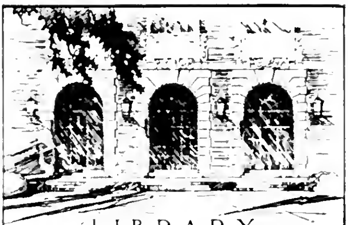

Composition of Mature Corn Stover

As affected by

Variety, Soil Type, and Fertilizer Treatment

By D. C. Wimer

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CONTENTS

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By D. C. WIMER, Assistant Chief in Soil Physics

INTRODUCTION

THE PLOWING DOWN of cornstalks is generally recognized as good farming practice. When it appeared that the European corn borer might make it necessary to burn all cornstalks, renewed consideration was given to the probable effect that continued burning of cornstalks would have on the productivity of Illinois soils.

As an outgrowth of this situation, a study of the fertilizing value of cornstalks on Carrington silt loam[a] was begun in 1924. A brief resumé of this work appears progressively in the annual reports of the Illinois Station. As a supplementary phase of this project, studies on the composition of mature corn stover were started in 1927.

The practice of returning cornstalks as residues instead of burning them is common, tho not universal, in the corn belt. Some investigations involving their use in conjunction with straws and green-manure crops extend over a period of more than thirty years. Data from these studies do not show the relative influence of the individual materials on crop yields. Too, the value of cornstalks when used alone is not known, and can be ascertained only by long-continued experimentation. Their ultimate effect would be influenced by many factors, of which the composition and amount of stalks applied would be of first importance.

Many studies on the composition of the corn plant and its separated parts have been made, some at various periods of growth, others in connection with feeding trials. Results of neither group of studies, however, are satisfactory in showing the composition of mature corn stover grown under different conditions. Studies of the first group usually have not been concerned with the stover of field-grown corn, while those of the second group are generally based on proximate analyses, which furnish little information on fertilizing constituents other than nitrogen.

The analyses which have been reported show marked differences in the composition of corn stover. Such variation seems inevitable in view of the wide diversity of conditions represented. But the general lack

[a]The soil for experiment was formerly correlated as Muscatine silt loam.

of definite information as to the source of the samples precludes the possibility of making comparative studies to determine the probable influence of different factors on the composition of corn stover.

In consequence, a study of the composition of mature corn stover, representing many varieties grown under similar and different conditions, especially with reference to soil type and fertilizer treatment in Illinois, was undertaken. The immediate purpose of this work was to obtain more definite information on the composition of stover and its separated parts. Such information would furnish a more satisfactory basis on which to compute the plant-nutrient balance in soils, or to study the comparative effects on crop yields of different methods of handling the corn stover.

REVIEW OF LITERATURE

No effort has been made to review the voluminous literature on the composition of plants. Only such contributions as are directly concerned with, or closely related to, the present studies on the composition of corn stover will be cited.

Studies of the Composition of Corn Stover Based on Proximate Analyses

Nutrition Investigations.—The earlier, and perhaps more extensive, studies on the composition of corn stover were those made in connection with nutrition investigations. A complete bibliography of those on corn and corn products has been prepared by Keith.[13*] Obviously the analyses which were made incident to such studies indicate the nutritive value of the corn stover rather than show its content of fertilizing constituents. With but few exceptions, the results on the nitrogen and ash contents of stover, which may be obtained from these analyses, have been of little value in this work. Comparative studies could not be made because definite information as to the conditions represented by the respective analyses was generally lacking.

Fertilizer Investigations.—Some of the earliest investigations concerned with the use of fertilizers suggested that their effects be measured not merely by yields, but also by the quality of the crop produced. The significance of the latter is reflected in the statement of Hills and associates,[10*] who wrote that "the influence of fertilization, or the lack of such influence upon the composition of a crop, is a matter second only in importance to consideration of yield." Woods[23*] called attention to the source of error involved in the ordinary method of esti-

*These numbers refer to literature citations on page 257.

mating the effects of fertilizers which assumes uniform content of moisture and nutrients in crops produced.

The composition of corn stover as affected by fertilization has been reported by several experiment stations; specific reference, however, will be made only to the work done at Connecticut, Pennsylvania, and Kentucky. Woods[23*] concluded that mineral fertilizers, when used alone or mixed, without nitrogen, increased yields and the total amount of protein, but not the percentage of protein. Nitrogen alone or in combination with mixed minerals produced a slight increase in percentage of protein over the unfertilized crop, but when compared with the stover from the mixed minerals treatment, the percentage of protein increased with the amount of nitrogen added. These studies also showed that variations in the composition of stover were due to soil and climatic influences, as well as fertilization of the soil, and were as wide with seed from the same source as from different sources.

In a subsequent report Woods and Gibson[24*] concluded that the great variation in the composition of corn stover was no doubt less dependent upon the fertilizers applied than it was upon the difficulty of securing representative stover samples and upon the yield of grain.

Analyses reported by Frear[8*] show a greater variation in the composition of stover (referred to as fodder) than of grain, which is in agreement with other investigations reviewed. The changes in composition of either grain or stover, due to the use of fertilizers, were not so great as reported by others. Mineral fertilizers alone caused a marked decrease in the introgen content of the stover, yet this treatment was the most effective in increasing yields. The use of nitrogenous fertilizers, especially those containing soluble nitrogen, seemed to increase the nitrogen content of stover. All fertilizers, except mixed minerals when used alone or in combination with sulfate of ammonia, increased the ash content of the stover.

Scovell and Peter[17*] found that corn stover was more variable than the grain in nitrogen, P_2O_5, and K_2O content; however, in the absence of potassium, the variation in the composition of the grain was considerable. When applied with either nitrogen or phosphorus or both, potassium produced large increases in yields, but the differences in composition of either grain or stover, due to treatment, were generally less than those caused by soil variation.

Composition of the Corn Plant at Various Stages of Growth

Studies on the composition of the corn plant at different stages of growth have not been concerned generally with fully matured corn stover; neither do they show the content of the different nutrient elements, except nitrogen indirectly. While the analytical results in most cases are not comparable with those obtained in the present studies, reference will be made to certain observations noted and conclusions drawn.

Hornberger[11*] found that the percentages of both nitrogen and the mineral elements decreased as the corn plants grew older. The rate of absorption of most elements was reduced after ear formation, and the plants suffered an actual loss in weight of all elements except phosphorus during the maturing period.

It was concluded by Schweitzer[16*] that "the plant takes up nearly all the ash ingredients it needs during the first stages of growth, and subsequent additions are mechanically absorbed with the water imbibed by the roots." Hence, to develop well, the corn plant must have an abundance of readily available mineral nutrients during its early growth.

The studies reported by Jones and Huston[12*] are of special interest since they show the total nitrogen, P_2O_5, K_2O, and ash contents of corn grain and stover when the plants reached maturity. Table 1 shows a summary of their results, expressed in percentage on the dry basis, for the later growth periods.

All constituents, except potash, continued to increase in the whole plant up to October 8; potash reached its maximum on October 1, when the corn was in the ensilage stage. After August 28, when the first sample to be separated into ears and stalks was taken, the percentages of nitrogen, phosphoric acid, and potash decreased rather regularly in the vegetative parts of the plant. Differences in the com-

TABLE 1.—COMPOSITION OF CORN GRAIN AND STOVER AT DIFFERENT STAGES OF DEVELOPMENT, ACCORDING TO STUDIES REPORTED BY PURDUE AGRICULTURAL EXPERIMENT STATION[12*]

(Percentage on dry basis)

Stage of development	Part	N	P_2O_5	K_2O	Ash	Notes
October 8						
Ready to shock..........	Stalks[a]	.753	.149	1.584	7.265	Lower blades yellow, upper blades green, husks very dry
	Ears[b]	1.519	.685	.481	1.456	
November 12						
Ready for husking........	Stalks	.744	.143	1.547	6.896	Corn matured. Ears and stover in excellent condition
	Ears	1.652	.656	.489	1.487	
November 12						
Plants left in field........	Stalks	.632	.093	1.428	5.793	Marked reduction in stover due to loss of leaves
	Ears	1.512	.682	.483	1.425	

[a]Include blades and husks. [b]Grain and cob.

position of the shocked and unshocked corn when sampled November 12 are regarded as losses due to differences in exposure from October 8 to November 12.

Effect of Varying Supply of Nutrients.—Duley and Miller[5*] studied the effect of a varying supply of nutrients on the character and composition of corn. Plants of Reid Yellow Dent corn were grown in sand cultures with Pfeffer's nutrient solution of normal and N/20 concentrations, referred to as optimum and minimum, which were used in all possible combinations during three 30-day periods.

Top growth was increased by the optimum supply of nutrients, while both growth and fibrous development of the roots was favored by the minimum concentration. Ear production was determined largely by the nutrient supply available during the third 30-day period; fair ears were produced with the lower supply of nutrients provided the corn had received the greater supply of nutrients for the previous period. This was said to indicate that the nutrient material had been stored in the stalks and leaves for later use in development of the ears. The second 30-day period was the most important for the vegetative growth of the plants.

Potassium was more abundant than nitrogen in stalks and leaves; nitrogen was followed in abundance by calcium, then phosphorus. Variations in calcium with different treatments were much less marked than those with nitrogen, phosphorus, or potassium. When the plants were harvested after 90 days, the percentages of nitrogen and calcium in the leaves were higher than that in the stalks, while in general the reverse was true for phosphorus and potassium, except where the minimum concentration of nutrients was used for all three periods. The percentage of nitrogen both in leaves and in stalks decreased with each successive 30-day period, owing apparently to the use of the nitrogen in ear formation. Potassium showed a tendency to decrease in the leaves but to increase in the stalks during the third period. This difference was regarded as due either to translocation of potassium to other parts of the plant or else to loss thru leaching.

