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# Soil Fertility Investigations

## Brown Limestone Land of Southwestern Missouri

(Newtonia Experiment Field)

H. H. KRUSEKOPF

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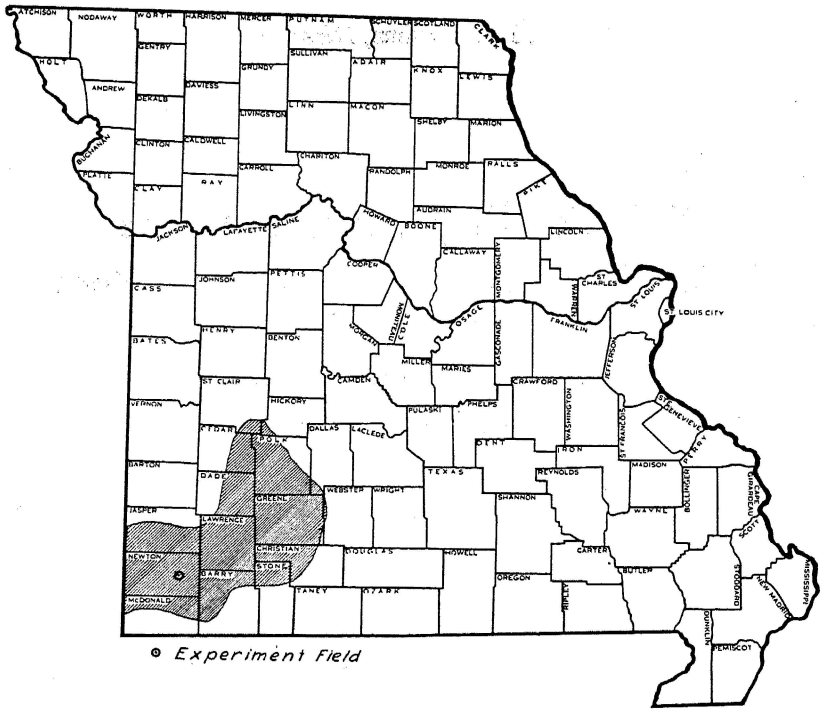


Fig. 1.—Map of Missouri showing location of Newtonia experiment field. Shaded area indicates region of brown limestone soils.

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## Brown Limestone Land of Southwestern Missouri

(Newtonia Experiment Field)

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The maintenance of the productivity of the soils has always received much consideration from the farmers in southwestern Missouri. In furtherance of that interest, the Missouri Agricultural Experiment Station in 1921 established an experiment field near the village of Newtonia in the northeastern part of Newton County. The field was located on the farm of J. W. Brown, and operated for seven years by Clyde Farley and for three years by J. D. McBride. In addition to soil fertility studies, extensive investigations were made in field crop improvement, variety tests, etc., by the Field Crops Department. Results of the soil fertility studies only are included in this report.

### THE SOIL

The soil on the experiment field is locally known as "red limestone land". In the state soil classification it formerly was named Crawford silt loam, but is now classified as Newtonia silt loam. The surface soil is a mellow, brown to reddish brown, silt loam to an average depth of about 12 inches. Below this depth the soil changes gradually to a deeper red color and heavier texture, so that the subsoil is a reddish brown, friable silty clay. This material extends to a depth of several feet.

The soil is representative of the brown and red colored, stone free Ozark Border soils of southwestern Missouri. It is characterized by its mellow, open structure, which is favorable to deep root penetration and good moisture holding conditions. The original vegetation probably was grass (prairie), but the relatively low content of organic matter makes the soil resemble forest land. In productivity it is rated as medium, but there are few soils more responsive to treatment or adapted to a wider range of crops.

The majority of the brown limestone soils of southwestern Missouri contain varying amounts of chert gravel. They differ from the soil on the experiment field in the content of gravel. In general, the gravelly types are not as desirable for farming and are somewhat inferior in moisture holding power. They are responsive, however, and the results obtained on this experiment field will apply rather generally to all the brown limestone soils in this region.

## CROPPING SYSTEM AND SOIL TREATMENTS

The purpose of the experiment field was to determine the value of various soil treatments under different cropping systems The plan consisted of two lines of experiments. In Experiment I various fertilizers and soil treatments were compared. Experiment II was primarily for determining the fertilizer value of wheat straw when applied at various rates and times. For convenience of discussion each experiment will be described separately.

