MAY, 1943 BULLETIN 469

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
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Soybeans and Soil Conservation

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Soybeans can be grown successfully without serious soil erosion. For conservation of soil, contour planting and terraces are two of the essential practices on sloping land for production of this essential seed crop.

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Summary and Conclusions

When grain production of the soybean is considered, grain yields reflect the amount of soil fertility, or plant nutrients, delivered by the soil. Lime, phosphate and potassium added to the soil increased grain yields on Putnam silt loam. There was the indication of value in putting the fertilizer at greater depths in the soil as occurs when fertilizer is plowed under. These additions of nutrients were reflected as increased yields of grain as well as of straw. The grain production was higher the deeper the surface soil, possibly not only through increase in fertility offered in the deeper root zone, but also through the more ample water supply conserved in the deeper zone for rainfall storage.

These studies show the importance of careful soil management if soybean grain production per acre is to be increased. They indicate that soybeans are conducive to erosion as a crop, only when their position or order in the rotation follows a crop in which excessive tillage has caused the destruction of the granular soil structure during growth of the crop. Soybeans following sod were not very conducive to erosion, but following corn they were.

The fact that soybeans can be either erosion conducing or soil conserving reminds us that they are a hazardous crop for widespread production on sloping land. Measured erosion from soybeans has been almost wholly from plots no longer than the normal terrace spacing. Thus, the losses as reported are a measure of the soil movement between terraces, if not farmed on the contour. Losses from fields with full length slopes would be several times higher.

In soybean production on sloping land, the beans should *not be used in addition to corn but in place of corn* in a soil conserving rotation, and with all the fertility building practices and supporting soil conservation practices recommended for the particular piece of land. On the claypan soils, lime appears very essential, and the use of phosphate and potash fertilizer with the beans as well as with the small grain of the rotations is a very profitable, if not an essential practice for economical production.

Most sloping fields require terraces with contour tillage as the necessary supporting practices for soybean rotations. On fields of short slope and irregular topography, contour tillage with grassed waterways or buffer strip-cropping with grassed waterways would be practical supporting practices.

These data, suggest that soil conservation is not inimical to increased soybean production for grain, but rather it is the very essence of it. Conservation of water and of soil fertility either as applied soil treatments, or represented in increased depth of the soil retained against erosion, are all helps in securing larger yields per acre, so essential in economic and increased production.

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The increased need for soybeans as an oil-and protein-producing crop confronts us with the problem of increasing the acreage of a crop considered conducive to erosion rather than conserving in its effects on the soil. Under war stimulation, the acreage of soybeans in Missouri reached the all-time high of 770,000 acres in 1942, or 6 per cent of the total harvested crop acreage in the state. The ten-year (1931-40) acreage of this crop as an average was 502,000 acres with only 20 per cent grown for grain. The acreage for grain has been increasing rapidly. In 1941 it was 187,000 acres or 35 per cent of the 531,000 total. In 1942 it was 500,000 acres or 65 per cent of the 770,000 total. For 1943, the war goal for grain has been set at 462,000 acres for Missouri. The acreages by years are set forth in Table 1.

TABLE 1. ACREAGE AND YIELD OF SOYBEANS IN MISSOURI SINCE 1930

Year	Hay soybeans		Grain soybeans		Other uses	Total
	Acres	Yield T/Ac.	Acres	Yield Bu./Ac.	(acres)	acres
1931	420,000	1.2	121,000	9.0	7,000	548,000
1932	503,000	1.3	106,000	10.0	14,000	623,000
1933	360,000	1.1	167,000	9.0	13,000	540,000
1934	564,000	.7	142,000	5.5	37,000	743,000
1935	300,000	1.1	142,000	7.5	18,000	460,000
1936	186,000	.6	45,000	5.0	149,000	380,000
1937	155,000	1.3	58,000	11.0	22,000	235,000
1938	268,000	1.4	60,000	13.0	62,000	390,000
1939	343,000	1.4	89,000	13.0	60,000	492,000
1940	401,000	1.4	109,000	13.0	94,000	604,000
10-yr. Ave.	350,000	1.2	104,000	9.6	48,000	502,000
1941	250,000	1.2	187,000	11.5	94,000	531,000
1942	126,000	1.4	500,000	15.0	144,000	770,000
1943 Grain bean goal			462,000	--	--	--