Where the minimum nutrient solution was used for all periods, relatively large amounts of potassium and calcium but small amounts of nitrogen and phosphorus were absorbed, while the reverse was true with the optimum solution. Since, with a change in concentration of nutrient solution, nitrogen and potassium are more variable, both in percentage and in total amount, than phosphorus and calcium, they were thought to be chiefly responsible for limiting growth when the lower concentration was used.

Effect of Varying Supply of Moisture.—The effects of a varying supply of moisture on the development and composition of corn were studied by Duley and Miller.[6*] Plants of Reid Yellow Dent corn were grown in potometers (24 inches in diameter and 30 inches deep) filled with a fairly fertile silt loam soil which was maintained at 28 or 13 percent moisture. All possible combinations with these two moisture contents, indicated as optimum and minimum, were used during three 30-day periods.

The total production of dry matter was influenced to a greater extent by the moisture supply in the second 30-day period. The effects of drouth during the first period were almost entirely overcome if optimum moisture prevailed for the remainder of the season. Corn plants receiving optimum moisture for the entire season had more leaf area than those receiving minimum moisture; the approximate differences after 30, 60, and 90 days were 300, 50, and 18 percent. Changes in moisture content affected leaf growth more than other parts of the corn plant. Where such changes were made in the third period, stalk growth was modified only slightly.

The average contents of nitrogen and the mineral elements were higher for plants grown with minimum moisture. As the plants grew older, the percentages of these constituents usually decreased, with the more marked reduction taking place where optimum moisture was used.

Fertilizing Constituents of Mature Corn Stover

Information as to the fertilizing constituents of mature corn stover is rather meager. The analytical results which have been published would indicate that the composition is extremely variable. To call attention to this variation, the data in Tables 2 and 3 have been assembled. No attempt has been made, however, to present all available analyses; neither has any selection been made so as to magnify or to minimize the amount of variation shown.

In the preparation of Table 2, several recalculations were necessary in order to have all analyses on a comparable basis. Where such recalculations have been made, they are noted.

The extreme variations in composition are compared with the average composition of corn stover in Table 3. In this table the single elements, rather than oxids of the mineral elements, are given; also, they are expressed, not in percentages, but in pounds per ton of dry stover.

TABLE 2.—COMPOSITION OF CORN STOVER AS REPORTED IN DIFFERENT PUBLICATIONS
(Percentage on dry basis)

N	P_2O_5	K_2O	CaO	Note*	Reference
.860	.100	.660	.685	....	N. Y. (Geneva) Rpt. (1888) p. 249
.661	.104	1.379	....	(a)	Delaware Sta. Rpt. (1890) p. 152
.349	.290	.588	....	....	New Jersey Sta. Rpt. (1894) p. 130
.880	.250	1.250	....	(b)	U. S. Dept. of Agr. Yearbook (1896) p. 360
....	.354	1.922	.581	(c)	Ohio Sta. Bul. 207, p. 44. 1909
.565	.460	1.934	.577	(a-c)	Hopkins—Soil Fertility and Permanent Agriculture, p. 603. 1910
1.250	.325	1.525	....	(a)	Mass. Sta. Rpt. (1911) p. 268
....	.235	2.216	.710	(c)	Ohio Sta. Bul. 255, p. 255. 1913
.744	.143	1.547	....	....	Indiana Sta. Bul. 175, p. 614. 1914
.632	.093	1.428	....	....	Indiana Sta. Bul. 175, p. 615. 1914
....	.442	.....	.575	....	Wis. Sta. Res. Bul. 30, p. 3. 1914
....	.501	2.067	.739	....	Wis. Sta. Res. Bul. 33, p. 118. 1914
1.037	.497	1.417	....	(c)	Weir—Productive Soils, p. 383. 1920
1.090	.347	1.608	.462	(c)	Jour. Agr. Res. 27, p. 850. 1924
.880	.218	2.062	.661	(c)	Bear—Soil Management, 2d ed., p. 18. 1931.
.800	.230	1.040	.490	(c)	Illinois Sta. Soil Rpt. 49, p. 54. 1931

*Recalculations made: (a) computed to dry basis, (b) pounds per ton converted to percent, (c) mineral elements computed to oxids.

TABLE 3.—FERTILIZING CONSTITUENTS IN A TON OF DRY CORN STOVER

Constituent	Variation in content	Average content[a]
	lbs.	*lbs.*
Nitrogen	7.0 to 25.0	16.0
Phosphorus	.8 to 5.0	2.0
Potassium	9.8 to 36.9	17.3
Calcium	6.6 to 13.7	7.0

[a]As given in Ill. Agr. Exp. Sta. Soil Rpts.

Elemental Composition Studies

The elemental composition of the corn plant and its separated parts has been studied by Latshaw and Miller.[15*] They selected five "mature" Pride of Saline corn plants grown on Summit silt loam[a] at Manhattan, Kansas, in 1920 for their analytical work. When harvested, the grain was in the late-dough stage, well glazed and dented, while the leaves were still green and all attached to the plants. Full maturity of the plants, therefore, had not been reached; on the other hand, loss thru leaching or actual removal of various plant parts had not occurred. Separate analyses were made of the leaves, including husks and sheaths, the stems, and the grain, of the individual plants

[a]Based on information and samples furnished by Dr. F. L. Duley, Department of Soils, Kansas State Agricultural College.

grown under the same conditions, in order to determine the variation in composition.

The authors state that "Although the percentage elemental composition is uniform in a like organ of the different plants, the actual amount of a given element expressed in grams varies considerably" since plants "which seem to be uniform in size and general appearance show marked variations in dry weight and in the distribution of this matter in the various organs of the plant."

The average amounts of carbon, nitrogen, phosphorus, potassium, and calcium in the corn grain, stover, and the separated parts of the stover are reported in Table 4. The composition of stover has been

TABLE 4.—ELEMENTAL COMPOSITION[a] OF CORN GRAIN, STOVER, AND THE SEPARATED PARTS OF THE STOVER
(Percentage on dry basis)

Part	Carbon	Nitrogen	Phosphorus	Potassium	Calcium
Stover[b]	42.76	1.09	.153	1.36	.33
Leaves	41.27	1.30	.207	1.48	.47
Stems	44.51	.84	.089	1.23	.17
Grain	44.72	2.15	.340	.42	.025

[a]Ten other elements, including hydrogen, oxygen, magnesium, iron, sulfur, silicon, manganese, aluminum, and chlorin, were also determined. [b]Computed.

computed from the data reported by Latshaw and Miller for leaves and stems. Since these parts made up 28.10 and 24.02 percent respectively of the total dry matter of the entire plant, the dry stover consisted of 53.9 percent leaves and 46.1 percent stems.

Of the total dry weight of the corn plant, the stover made up 52.12 percent and contained 51.09 percent of the carbon, 38.79 percent of the nitrogen, 39.11 percent of the phosphorus, 77.34 percent of the potassium, and 76.17 percent of the calcium. More fully matured stover, similar to that used in the present studies, would be expected to give much lower values. More of the materials would be translocated or perhaps lost thru leaching, while a further reduction would result from the loss of leaves and other parts of the plant.

PLAN OF ILLINOIS EXPERIMENTS

Size of Stover Samples.—Samples of mature corn stover for the season of 1928 were used for the analytical work. The samples were taken just after the corn was shucked. Each sample consisted of 10 stalks, including leaves and husks, and was collected by taking one stalk from 10 consecutive hills in which there was a uniform stand of

2 plants each. Each 10-stalk sample was secured from a soil area that was uniform in character and representative of an important soil type. The stalks were cut off about 3 inches above the surface of the ground.

The size of sample to be taken was decided upon after a statistical study of the total ash and protein contents of individual corn plants reported by Ladd.[14*] It was found that the probable error of the mean of 16 stalks was only slightly less than that of 8 stalks. From this it was concluded that the larger number of stalks would not increase appreciably the accuracy of the work, altho it would add greatly to the problem of collection and preparation of the samples.

Information as to the probable variation of the different elements was obtained from the analytical data reported by Latshaw and

TABLE 5.—VARIATION IN ELEMENTAL COMPOSITION OF CORN LEAVES AND STEMS, BASED ON ANALYSES OF FIVE PLANTS
(Percentage on dry basis)

Element	Leaves	Stems
Nitrogen	1.30 ± .04	.84 ± .06
Phosphorus	.208 ± .011	.089 ± .007
Potassium	1.48 ± .04	1.23 ± .07
Calcium	.47 ± .02	.17 ± .01
Carbon	41.27 ± .17	44.51 ± .31

Miller,[15*] who determined the elemental composition of the separated parts of five individual corn plants grown under the same field conditions. The data in Table 5, prepared from their individual analyses, show that the probable error of the mean in all cases was small.

The reliability of sampling for the work reported in this bulletin cannot be determined by means of statistical methods owing to a lack of replication of samples. For the purpose of this work the assumption was made that a sample of 10 stalks was representative of a particular set of conditions, where both the soil type and the stand of corn were uniform.

General Source of Samples.—Stover samples were collected from sixteen Illinois experiment fields. The complete record of all samples, given in Table 29 of the Appendix, indicates the experiment field; also the plot from which each sample was obtained; the soil type represented; the fertilizer treatment used and the variety of corn grown. Definite information concerning some of the important soil and climatic differences on the various experiment fields will be found on pages 188 to 196.