## EXPERIMENT I

The four year cropping system used in this experiment included corn, soybeans, wheat and red clover in the order named. In this system each grain crop is followed by a legume crop. It is a crop rotation that is no longer generally used in this region except on the more productive soils. It is now generally recognized that of the two legumes, only clover has a marked residual beneficial effect on the following crop. All crops, including the straw, were removed from the land. The soybeans were planted in rows and cultivated the same as corn. Wheat was sown at the rate of 6 pecks per acre. Michigan Wonder was the variety used most of the time.

The soil treatments included six different materials. The amount used per acre and the time of application is given in the following table:

| | | |
|---|---|---|
| Superphosphate 16% | @ | 175 lbs. before corn and wheat. |
| Potash | @ | 15 " " " " " |
| Sodium Nitrate | @ | 40 " " " " " |
| Manure | @ | 8 tons before corn. |
| Rock Phosphate | @ | 1000 lbs. before corn. |
| Limestone | @ | 2 tons before wheat, once in 8 years |

It should be noted that the amount of fertilizer was less than the amount now generally used by farmers. Superphosphate 16% at 175 is equivalent to 140 lbs. of superphosphate 20%. The small amount of potash used may account for the small crop increase resulting from this treatment. The combination was a 2.8-12-3.2 fertilizer at the rate of 230 pounds. Sodium nitrate likewise was applied in small amounts. The manure was applied on the clover sod and plowed under before corn. The rate of application was probably in excess of the amount of manure that can be produced under the cropping system used. The rock phosphate was applied with the manure once in four years. The soil on the experiment field has a lime requirement of about 2 tons per acre, and is considered to be moderately acid. The limestone was applied once in 8 years to

the land before sowing wheat. The response from this treatment was very marked.

**Comparative Yields and Returns**

The consistent and large response of the grain crops and of clover to every soil treatment is outstanding. Table 2 gives the average yield (1921-1931) of each crop and for each soil treatment. In the case of corn, soil treatments increased the yield from 50 to 100 per cent. For wheat, every treatment, with the exception of manure alone, more than doubled the yield. It should be noted that the fertilizers were applied preceding the grain crops and the largest response should come from these. A combination of limestone and fertilizer or limestone, manure and fertilizer gave the largest crop increases.

During the 11 year period there were 2 clover failures due to dry weather. On the untreated land clover failed 5 times, and even in the favorable seasons the yield of hay was small and of poor quality. The brown limestone soils are considered well adapted to clover, but obviously limestone is needed for satisfactory yields.

The soybean yield in both grain and hay was low. The beans were planted in wide (3½ ft.) rows. The rate of seeding was ½ bushel per acre. This rate is probably too low for variety (Virginia) used. It is probable, also, that broadcast seeding earlier in the season would have resulted in larger yields. Even so, the effect of soil treatments was not nearly so marked as for the other crops.

The effect of manure is most apparent on corn. It should be noted however, that the corn yields were highest for the same treatments that gave the largest clover yields. This would indicate that the organic matter supplied by the clover is more effective for corn than is manure. In the cropping system used, manure alone as a fertilizer did not have much effect on wheat. The largest yields were obtained with all crops when the manure was supplemented with phosphate and limestone. The yields for rock phosphate did not quite equal those for superphosphate when these fertilizers were used with manure and limestone.

Both potash and sodium nitrate were applied in small amounts, but the crop increase, particularly for potash, was very significant. The nitrogen, phosphorus, and potash was applied in the approximate ration of 1-4.5-1¼, and in an amount equivalent to about 175 lbs. of a 3.4-16-4 fertilizer.

Table 3 gives an estimate on the value of the crop increase, the cost of the soil treatments, and the net return of crop value over fertilizer cost. The values assigned to the various crops and fer-

TABLE 1.—AVERAGE YIELD (11 YEARS) OF GRAIN AND HAY FOR CORN, SOYBEANS, WHEAT AND CLOVER.