Because soil erosion is encouraged by soybeans, as they are commonly used following another cultivated crop, and because this crop has been considered more effective as a forage than as a grain producer,[1] soil conservation research was directed toward this crop more specifically as it pertains to the production of the beans as grain. The following progress report of some studies is presented as an aid toward the increase in soybean acreage for maximum grain production through soil treatments and with minimum soil destruction and soil loss through erosion. The following phases of soil conservation under cropping to soybeans were given consideration: (a) mechanical aspects of the crop as a soil cover when drilled solid or in rows, and with a cover crop following, (b)

[1]Missouri College of Agriculture, Agr. Ext. Service, Circular 450, 1942.

condition of the soil as influenced by the preceding crop, (c) fertility of the soil in relation to the yield as demonstrated by differences in the soil treatments and in the depths of the surface soil, and (d) conservation effect of contouring and other supporting practices. Soil conservation studies at Columbia, Bethany and McCredie, Missouri supplied the data.

Erosion Under Soybeans in Rows 42 and 8 Inches Apart

The first measurements of erosion from soybeans were made on the erosion plots of the Missouri Agricultural Experiment Station at Columbia during the 8-year period 1924-31. The beans were grown in 42-inch rows up and down the slope during the first four years, and drilled in 8-inch rows up and down the slope during the second 4-year period. Although the rainfall was different in these two periods, comparisons of runoff and soil loss can be made during each period with that from a continuous corn plot.

The data show that beans drilled in 8-inch rows allowed 89 per cent as much runoff and only 46 per cent as much soil loss as when grown in 42-inch rows. The beans were cut for hay each year, and were followed by an early-seeded winter cover of rye which was plowed under the following spring before the next crop of beans. The data are shown graphically in Figure 1.

Soybeans were grown at the Bethany Experiment Farm, for hay in 42-inch rows and cultivated in a rotation of corn-soybeans-oats-meadow, and some were drilled in 8-inch rows in a rotation of corn-soybeans-wheat-meadow. The erosion data for the 8-year period 1932-39 show that the rotation with the beans drilled in 8-inch rows and followed by wheat, allowed only 75 per cent as much runoff and 62 per cent as much soil loss as those in wider rows. For the 5-months period, May to September, which included soybean planting and harvest, the beans drilled in 8-inch rows allowed only 63 per cent as much runoff and soil loss as that from the soybeans in 42-inch cultivated rows. The data are shown graphically in Figure 2.

The yield of soybean hay at Bethany in 1932 was 18 per cent higher on the plot drilled in 8-inch rows than that on the plot with 42-inch rows. During 1936, grasshoppers and drought caused a failure on both plots. In 1942, grain beans drilled in 8-inch rows yielded 27 per cent more than when grown in 42-inch rows. During the same year at McCredie, the beans in 42-inch rows outyielded the drilled beans. Although the yield data are meager, they support recommendations previously published[2] that drilling in narrow rows is preferable for either grain or hay bean production, on land of relatively high fertility. The soil on the Bethany farm is relatively high in fertility. The erosion data also support recommendations made in the same publication, that beans should be drilled in narrow rows on land subject to erosion.

[2]Missouri Agricultural Exp. Sta. Bulletin 445.

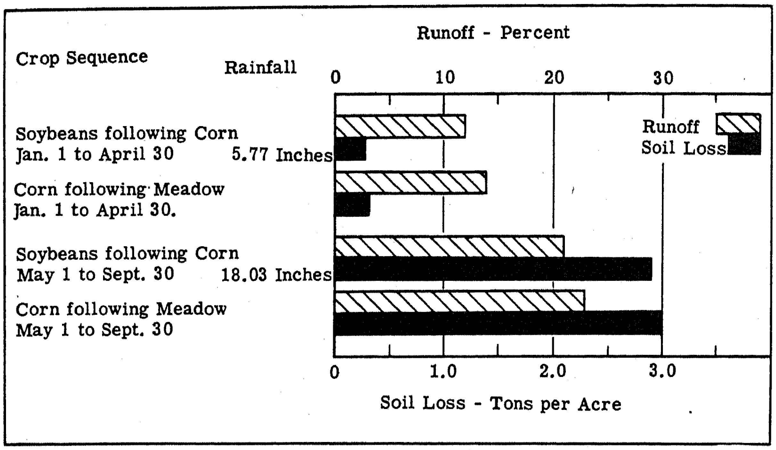

Fig. 1.—Four-year average annual runoff and soil loss from continuous soybean and corn plots on Shelby soil of 3.7% slope.