The following summary shows the varieties, soil types, and treatments represented by the stover samples used in this investigation.

Varieties	*Soil types*	*Treatments*[a]
Black Hawk	Muscatine silt loam	0
Calico	Grundy silt loam	R
Champion White Pearl	Grundy silt loam, grayish phase	RL
Funk 90-Day	Grundy clay loam	RLrP
Funk 176A	Drummer clay loam	RLsP
Golden Glow	Elliott silt loam	RLbP
Krug	Putnam silt loam	RLslP
Minnesota 13	Sidell silt loam	RLuP
Mohawk	Carrington silt loam	RLrPK
Reid Yellow Dent	Carrington silt loam, deep phase	RLrPKG
Rustler	Saybrook silt loam	RLrPG
Sommer Yellow Dent	Saybrook silt loam, deep phase	RrP
Stanley White	Cisne silt loam	RsP
Western Plowman	Cisne silt loam, deep phase	RbP
Will County Favorite	Onarga sandy loam	RslP
		LeL
		LeL KCl
		LeLsP KCl
		LeLrP KCl
		LeLrP K
		5-15-5

[a]Symbols used: 0 = no treatment. R = crop residues. L = limestone. rP = rock phosphate. sP = superphosphate. bP = bone phosphate. slP = slag phosphate. uP = underacidulated phosphate. K = kainit. KCl = muriate of potash. G = gypsum. Le = legume catch crop. 5-15-5 = mixed fertilizer analysis.

Preparation of Samples.—In preparing the stover for analysis, the leaves and husks were separated from the main part of the stalk. The leaf sheaths were included with the stalk portion of the sample, since it was thought that where corn stover was pastured or allowed to stand until spring, the leaves and husks would be removed, while the leaf sheaths would remain with the stalks. In this work the two portions of the stover samples are referred to as "stalks," which include the stalks and leaf sheaths, and "leaves," which include the leaf blades and husks.

The stalk and leaf samples were dried at a temperature of approximately 100° F. for a period of two weeks. No attempt was made to secure a water-free condition of the stover, but rather to make possible the drying of all samples to a more or less uniform moisture content, after which they were weighed and shredded. The shredded material was then ground in a Wiley mill so that the entire sample would pass a 2-mm. sieve. After thoro mixing, a portion of the 2-mm. material was subjected to further grinding until all of it was fine enough to pass a 1-mm. sieve.

Methods of Analysis.—The moisture content of the samples was determined by drying the material in electric ovens at 100° C. for 24 hours. This temperature was used in preference to 105° C. because it appeared to cause less variation in losses other than moisture.

The official methods of analysis of the Association of Official Agricultural Chemists were used for the determinations of nitrogen, phosphorus, and calcium. The Gunning method was used for nitrogen and the magnesium-nitrate method for phosphorus.

Ignition of the samples for the calcium determinations was accomplished by charring the material in a gas muffle at a dull red heat for one hour, after which it was transferred to an electric furnace with a temperature of 650° C. for one-half hour. The resultant ash was weighed and reported as total ash.

The cobaltinitrite method of Hibbard and Stout,[9*] with certain modifications suggested by Bray and DeTurk,[a] was used for the determination of potassium.

Carbon was determined by a modification of the method reported by Winters and Smith.[21*] This modified procedure was perfected by Winters[22*] especially to determine the total carbon content of corn stover and similar plant materials.

Analytical Results.—Determinations of the elements reported were made both for stalks and for leaves, and the composition of the stover was calculated from the composition of the separated parts—stalks and leaves. For example, the percentages of nitrogen were .78 and .97 respectively for stalks and leaves in one sample, which consisted of 80 percent stalks and 20 percent leaves. The nitrogen content of the stover was computed to be .82 percent by using the formula:

$$\%\text{ N in stover} = \frac{(80 \times \%\text{ N in stalks}) + (20 \times \%\text{ N in leaves})}{100}$$

The original plan to analyze the composite sample of stover was abandoned for several reasons. Earlier work had shown a tremendous variation in the composition of stalks and leaves. Then, too, it was realized that where cornstalks are allowed to stand until spring or where they are pastured, the leaves and husks are practically all removed. Thus it appeared that the additional information obtained by having the analyses of both stalks and leaves would justify the additional work involved.

The amounts of nitrogen, phosphorus, potassium, calcium, organic carbon, and total ash, as herein reported, represent the averages of duplicate determinations on a water-free basis.[b] As an indication of

[a]Unpublished method used in the division of Soil Fertility, Department of Agronomy, University of Illinois.

[b]Data on organic carbon and total ash have been omitted from the tables thruout the main portion of this bulletin. These values for stover and its separated parts are presented without discussion in the Appendix, Table 33.

the reliability of the analytical work, the probable error of a single determination, calculated by Student's method,[19*] for each element, and for total ash, in stalks and in leaves is given in Table 6.

To the errors involved in the respective determinations should be added the errors of sampling. These, as noted previously, cannot be analyzed statistically because of an insufficient number of samples for any specific set of conditions. Reference to the complete record of samples would indicate that while many represent what may appear

TABLE 6.—PROBABLE ERROR OF A SINGLE DETERMINATION, AND SIGNIFICANT DIFFERENCES IN COMPOSITION
(Values in percent)

Determination	Probable error of a single determination		3.8 × the P.E. of a single determination		Significant differences in composition of either stalks or leaves
	Stalks	Leaves	Stalks	Leaves	
Nitrogen	.006	.008	.023	.030	.03
Phosphorus	.004	.004	.015	.015	.015
Potassium	.021	.020	.080	.076	.08
Calcium	.009	.011	.034	.042	.04
Organic carbon	.295	.281	1.121	1.068	1.25
Total ash	.064	.129	.243	.490	.50

to be similar conditions, the conditions in reality are not identical and hence the samples are not true replicates.

Differences in composition, unless greater than .015 percent for phosphorus, .03 percent for nitrogen, .04 percent for calcium, .08 percent for potassium, .50 percent for total ash, and 1.25 percent for organic carbon, are not considered significant but within the limits of experimental error. These values are 3.8 or more times "the probable error of a single determination" given in the preceding table. Furthermore, the value designated as a significant difference for each respective element, also for total ash, is not only larger than the greatest difference between any duplicates but at least double the difference between the duplicates in 85 percent or more of the determinations.

In the tables and discussions which follow, emphasis is placed on the composition of stover as a whole and not of its separated parts. A complete summary, however, of the data on the composition of stalks and of leaves is given in the Appendix, Table 31. In addition to the percentage composition, the pounds of nitrogen, phosphorus, potassium, and calcium contained in the stover, or in its separated parts, per acre are also reported (Appendix, Table 32). The latter expression—pounds per acre—provides a more convenient way in which to compute the additions where stover is plowed under, or to estimate the losses if the stover is burned or otherwise removed from the land.

Computation of Acre-Yields.—The material which follows serves to indicate the source of yield values and to call attention to certain relationships shown. The things presented include: (1) the proportion of stalks to leaves in the sample; (2) the computed yield of stover per acre; (3) the yield of grain per acre; and (4) the stover-grain ratio. The proportion of stalks to leaves is based on the dry weights of the separated parts of the stover, and is expressed as a ratio in which the weight of leaves is taken as 1. This value for all samples appears only in the Appendix, Table 29. The yield of stover per acre was computed from the weight of the stover sample, which consisted of 10 stalks from 10 consecutive hills having 2 plants each. Thus the sample was collected where a perfect stand obtained, and on this basis represented 1/800 of the total plants per acre. The yield values computed in this manner are no doubt too high since a 100-percent stand would be rare. On the other hand, the losses of stover, especially of leaves and tassels, prior to the time samples were collected would tend to lower the true values. But in neither case is there any satisfactory way in which to make allowance for an imperfect stand or to compensate for losses.

In the case of certain plots from which stover samples were collected, the cornstalks were removed and weighed just after the corn was shucked. This makes possible a limited number of comparisons between the computed and recorded yields of stover. Without exception, the computed yield for each of 15 plots was less than the recorded yield; the difference in yields varying from .4 to 58.6 percent. These variations were due to many factors, of which moisture was the most important. The recorded yield represents the field weight of moist material, while the computed yield is based on the weight of material dried at 100° F. for two weeks. Another factor causing considerable variation was the method of thinning practiced. On seven fields, represented by seven of the above comparisons, the number of plants was not uniformly thinned to 2 per hill.

The yield of grain for the plots from which the stover samples were collected are reported in Illinois Agricultural Experiment Bulletin 327, except for the corn grown in variety tests or used in corn borer work. For these, the yields were obtained from the field records of the Agronomy Department.

The stover-grain ratio should be based on the proportion of stover to grain in the sample, but unfortunately the ears from the sample stalks were not weighed separately. The ratio, therefore, instead of being derived from the actual samples, is a comparison of the computed yield of stover with the actual yield of grain per acre. These ratios, in which the weight of grain is taken as 1, are reported only in the Appendix, Table 29.

SOIL AND CLIMATIC CONDITIONS REPRESENTED

The purpose of this section is to set forth in a comparative manner some of the more important conditions under which the stover, used in this work, was grown. As noted previously, samples were obtained from sixteen experiment fields, widely distributed over Illinois. From the material which follows it is evident that the samples used represent a wide diversity in soils and in climate.