| Treatment | Corn | | Soybeans | | Wheat | | Clover | |
|---|---|---|---|---|---|---|---|---|
| | Avg. Yield | Inc. | Avg. Yield | Inc. | Avg. Yield | Inc. | Avg. Yield | Inc. |
| | Bu. | | Bu. | | Bu. | | Lbs. | |
| None | 20.46 | | 5.17 | | 7.44 | | 556 | |
| Superphosphate 175 Lbs. | 29.21 | 8.75 | 6.40 | 1.23 | 17.06 | 9.62 | 1812 | 1256 |
| Superphosphate 175 Lbs., Lime 2 Ton | 33.82 | 13.36 | 7.17 | 2.00 | 18.64 | 11.20 | 2859 | 2303 |
| Superphosphate 175 Lbs., Potash 15 Lbs., Lime 2 T. | 36.18 | 15.72 | 7.18 | 2.01 | 19.29 | 11.85 | 3435 | 2879 |
| Nitrogen 40 Lbs., Phos. 175 Lbs., Potash 15 Lbs., Lime 2 T... | 37.01 | 16.55 | 7.63 | 2.46 | 21.31 | 13.87 | 3282 | 2726 |
| Manure 8 T. | 33.93 | 13.47 | 7.21 | 2.04 | 12.83 | 5.39 | 1314 | 758 |
| Manure 8 T., Superphosphate 175 Lbs. | 35.03 | 14.57 | 6.46 | 1.29 | 18.37 | 10.93 | 2120 | 1564 |
| Manure 8 T., Lime 2 T., Superphosphate 175 Lbs. | 39.72 | 19.26 | 7.94 | 2.77 | 22.78 | 15.34 | 3607 | 3051 |
| Manure 8 T., Lime 2 T., Rock Phosphate 1000 Lbs. | 38.52 | 18.06 | 7.35 | 2.18 | 18.09 | 10.65 | 3198 | 2642 |

TABLE 2.—AVERAGE YIELD OF FODDER AND STRAW FOR CORN, SOYBEANS AND WHEAT.

| Treatment | Corn fodder | | Soybean hay | | Wheat straw | |
|---|---|---|---|---|---|---|
| | Avg. Yield | Increase | Avg. Yield | Increase | Avg. Yield | Increase |
| | Lbs. | | Lbs. | | Lbs. | |
| None | 1966 | | 1300 | | 867 | |
| Superphosphate 175 Lbs. | 2274 | 308 | 1734 | 434 | 1757 | 890 |
| Superphosphate 175 Lbs., Lime 2 Tons | 2587 | 621 | 1898 | 598 | 1944 | 1077 |
| Superphosphate 175 Lbs., Potash 15 Lbs., Lime 2 T. | 2602 | 636 | 1838 | 538 | 1940 | 1037 |
| Nitrogen 40 Lbs., Phos. 175 Lbs., Potash 15 Lbs., Lime 2 T. | 2797 | 831 | 1928 | 628 | 2213 | 1346 |
| Manure 8 Tons | 2749 | 783 | 1852 | 552 | 1534 | 667 |
| Manure 8 Tons, Superphosphate 175 Lbs. | 2720 | 754 | 1760 | 460 | 1918 | 1051 |
| Manure 8 T., Lime 2 T., Superphosphate 175 Lbs. | 2949 | 983 | 2040 | 740 | 2465 | 1598 |
| Manure 8 T., Lime 2 T., Rock Phosphate 1000 Lbs. | 2970 | 1004 | 2003 | 703 | 2249 | 1382 |

TABLE 3.—THE ESTIMATED VALUE OF THE CROP INCREASE MINUS THE COST OF THE SOIL TREATMENT GIVES AN INDEX OF THE NET RETURNS DURING THE FOUR YEAR ROTATION.

| Treatment | Average Yields | | | | Value of crop increase | Cost of soil treatment 4 years | Net return in 4 years, value of crop increase over cost of treatment |
|---|---|---|---|---|---|---|---|
| | Corn | Soybeans | Wheat | Clover | | | |
| | Bu. | Bu. | Bu. | Lbs. | | | |
| None | 20.46 | 5.17 | 7.44 | 556 | | | |
| Superphosphate 175 Lbs. | 29.21 | 6.40 | 17.06 | 1812 | $23.55 | $ 5.63 | $17.92 |
| Lime 2 Tons, Superphosphate 175 Lbs. | 33.82 | 7.17 | 18.64 | 2859 | 34.56 | 9.63 | 24.93 |
| Superphosphate 175 Lbs., Potash 15 Lbs., Lime 2 T. | 36.18 | 7.18 | 19.29 | 3435 | 39.75 | 10.44 | 29.31 |
| Superphosphate 175 Lbs., Nitrogen 40 Lbs., Potash 15 Lbs., Lime 2 T. | 37.01 | 7.63 | 21.31 | 3282 | 42.15 | 12.52 | 29.63 |
| Manure 8 Tons | 33.93 | 7.21 | 12.83 | 1314 | 21.15 | 12.00 | 9.15 |
| Manure 8 Tons, Superphosphate 175 Lbs. | 35.03 | 6.46 | 18.37 | 2120 | 30.55 | 17.63 | 12.92 |
| Manure 8 Tons, Lime 2 T., Superphosphate 175 Lbs. | 39.72 | 7.94 | 22.78 | 3607 | 47.53 | 21.63 | 25.90 |
| Manure 8 T., Lime 2 T., Rock Phos. 1000 Lbs. | 38.52 | 7.35 | 18.09 | 3198 | 39.22 | 22.00 | 17.22 |

