed to eat every bean altho they left shelled corn in the feed box. With cattle on full feed more of the beans are undigested than with dairy cows, but the proportion of beans in the manure is less than that of corn.

FEEDING SOYBEAN STRAW

The stems and pods remaining after soybeans have been threshed for seed are relished by horses, cattle, and sheep. These stems and pods are usually badly weathered but may be used for stocker cattle or as part of the hay for horses. There will, of course, be considerable waste, as the stock can not be expected to clean up as closely as when the plants are fed as hay. For the last three years at the Waseca substation the breeding ewes were wintered on 2 pounds of good corn silage per head per day and all the bean straw they cared to eat. The beans are fed in racks twice a day and the stubs taken from the racks make better bedding for the sheep than even rye straw, as they do not work into the wool. On this ration of soybean straw and silage, with no grain, mature sheep have come through the winter in good condition. About a month before lambing, alfalfa was gradually substituted for the bean straw. This feed has given excellent results, the ewes yearning from 150 to 200 per cent of strong active lambs and milking well. They were in good condition to go on spring pasture. The wool clip has averaged from 10 to 11 pounds, which is considered satisfactory for Shropshires. There was never enough of the bean straw for extensive feeding experiments with cattle or horses.

CULTURE OF SOYBEANS

The culture of soybeans is very similar to that of corn except that a slightly wider range of soil may be used. Beans have matured well on soil which contains too much alkali for corn, and have grown well

on shallow peat soils and on sandy land. They will do well on soil too acid for the successful growing of alfalfa or sweet clover. The seedbed should be prepared as for corn and the beans planted at about the same time and the same depth. It is customary to plant the beans as soon as the corn is in, about May 20 in southern Minnesota. Field trials in which the beans were planted every ten days from May 1 to June 10 indicate little variation in height or maturity up to May 20. Even later seedings have matured.

Drilled solid at the rate of $1\frac{1}{2}$ bushels per acre, the beans have not given very good results, as they are slow to start and the weeds are likely to get ahead of them. Pigeon grass is especially troublesome in this respect. When the beans are seeded solid the stems are finer, but the yield of forage is not materially greater and a considerable proportion of it is weeds. The most successful method of culture has been to plant the beans in rows at the rate of 2 or 3 pecks per acre, depending on the size of seed. The beans should stand from one to two inches apart in the row. Rows 28 to 30 inches apart will give a slightly higher yield than rows 36 inches apart, but they must then be cultivated with a one-horse cultivator^b or a beet cultivator. For small acreages, such as are usually grown in Minnesota, the beans may be planted with a corn planter so that they can be cultivated with the regular corn cultivating machinery.—To plant the rows nearer together, an ordinary grain drill may be used successfully, using every fourth or fifth hole and blocking the others with paper or wood. The drill seems to seed more uniformly than the corn planter, unless a special attachment is used. Plant the beans not more than 2 inches deep, as the whole bean must be pushed up through the ground; the two halves of the bean being the first leaves as with garden beans. After the plants are well established they will stand considerable rough treatment such as dragging, altho a corn weeder or a rotary hoe will probably give better results.

Cultivation should be just the same as for corn. This is one of the greatest drawbacks to growing any considerable acreage of beans on the average stock farm in southern Minnesota, as most farmers are growing all the corn they can well take care of. Extensive trials are being made yearly to try to discover some method of growing beans without cultivation in order to avoid this difficulty.

In some experiments the beans were seeded at the rate of one bushel per acre with one bushel of oats to take the place of the weed seed. The yields, however, were no better than when the beans were planted alone. Wisconsin reports success in growing soybeans with sudan grass, but this method has not been very successful at Waseca. Soybeans have been planted in a mixture with field peas, three pecks

of each. The peas grew fairly well, but seemed to crowd out the beans, so that the yield was no greater than when they were grown separately. Soybeans alone were seeded broadcast every ten days from May 1 to June 10, inclusive, and it may be possible to work out a method by which the land can be kept clean up to the first of June; or possibly some early crop can be taken from the land and the beans will then produce a satisfactory hay crop.

When planted with corn the most satisfactory results will be obtained when a bean-planting attachment is used, as the seeding will be uniform. When mixed with the corn the contents of the planter box should be stirred frequently as the beans tend to separate, making an uneven mixture over the field. Attachments may be had for almost any kind of planter at a cost of \$10 or \$12.

INOCULATION

On rich soil soybeans will grow and make a satisfactory yield without inoculation, but in this case they take all their nitrogen from the soil and as they contain a large amount of this valuable element they will rapidly reduce the nitrogen content of the soil.

When properly inoculated they take most of their nitrogen from the air and there is no loss of this element in the soil. When the beans are fed and the manure returned to the soil there is probably some gain in nitrogen. Commercial cultures may be obtained for about a dollar per acre and when used according to instructions will give satisfactory results. The cheaper way is to secure some soil from an inoculated field, sift it through a sieve from the fanning mill to remove all lumps, stones and sticks, and after the beans have been moistened mix this with them at the rate of 10 pounds or more per bushel. At the Waseca station mixing the dry soil with dry beans at planting time has given satisfactory results. When well inoculated the nodules on the roots are very abundant and are as large as peas, sometimes larger. They may be readily discovered by digging down beside a growing plant. They disappear rapidly after the crop is cut. Soybeans are shallow rooted and do not open up the subsoil as well as alfalfa or sweet clover, but they do leave the field in very fine condition for any succeeding crop.