Soil Types Represented

The soil types represented by the stover samples are as follows on the respective fields:

Mt. Morris	Muscatine silt loam
La Moille	Muscatine silt loam
Kewanee	Muscatine silt loam
Aledo	Grundy silt loam
Carthage	Grundy silt loam, grayish phase
Hartsburg	Grundy clay loam
Sidell	Sidell silt loam Drummer clay loam
Minonk	Drummer clay loam
Joliet	Elliott silt loam
DeKalb	Saybrook silt loam Saybrook silt loam, deep phase
Urbana	Carrington silt loam, deep phase (Davenport plots) Carrington silt loam and Sidell silt loam (South Farm)
Alhambra	Putnam silt loam
Toledo	Cisne silt loam
Oblong	Cisne silt loam, deep phase
Palestine	Onarga sandy loam

Descriptions of the soil types, except as noted below, are given in Bulletin 273 of this Station (1926), page 313. More recent correlation of Illinois soils has necessitated certain changes in the soil-type names as given in this publication. These changes, together with the experiment fields involved, are here indicated:

Tama silt loam, Mt. Morris, *changed to* Muscatine silt loam.

Loessial Clyde clay loam, Minonk and Sidell, *changed to* Drummer clay loam.

Carrington silt loam, light phase, Sidell and Urbana South Farm, *changed to* Sidell silt loam.

Muscatine silt loam, Davenport plots, Urbana, *changed to* Carrington silt loam, deep phase.

Clarion silt loam and Grundy silt loam, DeKalb, *changed to* Saybrook silt loam and Saybrook silt loam, deep phase, respectively.
Webster silt loam, Joliet, *changed to* Elliott silt loam.
Gray Silt Loam On Tight Clay, Toledo and Oblong, *changed to* Cisne silt loam and Cisne silt loam, deep phase, respectively.
Plainfield sandy loam, Palestine, *changed to* Onarga sandy loam.

Drummer clay loam was developed under somewhat better drainage conditions than the Loessial Clyde clay loam. In consequence the profile features of the Drummer clay loam are more comparable to those of the Grundy clay loam, which is described in the reference given.

Unpublished analytical data, based on samples taken according to arbitrary depths rather than horizons, indicate a wide variation in the chemical make-up of these soils. This variation is reflected in the differences brought out in Table 7, which shows the acidity, available phosphorus content, and clover growth without limestone. The information on acidity and clover growth is based primarily on material reported by Bauer,[3*] while that on available phosphorus has been reported by Bray.[4*] In both cases unpublished data have been used to supplement those reported.

In the case of available phosphorus, the respective soil types at Mt. Morris, Kewanee, Carthage and Sidell, also on the Davenport plots, gave somewhat larger amounts of phosphorus than the other soils which tested "low." On all the fields except Alhambra, DeKalb, Palestine, and Urbana South Farm, sweet clover is seeded in wheat and plowed down as a green-manure crop for corn. Unpublished field notes for 1928 report a good growth of sweet clover on the unlimed plot at Hartsburg and Minonk; a fair growth at LaMoille and Carthage; very little growth at Mt. Morris, Aledo, and Sidell; and a very poor growth at Kewanee and on the Davenport plots at Urbana. On both the Toledo and Oblong fields the sweet clover was severely winterkilled, while at Joliet an excellent growth was plowed down for first-year corn in 1927.

Many of the differences in the composition of the stover, as well as those in yield of both stover and grain, appear to have a very definite relation to the differences shown in Table 7. Some of these relationships are noted in discussions which accompany the data presented.

The relative productivity of the untreated soil types on the different fields is shown by Fig. 1. This comparison is based on the average yields of corn, oats, and wheat on Plot 5 (1-W on the Davenport plots) of the particular series from which the stover samples were collected. No satisfactory comparison of the yields of clover or other legumes was possible. Alhambra, DeKalb, and Urbana South Farm have been omitted from the graph since there are no untreated plots on these

TABLE 7.—ACIDITY, AVAILABLE-PHOSPHORUS CONTENT, AND CLOVER GROWTH, DIFFERENT SOIL TYPES

Field	Soil type	Acidity in different horizons, Comber method			Available phosphorus, Bray test	Clover growth without limestone
		A_1	A_2	B_1		
Mt. Morris	Muscatine silt loam	Strong	Strong	Strong	Low	Red, but no sweet clover
LaMoille	Muscatine silt loam	Slight	Medium	Slight	Medium to low	Sweet clover
Kewanee	Muscatine silt loam	Strong	Medium	Medium	Low	Red, but no sweet clover
Aledo	Grundy silt loam	Medium	Medium	Slight	Medium	Red, but no sweet clover
Carthage	Grundy silt loam, grayish phase	Strong	Medium	Medium	Low	Sweet clover
Hartsburg	Grundy clay loam	Very slight	None	None	High	Sweet clover
Sidell	Drummer clay loam	Medium	Slight	Very slight	High	Sweet clover
Minonk	Drummer clay loam	Slight	Very slight	None	High	Sweet clover
Joliet	Elliott silt loam	Medium	Slight	None	Low	Red, but no sweet clover
DeKalb	Saybrook silt loam	Medium	Slight	None	Low	Red, but no sweet clover
Urbana						
Davenport plots	Carrington silt loam, deep phase	Medium	Slight	Very slight	Low	Red, but no sweet clover
South Farm	Carrington silt loam	Medium	Slight	None	Low	Red, but no sweet clover
Sidell	Sidell silt loam	Medium	Medium	Slight	Low	Red, but no sweet clover
Alhambra	Putnam silt loam	Strong	Strong	Strong	Low	None
Toledo	Cisne silt loam	Very strong	Strong	Strong	Low	None
Oblong	Cisne silt loam, deep phase	Very strong	Strong	Strong	Low	None
Palestine	Onarga sandy loam	Medium	Medium	Medium	Medium	None

fields. Sidell is represented by Sidell silt loam rather than Drummer clay loam.

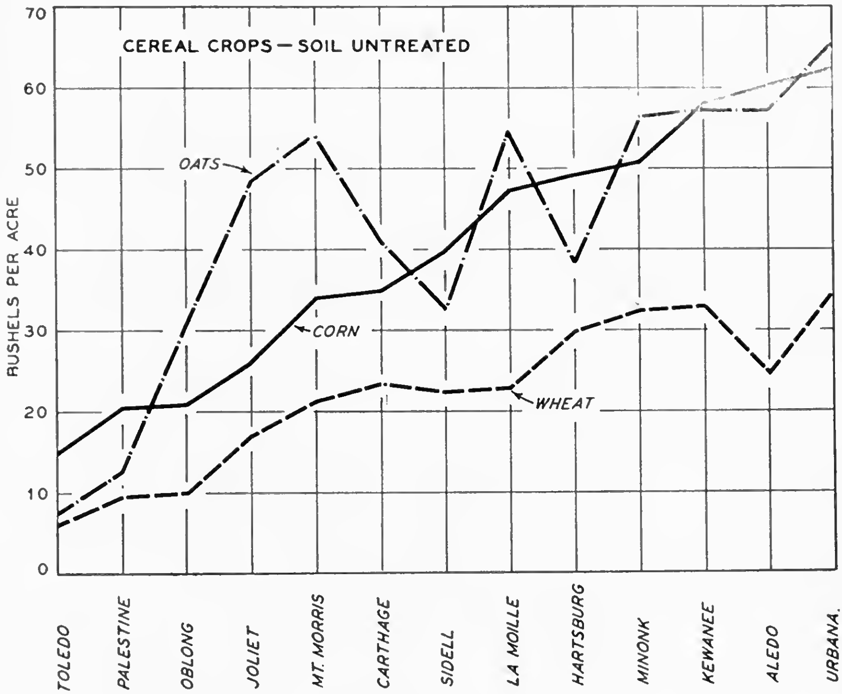

FIG. 1.—AVERAGE YIELDS OF CORN, OATS, AND WHEAT ON UNTREATED PLOTS OF THIRTEEN ILLINOIS SOIL EXPERIMENT FIELDS FOR THE FIFTEEN YEARS 1914-1928

The fields are arranged in order of increasing corn yields. The Toledo and Urbana fields represent the two extremes for all three cereal crops. Toledo produced 14.7, 7.2, and 5.9 bushels of corn, oats, and wheat respectively an acre; whereas Urbana (Davenport plots) produced 62.3, 65.4, and 34.2 bushels of these crops.

Crop Rotations Practiced

The crop rotations practiced on the main series of the respective experiment fields are shown in the following outline. This has been prepared from the material contained in Bulletin 273 of this Station, to which the reader is referred if more detailed information on the cropping systems is desired. Unless otherwise specified, "clover" means red clover. On the Hartsburg and Joliet fields alfalfa has been included in the "main series" rotation but had not been grown on the series from which the stover samples were secured.

Aledo, Hartsburg, La Moille, and Minonk	Corn, oats, clover, and wheat[a] changed in 1923 to corn, corn, oats (Hubam clover), and wheat.[a]
Carthage, Kewanee, and Mt. Morris	Corn, oats, clover, and wheat.[a]
Urbana (Davenport plots) and Sidell	Corn, oats, clover, and wheat[a] with alfalfa for five years.
Joliet	Corn, oats, clover, wheat,[a] and soybeans changed in 1921 to corn, corn, oats, clover, and wheat.[a]
Urbana (South Farm)	Corn, oats, clover, and wheat (red-clover green manure) (Southwest rotation).
DeKalb	Corn, corn, oats, and clover (Saybrook silt loam) Corn, oats, wheat, and clover (Saybrook silt loam, deep phase).
Alhambra	Corn, oats, mammoth clover, and wheat (sweet-clover green manure).
Oblong and Toledo	Corn (cowpeas as catch crop prior to 1921), oats, clover, and wheat.[a] Sweet clover substituted for alsike in 1920 and 1922 respectively. Timothy and clover mixture used in place of sweet clover in 1925 and thereafter.
Palestine	Corn, soybeans, rye, sweet clover, and wheat[a] changed in 1926 to wheat (Hubam and alsike clover), wheat (sweet clover), corn, soybeans, and alfalfa.