Note—Values used in estimating costs and net return:

**Crop**

| | | |
|---|---|---|
| Corn | @ $ .70 | per bu. |
| Soybean seed | " 1.25 | " " |
| Wheat | " 1.00 | " " |
| Clover | 10.00 | Ton |

**Fertilizers**

| | | |
|---|---|---|
| Limestone | $ 2.00 | Ton |
| Manure | 1.50 | " |
| Superphosphate | 21.30 | " |
| Sodium Nitrate | 52.00 | " |
| Potash | 54.80 | " |
| Rock Phosphate | 12.00 | " |

RAINFALL BY MONTHS AND YEARS DURING PERIOD OF THIS EXPERIMENT. NEOSHO, MISSOURI.*

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1921 | 2.04 | 1.11 | 6.34 | 4.74 | 1.78 | 7.38 | 2.29 | 4.70 | 2.70 | .66 | 1.18 | 2.48 | 37.40 |
| 1922 | 1.83 | 2.01 | 7.45 | 6.50 | 4.19 | 3.52 | 6.75 | 1.31 | 2.52 | 1.47 | 5.55 | 1.96 | 45.06 |
| 1923 | 3.30 | 1.19 | 2.99 | 4.37 | 8.49 | 8.20 | 3.46 | .24 | 4.36 | 7.77 | 4.33 | 3.52 | 52.22 |
| 1924 | 1.83 | 2.07 | 2.31 | 4.22 | 6.31 | 5.15 | 7.80 | 5.20 | 5.18 | 1.38 | 2.81 | 2.90 | 47.16 |
| 1925 | 2.00 | 1.69 | 1.79 | 5.26 | 1.53 | 3.85 | 4.31 | 2.69 | 4.18 | 3.38 | 3.20 | 1.15 | 35.03 |
| 1926 | 2.29 | 1.85 | 2.71 | 1.94 | 5.08 | 6.69 | 2.82 | 9.68 | 12.46 | 4.03 | 3.73 | 2.88 | 56.16 |
| 1927 | 3.94 | .93 | 5.85 | 8.86 | 3.96 | 9.03 | 7.88 | 7.57 | 2.53 | 4.42 | 4.37 | 3.07 | 62.41 |
| 1928 | .70 | 1.76 | 2.44 | 5.30 | 4.40 | 13.89 | 6.60 | 9.62 | .45 | 4.70 | 4.27 | 1.99 | 56.12 |
| 1929 | 1.90 | 3.37 | 2.63 | 9.12 | 8.65 | 8.50 | 3.35 | .32 | 2.72 | 5.34 | 1.74 | .98 | 48.62 |
| 1930 | 5.32 | 1.22 | .71 | 6.35 | 6.46 | 6.65 | 2.56 | 2.18 | 12.87 | 4.79 | 4.08 | 2.07 | 55.26 |
| 1931 | .73 | 2.77 | 2.12 | 5.15 | 3.28 | 1.93 | 4.62 | 6.76 | 1.42 | 4.43 | 5.80 | .56 | 39.57 |

*U. S. Weather Bureau.