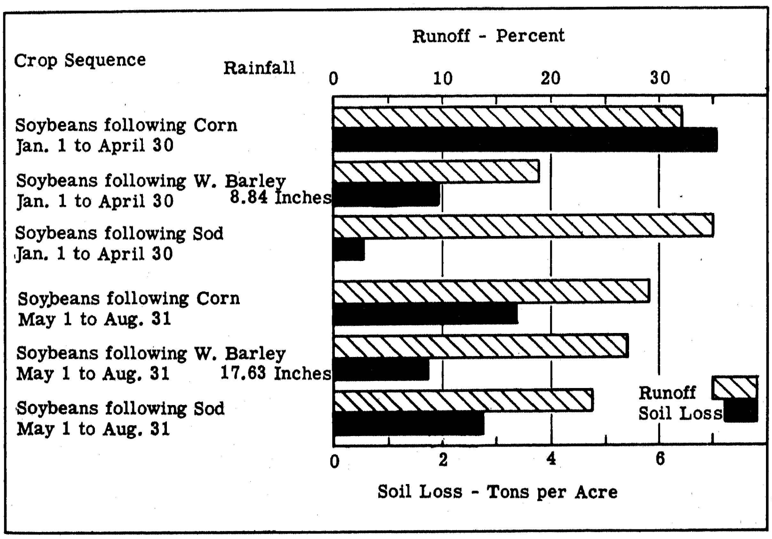

Fig. 2.—Average annual runoff and soil loss from a common soybean rotation and for the period soybeans are on the soil with both wide and narrow rows. Plots were Shelby loam of 8.1% slope.

Erosion Under Cover Crops with Soybeans

Barley seeded the last of August as a cover crop, following soybeans for hay, has been developing with sufficient rapidity to provide very good fall and winter cover. Wheat drilled about the fly-free date has not met this test, at least so far as shown by observations and a limited amount of experimental data. Wheat has been more winter hardy than the barley. If seeded in late August, undoubtedly wheat would provide a protection against erosion equal to that of barley. Observations indicate that rye, when seeded in August, also furnishes excellent fall and winter cover. The date of seeding to permit ample fall growth has been the important factor rather than the type of small grain used.

Soil loss from winter barley seeded in late August following soybeans cut for hay has averaged 1.62 tons per acre at McCredie, or about one-fourth of that from plots drilled either to wheat about the fly-free date, or to oats in the spring. These losses, for two periods during each of two years, are shown in Table 2. During the last four months of 1941 the soil loss from soybean stubble without a small grain crop as cover was 2.05 tons per acre, whereas that from late August-seeded winter barley was 1.15 tons per acre. The next year when wheat was seeded about October 1, the loss for the period was 3.35 tons per acre in comparison to 0.74 tons per acre from the winter barley seeded much earlier.

TABLE 2. EROSION LOSSES FROM HAY SOYBEAN PLOTS WITH AND WITHOUT WINTER COVER CROPS. PLOTS OPERATED UP AND DOWN SLOPE ON PUTNAM SILT LOAM, 3 PER CENT SLOPE, AND 90 FEET LONG

Cover following soybean harvest	Period	Rainfall	Runoff Inches	Runoff Percent	Soil loss Tons/acre
Winter barley drilled in late August	1/1-7/1 1941	16.57	3.95	24	1.28
	9/1-12/31 1941	27.93	9.58	34	1.15
	1/1-7/1 1942	22.18	3.99	18	.08
	9/1-12/31 1942	14.89	3.04	20	.74
Winter-killed wheat and oats	1/1-7/1 1941	16.57	3.33	20	5.07
Soybean stubble	9/1-12/31 1941	27.93	14.42	52	2.05
Soybean stubble and oats	1/1-7/1 1942	22.18	8.45	38	2.44
Soybean stubble with wheat	9/1-12/31 1942	14.89	4.48	30	3.35

Grain beans have been harvested too late for the establishment of a protective fall and winter cover crop. Rye has been easily drilled between 42-inch rows of grain beans in August and offers possibilities for beans in wide rows. Beans drilled solid have permitted only about half as much erosion as when drilled in 42-inch rows, according to experiments at Bethany and Columbia. Observations indicate that beans drilled solid, with a surface mulch of combined straw, will not have serious erosion losses on short, contour farmed slopes, or on terraced fields during the winter months when the beans have followed meadow sod.