([a]Seeding of sweet clover on the residues plots)

Soil Treatments Represented

The stover samples, except those from untreated plots, represent the grain system of farming. In this system "organic matter and nitrogen are applied in the form of plant manures, such as cornstalks; straw from wheat, oats and clover; the second crop of clover; and leguminous green manure crops. . . . " While various modifications of the residues system have been made, including the discontinuance of the oat and wheat straw, cornstalks together with a leguminous green-manure crop, usually sweet clover, have always been used.

In addition to residues the standard treatments have included limestone, rock phosphate, and kainit. The usual acre-rates of application for these materials were as follows: limestone 2 tons after the initial application of 4 tons; rock phosphate 1 ton; and kainit 800 pounds every four years or once during a rotation. The phosphate and kainit were applied before, and the limestone after, the clover sod was plowed for wheat.

Samples of different varieties on the same field were grown with similar treatment of residues and rock phosphate with or without limestone, depending on the soil type concerned. On 12 of the 16 fields the samples represent various combinations of the standard treatments: residues and limestone; and residues, limestone, and rock phosphate. They also represent residues, limestone, rock phosphate, and kainit; residues alone; and no treatment. On five fields various comparisons with different phosphorus carriers, both with and without limestone, are possible. Other treatments include gypsum used with and without kainit and also a complete fertilizer as a supplement to the standard treatments.

The rates at which the various fertilizing materials were applied and the methods of applying them are described in Bulletin 273 of this Station and the yearly supplements.[a] The total applications of the fertilizing materials are shown in Table 30 in the Appendix. Reference to Table 29 in the Appendix will indicate the field and plot source of the respective samples.

Climate

While the important effect of climate on growth and yield is recognized, the weather records do not supply adequate specific information with reference to climatic conditions obtaining at the various experiment fields. This is especially true of such things as light duration and intensity, relative humidity, temperature changes, and wind velocity. The material on climate is therefore limited to two items: (1) the amount and distribution of rainfall, and (2) the length of the growing season, as recorded at the weather stations nearest the respective fields. These data are shown in Fig. 2 and Table 8.

For most of the fields the total rainfall for the six months April 1 to September 30, 1928, was practically the same as the fifteen-year average 1914-1928. At Alhambra, DeKalb, and Mt. Morris, the rainfall was 2.4, 2.6, and 5.2 inches more than average, while at Hartsburg and Minonk it was 4.2 and 5.5 inches less. The rainfall was markedly deficient in the spring of 1928, especially during the month of May. This was particularly true in northern Illinois on the fields at Minonk, Joliet, and DeKalb and to a lesser extent on those at La Moille, Mt. Morris, Kewanee, and Aledo. It is probable, however, that the damage due to drouth early in the season on the northern fields was very much less than on the Palestine and Oblong fields during July and August.

In addition to the monthly distribution of rainfall on the experiment fields shown in Fig. 2, the rainless periods of 29 or more days duration and their occurrence during the growing season are given in Table 8. A rainless period was regarded as terminated when a rainfall of .5 inch or more occurred in 24 hours. Not only the number and duration of these rainless periods, but also their occurrence in relation to the development of the plant, is important. All fields except Aledo are

[a]Bulletins 280 (1925), 296 (1926), 305 (1927), and 327 (1928).

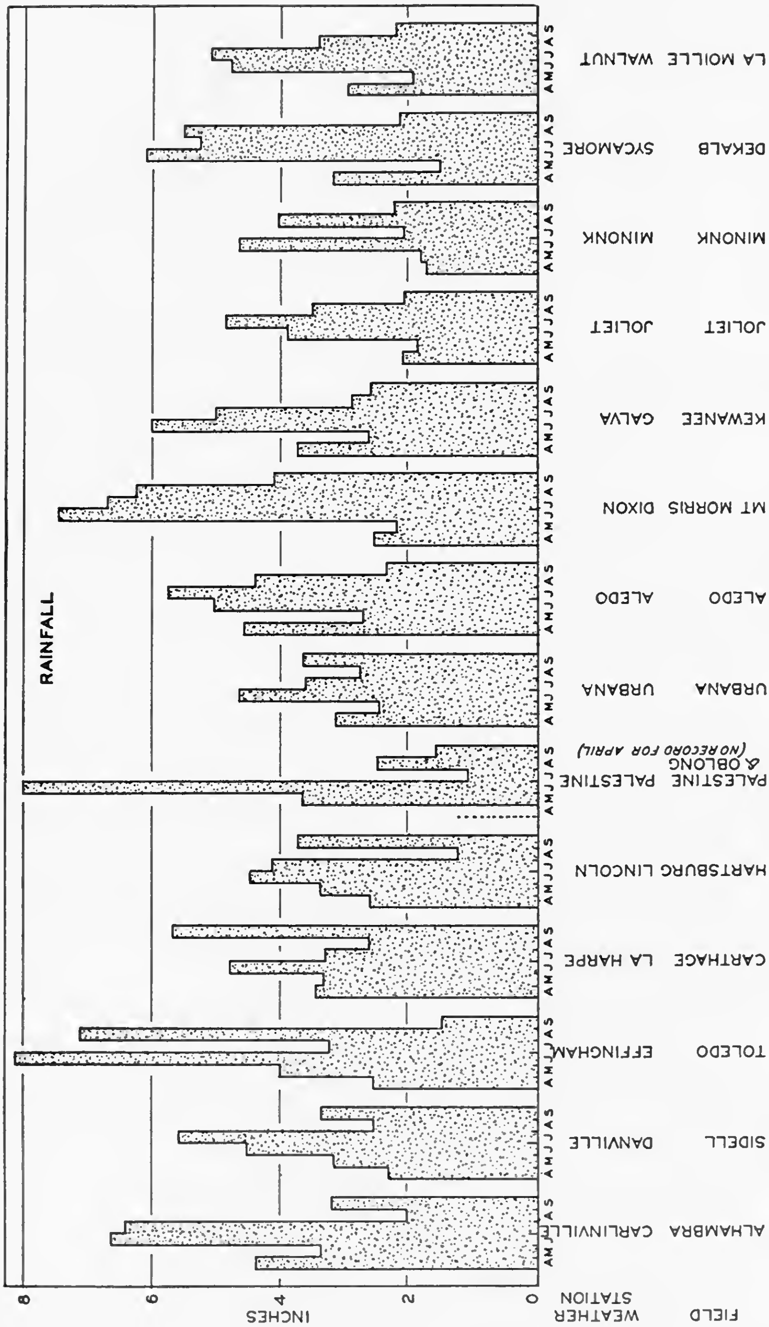

Fig. 2.—Monthly Distribution of Rainfall During the Growing Season of 1928 (April 1 to September 30) in the Vicinity of Sixteen Illinois Soil Experiment Fields

TABLE 8.—TOTAL RAINFALL, RAINLESS PERIODS, AND LENGTII OF GROWING SEASON AT FOURTEEN ILLINOIS WEATHER STATIONS, 1928

Weather station	Experiment field	Total rainfall Apr. to Sept.		Time and duration of rainless periods of 29 or more days, Apr. 1 to Sept. 30, 1928	Growing season, 1928	Dates of killing frosts	
		15-yr. av.	1928			Latest in spring	Earliest in fall
		inches	*inches*		*days*		
Aledo	Aledo	23.33	24.90	None	152	Apr. 27	Sept. 26
Dixon	Mt. Morris	21.88	27.07	Apr. 15 to May 17, 33 days; May 20 to June 17, 29 days	136	May 12	Sept. 25
Galva	Kewanee	22.81	22.89	Apr. 15 to May 17, 33 days; Aug. 5 to Sept. 11, 38 days	150	Apr. 28	Sept. 25
Joliet	Joliet	20.09[a]	18.29	Apr. 8 to June 16, 70 days	134	May 13	Sept. 24
Minonk	Minonk	22.04[a]	16.55	Apr. 1 to June 19, 80 days	134	May 13	Sept. 24
Sycamore	DeKalb	20.98	23.59	Apr. 16 to June 12, 58 days	136	May 13	Sept. 26
Walnut	LaMoille	22.14[b]	20.30	Apr. 8 to May 18, 41 days; May 20 to June 17, 29 days	136	May 12	Sept. 25
Carlinville	Alhambra	23.72	26.21	Apr. 14 to May 14, 31 days; Aug. 6 to Sept. 10, 36 days	149	Apr. 28	Sept. 24
Danville	Sidell	23.27[a]	21.57	Apr. 8 to May 10, 33 days	134	May 13	Sept. 24
Effingham	Toledo	24.81[a]	26.64	Aug. 30 to Sept. 28, 30 days	149	Apr. 28	Sept. 24
LaHarpe	Carthage	24.33	23.26	Apr. 14 to May 14, 31 days	151	Apr. 28	Sept. 26
Lincoln	Hartsburg	23.90	19.68	Apr. 14 to May 15, 32 days; July 23 to Aug. 22, 31 days	151	Apr. 28	Sept. 26
Palestine	Palestine and Oblong	21.84[b]	16.90[c]	June 23 to Aug. 23, 62 days; Aug. 30 to Sept. 28, 30 days	139	May 8	Sept. 24
Urbana	Davenport plots and South Farm	22.14	20.30	Apr. 15 to May 18, 34 days	149	Apr. 28	Sept. 24

[a]Fourteen-year average. [b]Thirteen-year average. [c]No record for April.

credited with one or two rainless periods of one month or longer. Perhaps the most serious of all was the one of 62 days, extending from June 23 to August 24, at Palestine, where the corn undoubtedly suffered severely from drouth. This was true in spite of the excessive rainfall in June, for the soil at Palestine has a low capacity for retaining useful water. A similar situation prevailed at Oblong.