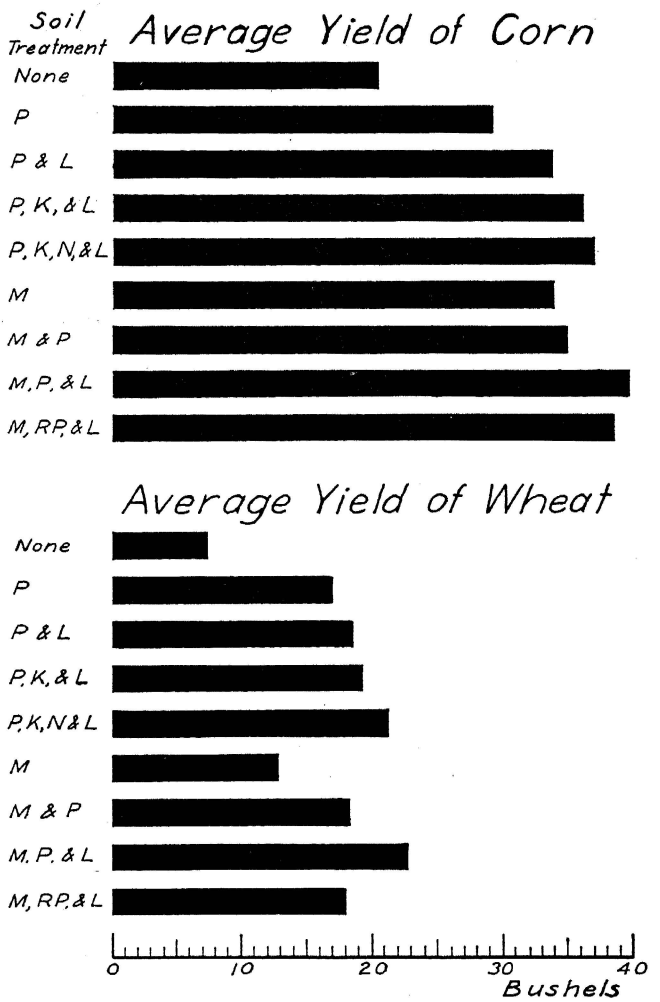


Fig. 2.—Diagram showing average yield of corn and wheat for different soil treatments in comparison to yield without treatment. Abbreviations used in diagram: P, superphosphate; L, limestone; K, potash; N, sodium nitrate; M, manure; RP, rock phosphate.

tilizing materials will vary for different years, but nevertheless can be used to determine the comparative value of the several soil treatments. It will be noted from this table that manure alone gave the lowest net return, and that the highest return was from a mixed fertilizer and limestone. In general, the table clearly shows that large net returns can be expected from soil treatments under conditions approximating those of this experiment.

### Conclusions and Recommendations

Certain conclusions can be drawn from the results of this experiment. Crop yields can be greatly increased by the regular use of soil treatments. The brown limestone soil is consistently responsive to various forms of fertilizer. Superphosphate is most effective when supplemented by limestone. Manure gives the largest returns when supplemented by both superphosphate and limestone. A mixed fertilizer such as 4-12-4 or 4-10-6 applied at the rate of 150 to 200 pounds per acre, is recommended for wheat. The same fertilizer is recommended for corn, particularly where manure, or manure and phosphate has not been plowed under. This fertilizer is best applied at the rate of 125 to 150 pounds per acre, using a fertilizer attachment on the corn planter which puts the fertilizer on either side of the hill and just below the level of the kernel in the ground. To use fertilizer on wheat is essential for profitable yields. The fertilizer stimulates fall growth, and enables the plants to better endure adverse winter weather. Manure may well be supplemented with superphosphate, especially when applied to wheat. The use of limestone is necessary for the successful growing of clover. Applications of about 2 tons per acre made once in 8 to 10 years will meet the requirements.

The responsiveness of the soil and the variety of crops grown, makes soil improvement comparatively simple in this region. A much more extensive use of fertilizer and also of limestone seems desirable. Fertilizing small grains, whether used for grain or pasture, should be a standard practice. Of prime importance in any system of soil improvement is to make soil treatments consistently and with regularity.

## EXPERIMENT II

### (Value of Wheat Straw as a Fertilizer)

Wheat has always been one of the major crops on the brown limestone soils in southwestern Missouri. Straw is produced in great quantities. With the introduction of dairying in this region, most of the straw is used as manure. In former years much of it was burned. There is much uncertainty as to the value of straw as a fertilizer. To obtain information of this, an experiment was established to determine the effect of straw applied in different amounts and seasons.

The soil on that part of the experiment field where this test was made, is a gray-brown silt loam. The surface soil is about 9 inches deep, and the subsoil is a light brown clay loam. In general, the productivity of the soil is somewhat lower than that of the soil in

Experiment I. This soil difference is in part responsible for the lower average crop yields.

**Cropping System and Soil Treatment.**—In this test the sequence of crops was corn, oats, wheat, clover. Because the amount of land was limited, only 2 crops in the rotation could be grown each year. Thus corn and oats came one year, and wheat and clover the following year. Two complete rotations were grown during the period of the experiment.

Table 4 gives the plan of the soil treatment. When straw was used as a manure it was applied on clover sod and plowed under before corn. Straw used as a mulch on wheat was applied in fall and winter.