Soil Condition and Erosion Under Soybeans

It is evident from observation that the preceding crop and the condition of the soil in terms of stable granular soil structure are factors in the extent of erosion under soybeans which deserve attention. Soybeans have generally been grown in a rotation following corn. The soil condition in consequence of two tilled crops in sequence has contributed materially to the general idea that soybeans are one of the erosion conducing crops. Erosion losses for the

Fig. 3.—Soybeans planted in wide rows with the slope may be distinctly hazardous to conservation of soil, in contrast to the crop drilled solid.

corn-soybean-wheat-meadow rotation have been the highest of any rotation on terraced land at the Bethany Experiment Farm. Soybeans occupied the land for the 5-months period May to September, and in that time lost 2.89 tons soil per acre in comparison to 3.0 tons per acre lost from corn, and .31 ton per acre lost from meadow. Thus, soybeans drilled solid were not as conducive to erosion as corn when they followed corn, and when corn had the advantage of following meadow in the rotation. Runoff and soil loss from corn and soybeans for the two periods of the year, January 1 to May 1, and May 1 to October 1, are shown in Figure 4.

Soybeans for hay have been grown in three different rotations at the McCredie Experiment Farm. The soil loss from the plots of the barley-meadow-soybeans rotation, in which the beans follow the meadow crop, has averaged only 1.86 tons per acre per year in comparison to 5.68 tons per acre from an annual rotation of winter barley-soybeans, and 8.51 tons per acre from a 4-year rotation of wheat and lespedeza-lespedeza-corn-soybeans. The runoff from the plots of the last and longer rotation has averaged about 20 per cent more than for either of the other two rotations.

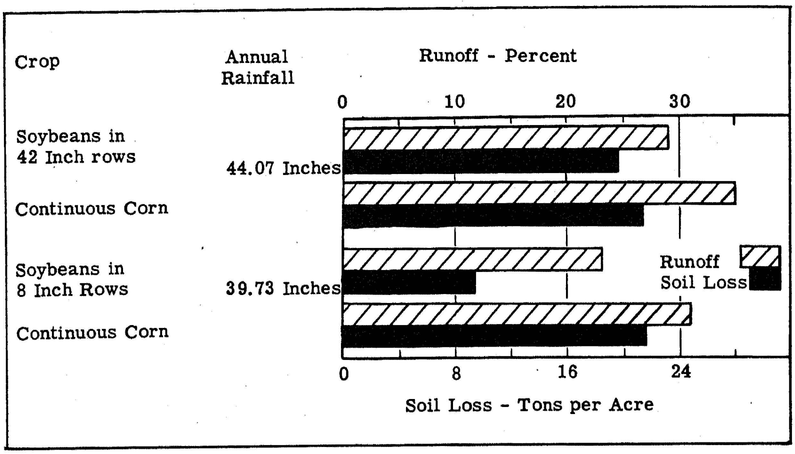

Fig. 4.—Erosion losses for soybeans and corn during two periods of the year on terraced Shelby loam soil. Ten-year period, 1932-1941.

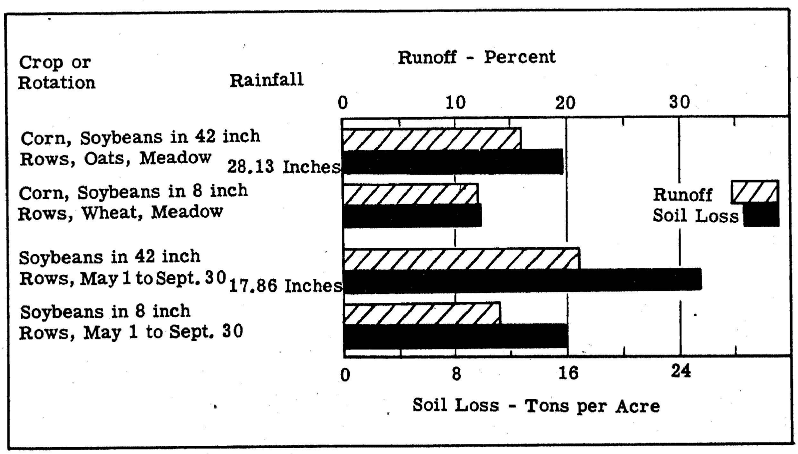

Fig. 5.—Erosion losses for soybeans following different crops during two periods of the year on plots of Putnam silt loam of 3% slope. Two-year period 1941-1942. Beans harvested for hay in late August.

For the 4-months period May to August, soybeans following winter barley lost 1.75 tons soil per acre; following meadow they lost 2.75 tons per acre; and following corn their erosion loss amounted to 3.38 tons per acre. Soybeans in the annual rotation with winter barley have outyielded the soybeans of the other two rotations.

Undoubtedly this heavier production of vegetative cover accounts for the lower soil loss from those plots during the soybean growing season.