The length of the growing season represents the number of days between killing frosts. Owing primarily to earlier killing frosts in the fall, the season in 1928 was considerably shorter than the average for the fifteen-year period 1914-1928, varying from 12 days shorter at Hartsburg to 45 days shorter at Palestine. Except for late-planted corn, chiefly that used in corn borer studies at Joliet and Sidell, no apparent injury to the corn resulted from frost.

VARIETAL DIFFERENCES IN THE COMPOSITION OF MATURE CORN STOVER

Corn varieties show marked differences in their ability to yield stover as well as grain. Variations in yield, when varieties are grown under the same conditions, must be attributed to varietal differences. What relation, if any, these variations bear to the composition of mature corn stover has been the basic problem in this phase of the work. These studies have sought to determine whether the variations in composition of different varieties of stover represent merely a reciprocal relation between yield and composition in that an increased (or decreased) yield is accompanied by a corresponding decrease (or increase) in the different elements, or an actual difference in the ability of corn varieties to absorb and store nutrients in their stover.

For these studies samples of stover were collected from experiment fields where variety tests were being conducted. Seed for a particular variety, when grown on different fields, was obtained from the same source. Table 9 shows the varieties used, their field sources, and the length of season required for maturity. Planting dates and dates of sampling, as well as the names of the soil types and descriptions of treatments, are also indicated.

Data on the approximate number of days from planting to denting, altho not for the 1928 season, will be satisfactory for comparative purposes. On the basis of these data the varieties were divided into four groups: early maturing, 100 to 105 days; medium-early maturing, 110 to 115 days; medium-late maturing, 120 to 125 days; and late maturing, 130 or more days. For the respective groups indicated there are 6, 8, 9, and 6 samples. Because of their unequal distribution with

TABLE 9.—LENGTH OF SEASON REQUIRED TO MATURE FOURTEEN VARIETIES OF CORN ON FOUR ILLINOIS SOIL EXPERIMENT FIELDS

Corn variety	Approximate days from planting to denting	Experiment field			
		Alhambra	DeKalb	Toledo	Urbana
Early					
Golden glow	100	.....	x	.....	x
Minnesota 13	105	.....	x	.....	x
Rustler	105	.....	x	.....	x
Medium-early					
Calico	110	.....	.....	x	.....
Funk 90-Day	112	.....	x	.....	x
Krug	115	x	x	.....	x
Western Plowman	115	.....	x	.....	.....
Medium-late					
Funk 176A	120	x	.....	.....	x
Sommer Yellow Dent	120	x	x	.....	x
Reid Yellow Dent	125	x	x	.....	x
Stanley White	125	.....	.....	x	.....
Late					
Black Hawk	135	x	.....	.....	.....
Champion White Pearl	135	x	.....	x	x
Mohawk	137	x	.....	x	.....
Conditions					
Corn planted, 1928	.....	May 10	May 28	May 24	May 21
Stover samples collected, 1928	.....	Oct. 31	Nov. 30	Nov. 5	Nov. 26
Soil type	.....	Putnam silt loam	Saybrook silt loam[a]	Cisne silt loam	Carrington silt loam
Soil treatment	.....	RLrP	RrP	RLrP	RrP

[a]Minnesota 13, Rustler, and one sample of Western Plowman were grown on a deep phase of Saybrook silt loam.

reference to soil type, fertilizer treatment, or climate, group averages for varieties are not given.

The material which follows deals first with different varieties grown under similar conditions. These data are given in Tables 10 to 13. Comparative studies of the same varieties grown on different fields, made in order to show the influence of environment on the composition of stover, are presented in Tables 14, 15, and 16. The tables give, for each variety, the nitrogen, phosphorus, potassium, and calcium contents of the stover, the yields of stover and grain, and the percentage of leaves.

Different Varieties Grown Under Similar Conditions

Varieties Grown at Urbana, South Farm

A probable relationship between length of season required for maturity and yields of stover and grain, nitrogen and phosphorus contents of the stover, and percentage of leaves is indicated by the data in Table 10 on the varieties grown at Urbana.

The percentage of leaves was greatest in the early varieties, with no consistent relationship between the length of growing period of

TABLE 10.—COMPOSITION OF MATURE STOVER OF DIFFERENT VARIETIES OF CORN GROWN AT URBANA, SOUTH FARM, ON CARRINGTON SILT LOAM
(*Treatment:* Residues and rock phosphate)

Sample No.	Variety	Composition of stover				Yield per acre		Leaves
		N	P	K	Ca	Stover	Grain	
		%	%	%	%	*lbs.*	*bu.*	%
1	Champion White Pearl (late)	1.25	.219	.41	.32	3 143	42.0	24.9
2	Sommer Yellow Dent (medium-late)	.99	.166	.34	.32	3 044	54.8	25.7
3	Reid Yellow Dent (medium-late)	.87	.127	.41	.34	3 006	56.6	26.9
4	Funk 90-Day (medium-early)	.72	.091	.50	.28	2 147	71.6	25.8
5	Funk 176A (medium-late)	1.00	.163	.62	.30	2 872	56.9	24.5
6	Krug (medium-early)	.79	.121	.41	.31	2 611	75.1	23.4
7	Rustler (early)	1.04	.141	.35	.32	1 018	39.3	28.1
8	Minnesota 13 (early)	.87	.114	.46	.31	1 432	55.6	32.3
9	Golden Glow (early)	.89	.134	.48	.31	1 705	38.9	27.4
	Average of 145 samples analyzed	.77	.111	.56	.31	2 607	52.9	27.3

TABLE 11.—COMPOSITION OF MATURE STOVER OF DIFFERENT VARIETIES OF CORN GROWN AT ALHAMBRA ON PUTNAM SILT LOAM
(*Treatment:* Residues, limestone, and rock phosphate)

Sample No.	Variety	Composition of stover				Yield per acre		Leaves
		N	P	K	Ca	Stover	Grain	
		%	%	%	%	*lbs.*	*bu.*	%
18	Krug (medium-early)	.98	.189	.64	.35	2 919	43.3	29.6
19	Sommer Yellow Dent (medium-late)	1.11	.171	.54	.38	3 043	50.6	26.5
20	Reid Yellow Dent (medium-late)	.87	.112	.61	.36	3 170	54.9	29.0
21	Funk 176A (medium-late)	.76	.177	.80	.39	3 082	41.9	25.4
22	Black Hawk (late)	.82	.251	.55	.35	3 133	49.5	27.3
23	Mohawk (late)	1.11	.220	.64	.42	3 581	48.8	25.7
24	Champion White Pearl (late)	1.01	.142	.53	.38	4 227	62.0	31.1
	Average of 145 samples analyzed	.77	.111	.56	.31	2 607	52.9	27.3

Table 12.—Composition of Mature Stover of Different Varieties of Corn Grown at DeKalb on Saybrook Silt Loam
(*Treatment:* Residues and rock phosphate)

Sample No.	Variety	Composition of stover				Yield per acre		Leaves
		N	P	K	Ca	Stover	Grain	
		%	%	%	%	*lbs.*	*bu.*	%
27	Reid Yellow Dent (medium-late)	.98	.128	.32	.37	2 295	26.4	22.3
28	Sommer Yellow Dent (medium-late)	.84	.118	.29	.28	1 995	26.1	23.5
29	Western Plowman (medium-early)	.84	.104	.40	.31	1 690	28.9	24.3
30	Funk 90-Day (medium-early)	.93	.128	.29	.28	2 069	40.4	19.4
31	Krug (medium-early)	.82	.107	.31	.30	2 381	29.2	20.0
32	Golden Glow (early)	.85	.115	.39	.29	2 618	32.1	26.1
33[a]	Minnesota 13 (early)	.71	.069	.49	.31	1 762	69.1	26.7
34[a]	Western Plowman (medium-early)	.82	.116	.39	.23	2 755	54.9	24.3
35[a]	Rustler (early)	.67	.076	1.02	.28	1 900	46.3	23.7
	Average of 145 samples analyzed	.77	.111	.56	.31	2 607	52.9	27.3

[a]A deep phase of Saybrook silt loam occurred on the three plots from which these samples were taken.

Table 13.—Composition of Mature Stover of Different Varieties of Corn Grown at Toledo on Cisne Silt Loam
(*Treatment:* Residues, limestone, and rock phosphate)

Sample No.	Variety	Composition of stover				Yield per acre		Leaves
		N	P	K	Ca	Stover	Grain	
		%	%	%	%	*lbs.*	*bu.*	%
137	Champion White Pearl (late)	.70	.170	.36	.27	2 140	18.1	27.0
138	Calico (medium-early)	.51	.155	.65	.30	2 463	27.0	30.1
139	Mohawk (late)	.73	.147	.34	.36	1 727	25.0	32.8
140	Stanley White (medium-late)	.97	.155	.26	.29	2 354	21.7	30.6
	Average of 145 samples analyzed	.77	.111	.56	.31	2 607	52.9	27.3

the other varieties and the proportion of leaves to stalks. Early-maturing varieties are generally characterized by stalks of small diameter with short internodes.