**Soil Treatments**

1.—None.
2.—Straw 3 T. before corn and 1 T. on wheat, Nov. 15.
3.—Straw 3 T. before corn and 1 T. on wheat, Nov. 15, Superphosphate 16% @ 175 lbs. on corn and wheat.
4.—Manure, 8 T. on corn.
5.—Superphosphate 16% @ 175 lbs. on corn and wheat.
6.—Straw 1 T. on wheat Nov. 15, and Superphosphate @ 175 lbs. on corn and wheat.
7.—Straw 2 T. on wheat, Nov. 15, and Superphosphate @ 175 lbs. on corn and wheat.
8.—Straw 1 T. on wheat Jan. 15, and Superphosphate @ 175 lbs. on corn wheat.
9.—Straw 2 T. on wheat Jan. 15, and Superphosphate @ 175 lbs. on corn and wheat.

**Interpreting the Crop Yields.**—The results of this test are summarized in Table 5. It is apparent from these figures that the yields of all crops were relatively low, and that straw has a low fertilizer value. In fact, straw may have an injurious effect when used in large quantities, either as a manure or mulch. The lowest yields resulted where 3 tons of straw were plowed under. This effect may be due to drying of the soil, but more probably is due to reduced nitrate content in the soil. The results are in accord with general observations that incorporation in the soil of large amounts of coarse organic matter may reduce the yield of the following crop. In no case did the straw give significant increases. Such increases as did occur can be attributed largely to the beneficial effect of superphosphate.

The use of straw as a top dressing or mulch on wheat was more or less common in former years. In this test straw mulch caused very small yield increase for wheat or other crops. Two ton applications gave lower yields than 1 ton. Applying the mulch in winter (January 15) was less injurious than applications made in fall

TABLE 4.—AVERAGE YIELD (8 YEARS) OF GRAIN AND HAY UNDER DIFFERENT METHODS OF FERTILIZATION WITH STRAW.

| Treatment | Corn | | Oats | | Wheat | | Clover | |
|---|---|---|---|---|---|---|---|---|
| | Avg. Yield | Inc. | Avg. Yield | Inc. | Avg. Yield | Inc. | Avg. Yield | Inc. |
| | Bu. | | Bu. | | Bu. | | Lbs. | |
| None | 16.05 | | 12.37 | | 8.13 | | 437 | |
| 3 T. straw before corn, 1 T. on Wheat Nov. 15 | 16.07 | .02 | 12.88 | .51 | 6.84 | —1.29 | 1363 | 926 |
| Same as above and Superphosphate 175 Lbs. before corn and wheat | 20.90 | 4.85 | 16.61 | 4.24 | 14.24 | 6.11 | 3017 | 2580 |
| Manure—8 Tons before corn | 28.52 | 12.47 | 17.00 | 4.63 | 14.71 | 6.58 | 1363 | 926 |
| Superphosphate 175 Lbs. before corn and wheat | 22.38 | 6.33 | 15.75 | 3.38 | 17.90 | 9.77 | 3081 | 2644 |
| Superphosphate 175 Lbs. before corn and wheat, 1 T. straw on wheat Nov. 15 | 24.44 | 8.39 | 19.57 | 7.20 | 14.60 | 6.47 | 3298 | 2861 |
| Superphosphate 175 Lbs. before corn and wheat, straw 2 T. on wheat Nov. 15 | 23.21 | 7.16 | 17.50 | 5.13 | 12.53 | 4.40 | 3291 | 2854 |
| Superphosphate 175 Lbs. on corn and wheat, straw 1 T. on wheat Jan. 15 | 26.77 | 10.72 | 21.70 | 9.33 | 16.12 | 7.99 | 2652 | 2215 |
| Superphosphate 175 Lbs. on corn and wheat, straw 2 T. on wheat Jan. 15 | 24.87 | 8.82 | 18.90 | 6.53 | 13.34 | 5.21 | 2247 | 1810 |

TABLE 5.—AVERAGE YIELD OF FODDER AND STRAW UNDER DIFFERENT METHODS OF FERTILIZATION WITH STRAW.