CURING FOR HAY

Soybeans should be cut for hay when the first leaves begin to turn yellow. Some authorities advocate cutting earlier, but the cattle will clean up all the hay when cut at this late stage, and the additional maturity of the seed probably gives the hay a higher protein content. The hay may be cut with a mower and handled the same as alfalfa. It is desirable to put it in small windrows with a side-delivery rake

as soon as the plants are slightly wilted. These small windrows may be turned and dried on both sides. Sometimes it is necessary to put the hay in cocks for further curing. Because of the large stems the beans are slow to cure, but they seem to be very little damaged by rain. They shed rain better than alfalfa or clover and harvesting is usually done at a time of year when dry weather is most prevalent in Minnesota. The crop has never been seriously injured in curing at the Waseca station. Another method of harvesting the crop is to cut it with a binder and shock it the same as grain.

HARVESTING FOR SEED

In harvesting for seed it is customary to let the plants stand until all the leaves have fallen. They may then be cut with a grain binder, beginning early in the morning or on a cloudy day when they are slightly damp and tough enough that they will not shatter much. When the plants are lodged it is usually advisable to use the large picker guard attachments that are used for harvesting lodged grain. Some will be left in the field but there will be comparatively little loss and if stock can be turned in after the crop is removed none will be wasted. The corn binder has been tried for harvesting beans, but it leaves more in the field than the grain binder and just twice as much time is needed to cut an acre, as only one row can be harvested at a time. Some have had good success with a self-rake reaper, but this implement is comparatively rare on Minnesota farms. A mower with a windrowing attachment such as is used for clover seed will do the work very nicely, but the beans are more difficult to pick from the field. Beans have been harvested for seed with an ordinary mower, but the horses and wheels traveling over them cause considerable shattering and loss. On small acreages the beans may be pulled and piled by hand. In shocking, it is the usual practice to set the bundles up two by two, to give the sappy stems a good chance to dry out.

THRESHING

The threshing of soybeans is not so difficult as is commonly supposed. An ordinary threshing machine will give very good results if the pulleys can be so arranged as to run the cylinder at about half its normal speed, keeping the speed of the rest of the machine the same as usual. From 300 to 450 revolutions per minute is probably best. If this is not possible, run at the usual speed but remove the concaves. The beans thresh better and split less if threshed when they are slightly damp, as when brought in from the field early in the morning. The pods and stems seem to work back over the shakers and sieves better when not too dry. The length of time the plants

have to stand in the field before threshing depends on their condition when cut. If thoroly mature when harvested the threshing may be done almost at once if care is taken to spread out the seed so that it will not heat in the bin.

VARIETIES

There are many varieties of soybeans, but only ten or twelve are adapted to Minnesota. The following table shows the varieties which have been tested at the Waseca station and their yields per acre.

Variety	1920	1921	1922	1923	Average	Hay 1923
	Bu.	Bu.	Bu.	Bu.	Bu.	Tons
Habaro	15.4	28.3	18.1	19.2	20.2	3.1
Elton	17.2	30.0	20.0	13.7	20.2	2.1
Manchu .....	...	...	18.4	15.8	17.1	3.3
Chestnut	13.6	32.2	17.9	20.2	21.0	3.3
Wisconsin Black ..	12.7	37.1	11.6	14.0	18.8	3.3
Minsoy	13.4	32.1	16.3	17.5	20.0	2.2
Black Eyebrow ....	...	...	14.3	14.4	14.4	3.4
Mandarin	9.8	20.8	...	16.4	15.7	1.8
Early Brown .....	...	...	14.2	24.5	19.3	3.8
Ito San .....	...	...	12.9	16.7	14.8	3.2
Soysota	10.4	16.1	...	...	13.2	...

* Two-year average.

The favorite variety for southern Minnesota is Habaro. This has been tested for several years and has always been one of the best yielders. In 1922 Manchu yielded an equal amount of seed and slightly more straw. Elton yielded a satisfactory amount of seed, but less forage than either Habaro or Manchu. Habaro stands up well, but does not grow quite so tall as Manchu. In 1923 Manchu planted May 10 was not fully mature at the time of the first killing frost, September 13. However favorable weather followed this frost and the beans matured without apparent injury to their germination. A test in November showed a germination of 89 per cent, which is fairly satisfactory for that time of year. We believe that Manchu and Habaro are the varieties best adapted for hay and seed in southern Minnesota. Black Eyebrow grows very tall, but tends to fall on the ground more than the others and does not give a high yield of seed. Midwest, or Medium Yellow, is too late for any part of Minnesota. Ito San and Wisconsin Black do not yield as much seed as the best varieties in southern Minnesota.