The yield of stover was greatest with the one late variety (Champion White Pearl) and decreased progressively as length of growing period decreased. The yield of grain did not follow this order, but was greatest with the two medium-early varieties. Second in grain yields were the medium-late varieties and one early variety (Minnesota 13), while the other two early varieties and the late variety ranked third. Stover yields, however, were more variable than grain yields.

For the nine varieties grown at Urbana the amount of potassium ranged from .34 to .62 percent, with both extremes represented by medium-late varieties, which showed comparatively little variation in yield. On the other hand, the stover of three varieties—one each for late, medium-late, and medium-early maturity—had the same potassium content (.41 percent) but the yields, especially of grain, were markedly different. In contrast with potassium, the calcium content of stover, with a range of only .06 percent among these nine varieties, was the least variable, and in most cases the differences were too small to be significant.

Champion White Pearl, the late variety, shows a markedly higher content of both nitrogen and phosphorus than the shorter-season varieties; which, in view of the high stover yield, means a comparatively large removal of these elements from the soil that is not offset by a correspondingly high yield of grain. There seems to be no fully consistent relationship between nitrogen and phosphorus contents of the stover and the length of season required for maturity. The medium-late varieties with one exception rank high in both nitrogen and phosphorus, while the medium-early varieties rank low, and one of the early varieties ranks low in phosphorus, but not in nitrogen.

That varieties, aside from differing widely in yields, may also differ markedly in composition of the stover, is indicated by the data in Table 10. This is particularly evident when the medium-early or medium-late varieties are compared. The explanation for these differences in composition may lie in differences in the feeding power of the varieties, or in their ability to translocate nutrients to the grain, or in both. In any case, the factors involved appear to be genetic.

Varieties Grown at Alhambra

Stover yields of all varieties grown at Alhambra were high, varying from 2,919 pounds per acre for Krug, the earliest, to 4,227 pounds for

Champion White Pearl, the latest; while grain yields of all varieties except Champion White Pearl and Reid Yellow Dent were less than the general average of all samples. The length of season required for maturity had a more definite relation to the yield of stover than to the yield of grain. These relationships are in agreement with those noted for the Urbana varieties. The composition of the stover, and the yields of the varieties grown at Alhambra are shown in Table 11.

The Alhambra varieties, like those at Urbana, showed that the phosphorus content of stover is more variable than that of nitrogen; potassium, however, is the least instead of the most variable of the three. While most of the differences in the amount of calcium are probably not significant, the actual percentage of calcium in the stover was somewhat higher for all varieties on this field than on the Urbana field. This is also true for the percentage of potassium, which varied more widely in the stover of the medium-late varieties than of varieties of different maturing groups. A similar relationship was noted at Urbana.

Sommer Yellow Dent and Mohawk stover had the highest nitrogen content. The stover of Funk 176A contained the least amount of nitrogen, yet the grain yield of this variety was 8.7 bushels per acre less than Sommer Yellow Dent, while both stover and grain yields were much lower than those of Mohawk. Champion White Pearl yielded 1,145 pounds of stover and 20.1 bushels of grain per acre more than Funk 176A, and still its stover contained about 25 percent more nitrogen than the stover of Funk 176A. The stover of this variety, however, had the highest percentage of potassium, or an amount nearly 50 percent greater than that in Champion White Pearl, which had the lowest percentage. These data fail to show any definite relation between the nitrogen or potassium content and the yield of stover or the length of growing season; but they do indicate that the utilization of nitrogen and potassium is influenced considerably by variety.

The phosphorus content of the stover appeared to be associated more with the yield of grain than with the yield of stover. The highest yielders of grain, Champion White Pearl and Reid Yellow Dent, had the lowest amounts of phosphorus in the stover. The somewhat greater amount of phosphorus in Champion White Pearl stover, in spite of much higher grain and stover yields, would suggest that this variety was better able to assimilate phosphorus. This power, it seems, is especially associated with the late varieties since Black Hawk and Mohawk, which had the highest amounts of phosphorus in the stover, both yielded more grain and stover than either Funk 176A or Krug.

Varieties Grown at DeKalb

The varieties grown at DeKalb, unlike those at Urbana and Alhambra, showed no definite relationship between the length of season and the yield of stover. Stover yields were low for all varieties grown on Saybrook silt loam on this field with the exception of Golden Glow, and for Western Plowman, grown on Saybrook silt loam, deep phase. The data on composition of stover and also on yield for varieties at DeKalb are given in Table 12.

The nitrogen content of the stover of the DeKalb varieties varied between wide limits. Four varieties, requiring widely different lengths of season for maturity, had essentially the same nitrogen content but varied greatly in yield. This fact indicates that differences in the ability of these varieties to utilize nitrogen may offer an explanation for the same percentage composition but a much greater removal of nitrogen by some varieties than others. The wide difference in the nitrogen content of Golden Glow stover in comparison with that of Minnesota 13 and Rustler is thought to be an evidence of the effect of soil variation as well as the influence of variety. The significance of soil differences on the composition of stover, shown by comparing the two Western Plowman samples, is discussed on pages 216 to 218.

Based on the phosphorus content of their stover, the DeKalb varieties fall into four groups: (1) Reid Yellow Dent and Funk 90-Day; (2) Sommer Yellow Dent, Golden Glow and Western Plowman (on Saybrook silt loam, deep phase); (3) Western Plowman and Krug; and (4) Minnesota 13 and Rustler. The differences between Groups 1 and 2, also Groups 2 and 3, are not significant. The early varieties, which yield more grain than the medium-late varieties, contained much less phosphorus in their stover, but these differences must be attributed to both soil and varietal influences. It would appear that the stover of Minnesota 13 and Rustler was somewhat depleted of its phosphorus by the much greater grain yields.

Of the three medium-early varieties, Funk 90-Day seems to possess greater capacity than either Krug or Western Plowman to utilize phosphorus, for while it yielded 40 percent more grain, the phosphorus content of its stover was 20 percent higher. A comparison of Samples 29 and 34, representing the same variety but different soil types, would indicate that the absorption of phosphorus is undoubtedly affected by the character of the soil. The stover of Western Plowman when grown on the deep phase of Saybrook silt loam contained .012 percent more phosphorus, even tho yields were almost doubled, than that of the same variety on Saybrook silt loam.

The stover of Rustler, a variety of early maturity, contained 1.02 percent of potassium. This amount is not only very high in comparison with that of other varieties, but also nearly double the average amount for all samples of stover analyzed. When compared with the other early-maturing varieties, Golden Glow and Minnesota 13, the stover of Rustler had 2 to 2½ times as much potassium. These early varieties, however, showed wide differences in their capacity to produce, especially grain, but it is doubtful if the differences in yield are sufficient to account entirely for the variation in potassium shown. Exclusive of Rustler, the potassium content of stover at DeKalb was generally much lower than is indicated by the data in Tables 10 and 11 for varieties at Urbana and Alhambra.

With the exception of one sample each of Western Plowman and Reid Yellow Dent, the calcium content of stover for the varieties grown at DeKalb was almost identical. Western Plowman contained .23 percent and Reid Yellow Dent .37, both values being significantly different from that of the other varieties grown on this field. In general, the data for calcium are practically the same as those at Urbana, but somewhat lower than those reported for stover grown at Alhambra.

Varieties Grown at Toledo

Corn in the variety trials on the Toledo field was small and stunted. The character of the soil, Cisne silt loam, together with the comparatively low content of nitrogen in the stover, would suggest that the low yields might possibly be attributed, at least in part, to a nitrogen deficiency quite as well as to "potash starvation," which is commonly mentioned as a cause of low yields on this soil. Potassium fertilizers when used on this soil, however, are very effective in increasing yields.

Data for varieties grown at Toledo, given in Table 13, show that the nitrogen content of stover was much more variable than the phosphorus content. This is a converse relationship to that noted for varieties on three other fields. The nitrogen content of the Stanley White stover was almost double that of Calico, a difference too great to be accounted for by the comparatively small differences in yields, especially of stover. Differences in the phosphorus content of stover for all varieties except Champion White Pearl were too small to be significant. A comparison of the two late-maturing varieties indicates that the amount of phosphorus in the stover had an indirect relation to yield of grain.

The range in the amount of potassium for different stover samples was as great as the range shown for varieties at Urbana, while that of calcium was even greater. In most cases the percentage of either element was considerably less than the amount contained in the stover of the Alhambra varieties but only slightly different from that in the stover varieties at DeKalb. The composition of stover for Calico should be noted particularly, since this variety in outyielding the others still maintained a large reserve of nutrients, except nitrogen, in its stover. In having stover with the lowest nitrogen percentage but the highest potassium, together with the greatest yields, Calico stands out as a variety which apparently either lacks the ability to utilize nitrogen or has an unusual capacity to assimilate potassium.

A similar situation was noted previously for Funk 176A at Alhambra, where it was a low yielder. However, in comparison with Calico, the yields of Funk 176A were greater by 14.9 bushels of grain and 619 pounds of stover per acre, yet its stover was richer in nutrients by .25, .022, .15, and .09 percent of nitrogen, phosphorus, potassium, and calcium respectively. In this instance the differences in composition of stover, also in yields, are not merely the influence of variety. This may, in fact, be less important than the effect of soil character in causing the differences reported.