| Treatment | Corn fodder | | Oat straw | | Wheat straw | |
|---|---|---|---|---|---|---|
| | Avg. Yield | Increase | Avg. Yield | Increase | Avg. Yield | Increase |
| | Lbs. | | Lbs. | | Lbs. | |
| None | 1701 | | 501 | | 926 | |
| 3 T. straw before corn, 1 T. on wheat Nov. 15 | 1579 | —122 | 500 | —1 | 804 | —122 |
| Same as above and Superphosphate 175 Lbs. before corn and wheat | 1681 | — 20 | 659 | 158 | 1042 | 116 |
| Manure 8 tons before corn | 2451 | 750 | 755 | 254 | 1309 | 383 |
| Superphosphate 175 Lbs. before corn and wheat | 1887 | 186 | 687 | 186 | 1746 | 820 |
| Superphosphate 175 Lbs. before corn and wheat, 1 ton straw on wheat Nov. 15 | 1836 | 135 | 839 | 338 | 1666 | 740 |
| Superphosphate 175 Lbs. before corn and wheat. Straw 2 T. on wheat Nov. 15 | 1960 | 259 | 684 | 183 | 1486 | 560 |
| Superphosphate 175 Lbs. on corn and wheat. Straw 1 T. on wheat Jan. 15.. | 2148 | 447 | 879 | 378 | 1630 | 704 |
| Superphosphate 175 Lbs. on corn and wheat. Straw 2 T . on wheat Jan. 15.. | 1914 | 213 | 651 | 150 | 1652 | 726 |

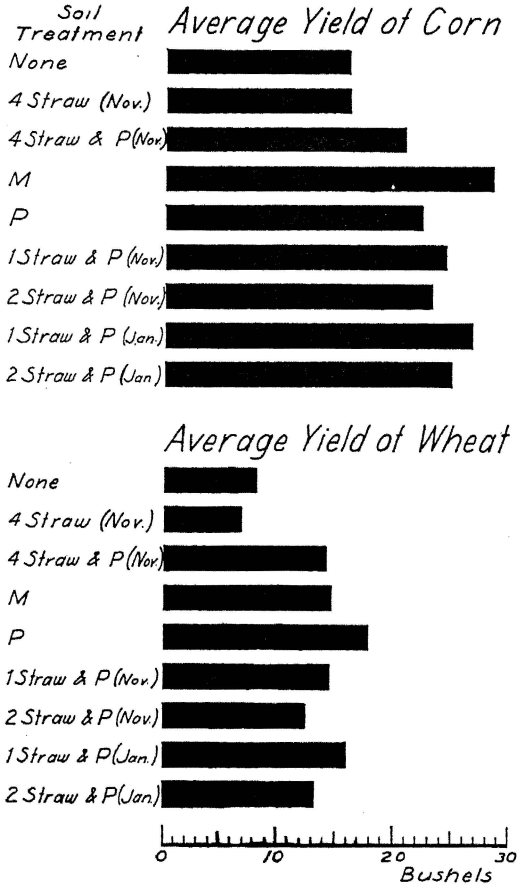


Fig. 3.—Diagram showing average yield of corn and wheat when straw is applied in different amounts and at different times. Number in column under soil treatment indicates tons straw applied. Letter P represents superphosphate fertilizer.

(November 15). A heavy mulch may even retard the development of the plants in early spring.

The straw had a beneficial effect on clover, as indicated by better stands. The straw tends to conserve soil moisture and thus favors clover during the early stages of growth.

From the results of this experiment it can be concluded that straw has a limited value as a fertilizer, and that its use in large quantities may even be injurious. This has no relation to the use of straw in checking soil erosion. Investigations elsewhere* have indicated that nitrogen fertilizer along with superphosphate and lime-

*Missouri Station Bulletin No. 369.

stone, hastens the decay of coarse organic material and produces an active manure. In this test superphosphate only was used with the straw. Larger yields from the straw would doubtless have been obtained if nitrogen had been added.

Harvesting wheat or other small grains with a combine leaves the straw on the land. The rapid decay of this material is desirable particularly if the land is to be plowed. Studies are now under way to determine the effect of applying nitrogen in hastening the decay of straw as left by the combine.

## EXPERIMENT II—REVISED
### (Fertility Studies with Corn and Wheat)

In the fall of 1928 the straw fertility test was discontinued, and the same land was utilized for studying methods of maintaining the productivity of the soil under a grain system of farming. A two year rotation of corn and wheat was adopted. It is obvious that such a cropping system is only adapted to very productive soil, and requires liberal fertilization in order that the fertility of the soil may be maintained. Both straw and fodder were removed from the land. No organic matter was supplied to the soil except where manure and sweet clover was used. The following soil treatments were made:

1.—None.
2.—Limestone @ 2 T., Sweet clover for green manure.
3.—Limestone @ 2 T., Sweet clover for green manure, Fertilizer (0-12-4) @ 200 lbs. annually.
4.—Manure 8 T. on corn, Superphosphate @ 200 lbs. on wheat.
5.—Manure 8 T. on corn, Superphosphate @ 200 lbs. annually.
6.—Fertilizer (4-12-4) @ 200 lbs. annually.
7.—Fertilizer (0-12-4) @ 200 lbs. annually.
8.—Fertilier (4-12-0) @ 200 lbs. annually.
9.—Fertilizer (0-12-4) @ 200 lbs. annually. Sodium Nitrate @ 100 lbs. annually (top dressing).