Soybeans grown for hay in the annual rotation with winter barley have certain advantages that contribute to their high hay yields. The soil quickly becomes innoculated for optimum soybean production, by growing the beans year after year. The winter barley of the rotation receives 100 pounds per acre of an 0-20-10 fertilizer each year when seeded. It is pastured out the next spring and the soybeans are drilled soon after May 15. Thus, some benefit may be derived by the soybeans from the fertilizer applied 9 months previously. In addition the manure droppings on the pastured barley represent return of fertility which benefits the soil condition and helps the bean growth.

The erosion losses for the two periods of the year, January 1 to April 30, and May 1 to September 1 are shown in Figure 5. Runoff trends appear erratic for the period January 1 to April 30. These results are an average for only two years in which runoff has been quite unpredictable during the late winter, on account of uneven snow cover and freezing and thawing. A tendency for plots generally allowing low runoff during the growing season to reverse in winter and have the highest runoff has been noted in both the Bethany and McCredie data.

The structural condition of the soil as influenced by the amount of tillage preceding the soybean crop is a significant factor in determining erosion under soybeans. These studies point out the possibility that soybeans have been considered a crop conducive to erosion because of their position in the rotation rather than because of any characteristic of the beans. The tillage the year before leaves the soil less stable and more erodible than when a sod crop precedes the beans. If the beans follow sod crops in the rotation, they cannot be classified as particularly conducive to erosion. These facts suggest that the soil conditions rather than the crop is the factor of concern.

Soil Fertility and Grain and Hay Yields of Soybeans

The stability of soil aggregates following a sod crop cannot be separated readily from the better crop yields following a sod crop. Both of these are associated with some changes in the supply of plant nutrients in consequence of the sod.[3] Soil treatments are likewise a factor so that erosion and crop production are in reality premised on the natural fertility of the soil and the fertility treatments given the soil.

Lime appears to be the soil treatment most consistently effective for increasing yields of soybeans in Missouri. Increased yields of soybean hay have been secured by the use of lime, both at the

[3]Whitt, D. M. and Swanson, C. L. W. The Effect of Erosion on Fertility Changes in the Shelby Loam Profile. Jour. Agr. Res. 651:283-98 (1942).

McCredie Farm and the University South Farm. In both cases the plots were on Putnam silt loam. Lime was applied at the beginning of the experiments, and either phosphate or phosphate and potassium fertilizer was used on the small grain of the rotation. The average hay yield of the eight comparisons during a 5-year period was 1.84 tons per acre on the limed plots, or 31 per cent more than from the untreated plots. This is a significant increase. It has been shown, however, that total hay yield is not the best measuring stick[4] of feeds produced. A balanced fertility program may increase the feeding value of the crop appreciably more than the actual increase in tonnage yield, whereas an unbalanced fertilizer treatment may result in high quantitative yield but of a quality representing little increase in total feeding value. Table 3 gives the results by years of the soil treatments on soybeans, from both McCredie and the South Farm.

TABLE 3. YIELDS OF SOYBEANS FOR HAY ON THE UNIVERSITY OF MISSOURI SOUTH FARM AND AT THE McCREDIE EXPERIMENT FARM. PLOTS ON PUTNAM SILT LOAM. TREATED PLOTS ALL RECEIVED LIME AT BEGINNING OF EXPERIMENT

Location	Year	Fertilizer on small grain of rotation	Yield - Tons/acre No treatment		Yield - Tons/acre Treated
South farm	1938	0-20-0	1.30		1.35
South farm	1939	0-20-0	1.12		1.43
South farm	1940	0-20-0	1.39		1.70
South farm	1941	0-20-20	1.75		1.90
South farm	1942	0-20-20	1.71		2.48
McCredie	1940	0-20-10	1.06		2.08
McCredie	1941	0-20-10	1.19		1.34
McCredie	1942	0-20-10	1.70		2.46
Average of all			1.40	(1)	1.84

(1) The yield increase may be considered significant.

Klemme[5] has reported an average soybean yield of 21.3 bushels per acre from 1 unfertilized and 5 fertilized fields of soybeans during 1942 on limed Gerald silt loam, a claypan soil of southwest Missouri, in comparison to 14.4 bushels per acre without lime. This yield increase of 48 per cent may be considered highly significant for the climatic condition of 1942. Data on the method of fertilizer placement reported by Klemme show an average yield of 20.25 bushels soybeans per acre, from the plowing under of the fertilizer, in comparison to 14.3 bushels per acre from placement in the surface soil by the fertilizer attachment on a modern corn planter.

At McCredie during 1942 placement of 300 pounds per acre of 0-20-10 fertilizer on the plow sole when breaking a grass-legume meadow for soybeans did not result in a significant grain yield

[4]Albrecht, Wm. A. and Smith, G. E. Biological Assays of Soil Fertility. Soil Sci. Soc. of Amer. Proc., 1941, Vol. 6.

[5]Klemme, Arnold. Plowing Down Fertilizer. Presented at the 18th Annual Meeting of the Joint Committee of Fertilizer Application, Saint Louis, Mo., Nov. 9, 1942.

Fig. 6.—Fertilizer plowed under on a limed field with heavy clay subsoil makes a difference in the midsummer crop growth.

difference over placement of 150 pounds per acre of the fertilizer in narrow bands at the sides of the seed row. During the three-week period following planting, more than 10 inches of rain fell on the newly plowed meadow sod. Thus, large quantities of water percolated through the soil, resulting in better distribution of the potash fertilizer, if not of the phosphate, and about equal yields were secured regardless of the method of placement. During dry seasons, placement of the fertilizer on the plow sole is expected to give superior results as indicated by Indiana results.[6]

Lime alone, or 0-20-10 fertilizer alone, did not significantly increase the grain yield of soybeans at McCredie during 1942. Lime and 0-20-10 fertilizer together increased the grain yield from 16.9 to 21.4 bushels per acre, or 27 per cent, where the fertilizer was placed in narrow bands on each side of the seed row by a corn planter-fertilizer attachment, and to 20.7 bushels per acre where the fertilizer was placed on the plow sole in plowing of the sod for the soybeans. Both of these yield increases may be considered significant.

There was not a significant difference in total stalk growth at the end of the growing season in the McCredie experiments according to the method of fertilizer placement, either on limed or unlimed soil. Early growth was superior where the fertilizer was placed in narrow bands at the sides of the seed row, but as the season progressed the growth with the fertilizer plowed under gradually drew away from the check area, and at the close of the season about equaled that where the fertilizer was placed in narrow bands beside the seed row.

[6]Plow-sole Fertilizer Benefit Tomatoes. Depts. of Horticulture and Agronomy. Better Crops with Plant Food, Vol. XXVI (1943) 6-8 pp.

Lime alone did not give a significant difference in total straw yield, but the use of lime and fertilizer together resulted in significantly increased total yield.

The stands on the limed section of the unfertilized strip, on the strip with the fertilizer in narrow bands beside the seed row, and on the strip with the fertilizer placed on the plow sole, were all less than those on the corresponding unlimed areas, although the difference was significant on only the unfertilized areas. However, those fewer plants on the limed area grew larger and produced sufficiently more beans to give a yield equal to that on the unlimed area when both were unfertilized and a yield significantly higher when fertilizer was used with the lime, regardless of method of placement. Liming was performed just before planting time, and there was not sufficient time for thorough distribution within the soil body at the time of germination and early growth. Thus, some plants received the benefit of the lime and were able to crowd out their less fortunate neighbors. Average stand, stalk growth, and yield for each area are given in Table 4.

TABLE 4. STAND, STALK GROWTH, AND YIELD OF SOYBEANS DURING 1942 AT McCREDIE, WITH DIFFERENT SOIL TREATMENTS. PUTNAM SILT LOAM SOIL, BEANS CONTOUR PLANTED IN 42-INCH ROWS AND CULTIVATED. YIELDS ARE AN AVERAGE OF 5 COMPOSITE SAMPLES

Fertilizer application	No lime			Limed 3 tons per acre		
	Stalks per acre	Straw per acre	Grain per acre	Stalks per acre	Straw per acre	Grain per acre
	1,000's	Tons	Bushels	1,000's	Tons	Bushels
None	83.6	.400	16.9	66.1	.484	16.8
150#/Ac. 0-20-10 narrow bands on each side of seed row	86.7	.598	16.3	81.6	.682	21.4
300#/ Ac. 0-20-10 on plow sole	83.0	.504	15.3	80.1	.622	20.7

The treatment of the soil clearly reflects itself in terms of the final grain yield of soybeans. This is significant in view of the variable number of plants as commonly measured for stand differences. Further, it suggests that if the soybean plant, which has been commonly emphasized as a forage crop, is to take its place as a grain producer, attention must be given on such soil types as the Putnam silt loam to the lime and other fertility items as soil treatments.