The annual and average crop yields for the different soil treatments are given in Tables 6 and 7. It should be noted that the low yields are due to an unfavorable season. Dry weather in 1930 was responsible for low yield of corn. The cumulative effect of the soil treatments is most apparent in the yields for 1931, and the results for that year are considered most significant.

Most outstanding in these results is the low yield of both corn and wheat for soil treatment No. 2 which did not contain fertilizer but included limestone and sweet clover. When fertilizer was added to this treatment the yields were increased more than 100 percent. It should be noted that the soil on these plots was the same that received heavy applications of straw in the previous experiment.

TABLE 6.—AVERAGE YIELD (3 YEARS) OF CORN AND WHEAT UNDER ANNUAL APPLICATIONS OF FERTILIZER.

| Treatment | Corn | | Wheat | |
|---|---|---|---|---|
| | Average Yield | Increase | Average Yield | Increase |
| | Bu. | | Bu. | |
| None | 13.58 | | 6.09 | |
| Sweet clover in wheat, under for corn. Limed.* | 12.12 | — 1.46 | 5.69 | — .40 |
| Same as above + 0-12-4 @ 200 lbs. on corn and wheat* | 23.69 | 10.11 | 17.37 | 11.28 |
| 8 T. manure before corn, Superphosphate 200 lbs. on wheat | 31.30 | 17.72 | 16.63 | 10.54 |
| Manure 8 T. + Superphosphate 200 lbs. on corn. 4-12-4 on wheat @ 200 lbs. | 31.41 | 17.83 | 21.56 | 15.47 |
| 4-12-4 @ 200 lbs. on corn and wheat | 27.98 | 14.40 | 17.93 | 11.84 |
| 0-12-4 @ 200 lbs. on corn and wheat | 24.99 | 11.41 | 16.72 | 10.63 |
| 4-12-0 @ 200 lbs. on corn and wheat | 26.27 | 12.69 | 18.40 | 12.31 |
| 0-12-4 @ 200 lbs. on corn and wheat. 100 lbs. sodium nitrate side dressing on corn and wheat | 27.86 | 14.28 | 20.75 | 14.66 |

*Very poor stands and growth of sweet clover occurred during time of this test. The effect of sweet clover on yield of grain crops was negligible.

TABLE 7.—AVERAGE YIELD OF FODDER AND STRAW.

| Treatment | Corn fodder | | Wheat straw | |
|---|---|---|---|---|
| | Average Yield | Increase | Average Yield | Increase |
| | Lbs. | | Lbs. | |
| None | 1269 | | 757 | |
| Sweet clover in wheat, under for corn, limed.* | 1600 | 331 | 531 | —226 |
| Same as above + 0-12-4 @ 200 lbs. on corn and wheat | 2213 | 944 | 1970 | 1213 |
| 8 ton manure before corn, Superphosphate 200 lbs. on wheat | 2313 | 1044 | 2346 | 1589 |
| Manure 8 tons + Superphosphate 200 lbs. on corn. 4-12-4 on wheat @ 200 lbs. | 2513 | 1244 | 2613 | 1856 |
| 4-12-4 @ 200 lbs. on corn and wheat | 1888 | 619 | 2220 | 1463 |
| 0-12-4 @ 200 lbs. on corn and wheat | 1928 | 659 | 1945 | 1188 |
| 0-12-4 @ 200 lbs. on corn and wheat | 1975 | 706 | 1429 | 672 |
| 0-12-4 @ 200 lbs. on corn and wheat, 100 lbs. sodium nitrate on corn and wheat side dressing | 2013 | 744 | 2694 | 1937 |

*See note under Table 6.

The experiment field was discontinued at the end of 1931. The weather conditions were not favorable during two years of the three-year test, yet the results obtained are considered highly significant as indicating the comparative value of the soil treatments used. Mixed fertilizers gave slightly larger yields than fertilizers containing only one or two plant food elements. It is probable that if the test could have been continued for a longer period of time, greater variations in crop yields in favor of the better soil treatments would have been obtained. In general, the results confirm the data from other tests on this field. The recommended soil treatments based on these tests are the same as those described under Experiment I in the first part of this report.