Soil Depth and Grain Yield[7]

In order to measure the influence on soybean grain yield of the total amount of soil fertility offered by the surface soil as it is deeper or shallower, six farm fields were sampled during 1942 to determine the effect of depth of surface soil on the yield of grain

[7]Unpublished data secured and reported by A. W. Zingg, Associate Soil Conservationist, Soil Conservation Experiment Station, Bethany, Missouri.

beans and on growth of stalks. Four of the fields were on Shelby loam soil and two on Marshall silt loam. The Illini variety of oil beans was grown on all but one field. On this Shelby loam field, Virginia, a popular hay variety, was grown and harvested for seed.

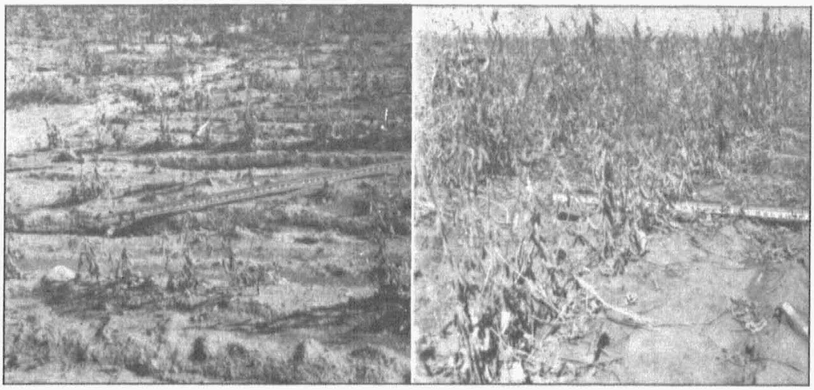

Fig. 7.—The deeper surface soil reflects itself in better yields of soybean seed on Shelby loan. Left—exposed subsoil with 3.3 bushels per acre. Right—surface soil 8 inches deep with 22.3 bushels per acre.

Considering the depth of the soil as the equivalent of variable amounts of soil fertility to be delivered to the crop, it was clearly evident that with increasing depth of soil there were increases in (a) bushels of grain per acre, (b) height of stalk, and (c) weight of beans as compared to the weight of hulls. The increase in yield with increasing soil depth was more pronounced on the Shelby than on the Marshall soil, which points to the proportionately greater loss in fertility with erosion on the Shelby soil and the greater care needed in seriously appraising erosion as it removes the fertility by which grain yields can be produced rather than forages only. The relatively low level of production on the two Marshall soil fields was caused by late June planting and an early killing frost, which resulted in immature beans. The low yield on the Shelby soil fields was on the one planted to Virginia beans.

Each added inch of surface soil resulted in an increased yield of 1.22 to 2.37 bushels per acre on the Shelby soil, and from 0.65 to 0.82 bushel per acre on the Marshall soil. The highest yield on zero surface soil depth, or the exposed subsoil, was 4.5 bushels per acre. The growing of beans on this field followed several years of meadow.

The height of the soybean plants in all fields increased with increasing depth of the surface soil. The growth of the Virginia bean stalks appeared to be more sensitive to soil depth than that of the Illini. The range of height of the Virginia beans was from 11 inches on zero surface soil depth to 46 inches on 12-inch soil depth, whereas for Illini the range was from about 13 inches on zero soil depth to 34 inches on 12-inch surface soil depth. Soil fertility as reflected in soil depth may be of more importance in hay bean production than is commonly supposed.

The grain yield and the height of the plant as a combination were related to the depth of the surface soil. The trend in all cases was the same although the degree of relationship varied with the two soils and the two varieties. The Illini beans grown on the Marshall soil, and the Virginia beans on Shelby soil made a large growth and had relatively few beans, in comparison to the Illini beans grown on the Shelby Soil. While this difference in growth and seed production of the Illini beans appeared to be in part due to the difference in planting dates, it is apparent that the balance of soil nutrients would have considerable bearing on the relative amount of stalk and grain growth.

The Conservation Effect of Contouring Soybeans

The soil and water loss measurements of plots in soybeans operated up and down the slope show that the range of losses for beans will vary between that of small grain and that of corn. Soil and water losses from contoured small grain and corn have been measured at the Bethany Experiment Farm during the 7-year period 1936-42 and serve as a guide to the expected losses for contoured soybeans. Contouring during this period reduced the water loss 20 per cent as an average, and the soil loss 52 per cent. The effectiveness of contouring in reducing soil erosion has varied widely from year to year, depending on the intensity and distribution of rainfall. It has ranged from 3 to 86 per cent of that from operating up and down the slope during the 7-year period of study.

Contour planting of the soybeans on the McCredie Experiment Farm during 1942 did not show significant yield increases over planting of the beans up and down the slope. Moisture was not a determining factor during the year, as the rainfall was ample and well distributed. Soil moisture samples taken during the growing season at McCredie showed that moisture in the soil did not drop to, or below, the plant wilting point. Samples were taken from all plots at McCredie on June 30, following the excessive rainfall of the month. Soil moisture was higher on the contoured plots, although not to a significant amount except for two of eight comparisons. Soil moisture samples taken from the beans in rows on September 22, after the 2.6 inch rain of September 19, did not show a significant moisture difference. Growth had stopped at this time and the soil was moist from a previous rain. No rains between these two sampling dates caused runoff from any of these bean plots which had been planted following plowing of a grass and legume sod.

Contour plantings of soybeans at the Bethany Experiment Farm during 1942 gave increased yields on the areas of deeper surface soil, and lower yields on the areas of shallower surface soil.

Six to ten farms were selected during the spring of 1942 on each of Putnam, Shelby, Marshall, Grundy and Pettis soils for yield determinations of soybeans for grain grown on the contour and up and down the slope. A period of excessive rainfall during 3 to 4 weeks beginning with soybean planting time prevented or delayed planting of most of these fields, so that only a few were eventually suitable for sampling. Seven fields were sampled in Clark County, six on Grundy silt loam and one on Lindley loam; and two in Cass County on Pettis silt loam.

TABLE 5. YIELDS OF CONTOURED AND UP-AND-DOWN-HILL PLANTED SOYBEANS ON NINE FARM FIELDS SAMPLED IN MISSOURI DURING 1942

County	Soil		Land	Row	Yield - Bushels per acre			
	Series	Depth	slope	width	Contour	Up and down	Difference	(1)
		Inches	Percent	Inches				
Clark	Grundy	12	8	46	18.3	19.8	-1.5	N.S.
Clark	Grundy	10	6 1/2	46	21.0	18.1	+2.9	H.S.
Clark	Grundy	8	4 1/2	15	18.1	17.3	+0.8	N.S.
Clark	Grundy	6	6	8	21.4	23.1	-1.7	N.S.
Clark	Grundy	6	7	23	14.2	9.0	+5.2	H.S.
Clark	Grundy	5	4	7	45.4	33.5	+11.9	S
Clark	Lindley	6	8	46	11.8	9.7	+2.1	S
Cass	Pettis	8	3	36	29.8	26.4	+3.4	N.S.
Cass	Pettis	8	3	36	23.0	25.0	-2.0	N.S.
Averages		8	6	29	22.6	20.2	+2.4	--

(1) Four composite samples were secured in each field and averaged to secure the yields reported in this table. The letters "N.S." mean that the yield differences are not significant; the letter "S" that the yield differences may be considered significant, and the letters "H.S." that the yield differences are highly significant.

The average yield of the nine fields of beans planted on the contour was 22.6 bushels per acre, or 12 per cent greater than that of beans planted up and down hill, which averaged 20.2 bushels per acre. Four of the nine fields showed significant yield increases with contouring. Of the other five fields on which the yield differences were not significant, three showed small decreases and the other two small increases in yield with contouring. Yields of all fields are shown in Table 5.

On the six Grundy silt loam fields, the contoured beans averaged 23.1 bushels per acre, or 15 per cent higher than the beans planted up and down hill, which averaged 20.1 bushels per acre. Three of the six fields showed significant increases in yield with contouring, whereas yield differences on the other three were not significant.

The effect of contouring on yield of beans as here reported is the result of one year's records. The rainfall of this year was ample in practically all localities where the beans were sampled. Contouring can not be expected to increase yields on soils of equal fertility when rainfall is well distributed and ample, except possibly on areas of limited fertility where the increased runoff by operation up and down the slope would change the relative fertility balance of the two areas. Thus, for 1942, yield increase with contouring could not be expected at either Bethany or McCredie. The average yield increase reported for the nine farm fields may be considered a conservative yield difference for the same reasons. It undoubtedly would be of greater magnitude if the period had been of sufficient length to sample all yearly rainfall patterns. The long-time effect of conserving soil fertility by the retaining of the surface soil body in consequence of contouring would act to further increase the yield differences.

Observation of soybeans on the McCredie Experiment Farm and on farm fields of the claypan soils indicated that the stand and yield were materially reduced where excess June rainfall did not readilty drain from the soil surface. This was true of both level fields and contoured areas on gently sloping fields that caused ponding of the excess rainfall. Thus, the practices of laying out contour lines with a small grade to facilitate drainage toward a grassed waterway, and progressive planting only down slope from each contour line, should be safeguards to be followed in contour planting of soybeans on claypan soils.