Composition in Relation to Yields

The comparative yields of grain and stover in relation to the nitrogen, phosphorus, potassium, and calcium content of the mature stover of the varieties grown at Urbana, Alhambra, DeKalb, and Toledo are shown in Figs. 3, 4, 5, and 6 respectively. In these graphs the varieties are arranged according to stover yield rather than in numerical order. On each field the varieties not only fluctuated widely in yields, but also showed tremendous differences in the ratio of stover to grain. Stover yields, in comparison with yields of grain, were apparently more variable at Urbana and less variable at DeKalb. At Alhambra and Toledo this variation in yields was not marked.

The amount of nitrogen in mature corn stover exceeded the amount of potassium, and potassium was followed in descending order by calcium and phosphorus. It will be noted, however, that the stover of three varieties (Funk 176A at Alhambra, Rustler at DeKalb, and Calico at Toledo) contained more potassium than nitrogen, while the stover of three other varieties (Reid Yellow Dent at DeKalb, also Mohawk and Stanley White at Toledo) contained more calcium than potassium. In the stover samples of the different varieties analyzed, the percentage of phosphorus was generally more variable than that of nitrogen. Both phosphorus and nitrogen ordinarily varied less than did potassium, while calcium showed the least variation of the four elements studied.

The graphs indicate that the nitrogen, phosphorus, and calcium contents of the stover followed the same general trend in the varieties at Urbana and DeKalb but not at Alhambra. The amounts of nitrogen and of potassium in the stover also appeared frequently to bear an inverse relation to each other; this relation, however, being less consistent for stover varieties at Urbana than for those on other fields.

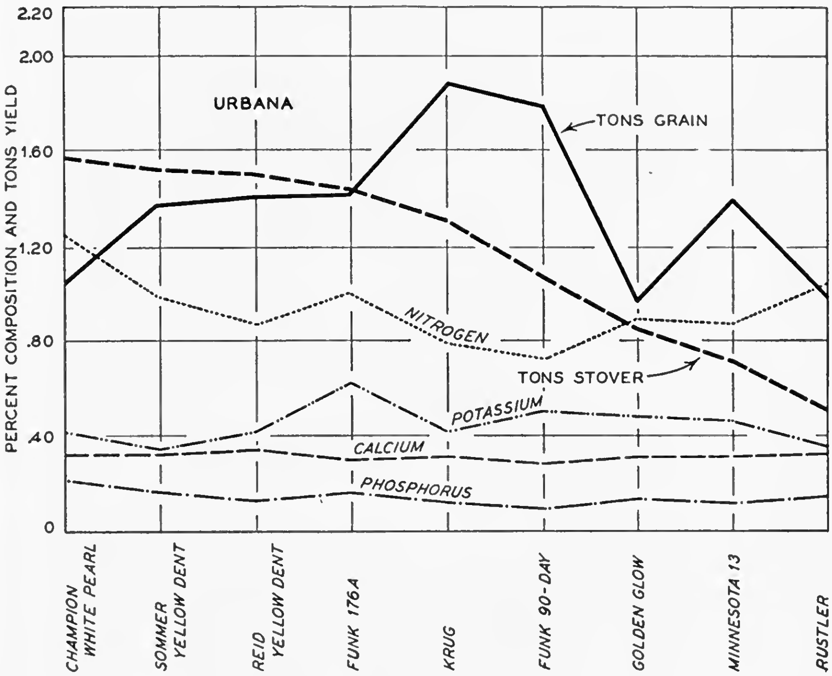

FIG. 3.—COMPOSITION OF MATURE CORN STOVER OF DIFFERENT VARIETIES IN RELATION TO STOVER AND GRAIN YIELDS, URBANA, SOUTH FARM
(See also Table 10)

At DeKalb the composition of stover seemed to bear no definite relation to either stover or grain yields, while at Urbana it appeared to be correlated negatively with yield of grain rather than yield of stover. A similar relationship, except for the nitrogen content, is apparent for the Alhambra varieties.

Corn varieties grown under similar conditions exhibit marked differences in their physical make-up. Variations in the size of stalks and the proportion of stalks to leaves are especially important in affecting the yield of stover. Snyder,[18*] in studying the protein content of forage crops, states that "corn stover varies widely in composition . . . . depending upon the density of the stalk and the proportion of leaves present." In other words, the composition of corn stover is variable because of varietal differences; altho the composition of the same variety may vary when grown under different environments.

The differences among varieties in composition of stover can be attributed chiefly to two factors: first, differences in yield and, second, differences in their ability to utilize nutrients. The interrelation of

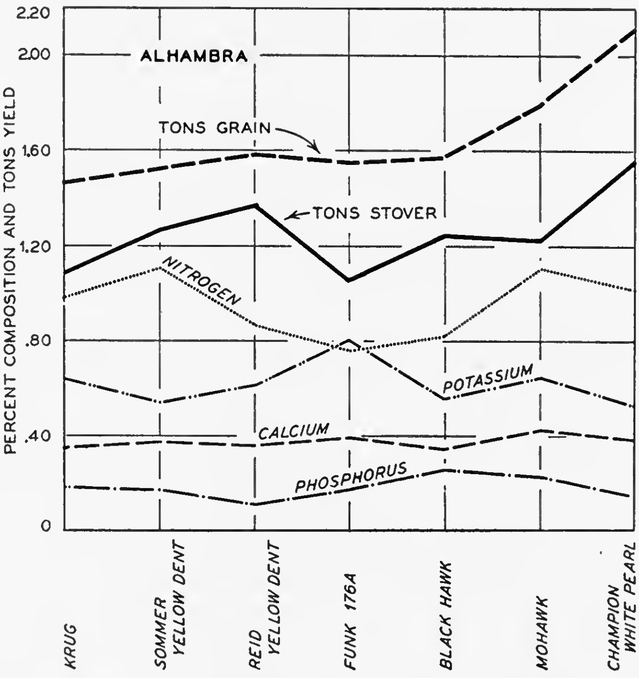

FIG. 4.—COMPOSITION OF MATURE CORN STOVER OF DIFFERENT VARIETIES IN RELATION TO STOVER AND GRAIN YIELDS, ALHAMBRA
(See also Table 11)

these factors is, however, recognized, for any factor which affects yield influences stover composition. In these studies variation in yield and in composition of the stover of different varieties on the same field must be accounted for primarily by varietal differences. Certain varieties appear to have greater power to assimilate nutrients than others. Varietal differences in the utilization of nutrients would no doubt affect yield, and therefore exert both a direct and an indirect influence on the composition of stover. The larger amount of nutrients in the stover of some varieties than others would indicate either that the intake of nitrogen or phosphorus, for example, was perhaps in excess of what was actually needed for growth, or that the translocation of nutrient materials from the vegetative parts of the plant in the formation and development of the ear was less complete. Unless the composition of corn grain is more variable than shown by various investigations, the emphasis must be placed on greater absorption of nutrients.

In some cases the yield and composition of stover bear an inverse relation to each other, since high yields of stover are commonly, tho

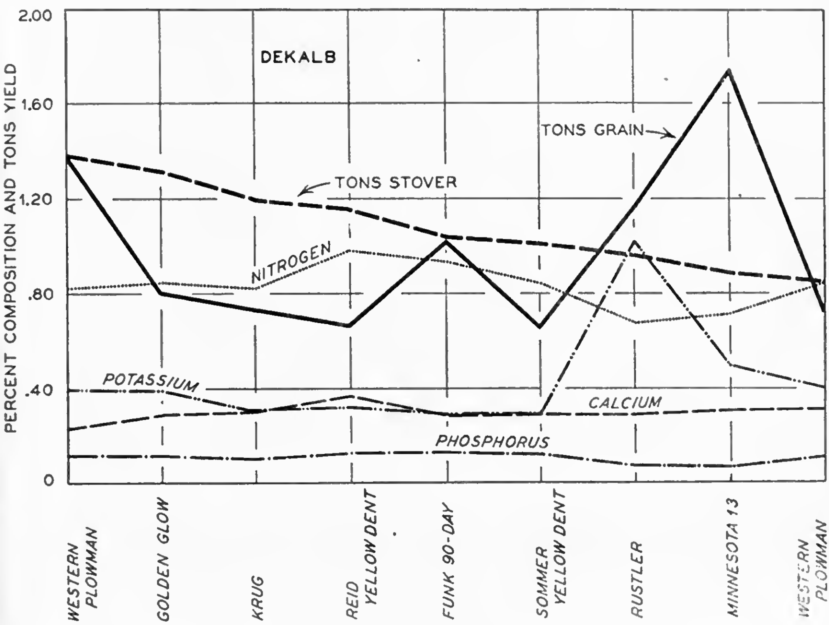

FIG. 5.—COMPOSITION OF MATURE CORN STOVER OF DIFFERENT VARIETIES IN RELATION TO STOVER AND GRAIN YIELDS, DEKALB
(See also Table 12)

not always, associated with low percentage composition, and vice versa. It must be remembered in this connection that the yield of stover, as well as its composition, determines the total amount of nutrients extracted from an acre. Thus the total removal of nutrients in the stover is not reflected by merely noting the percentage composition.

The wide variations in the percentages of nitrogen, phosphorus, and potassium are in contrast to the rather uniform calcium content of stover for different varieties. As previously noted, variations in the composition of stover are affected greatly by yields; altho there appears to be little or no relation between composition and length of season required for maturity. Based on the analyses of the separated parts of stover given in the Appendix, the nitrogen content of leaves is usually greater than that of stalks for most varieties. The stalks of the Urbana and Alhambra varieties, however, generally contained more phosphorus than did the leaves, altho the actual differences were rather small. This

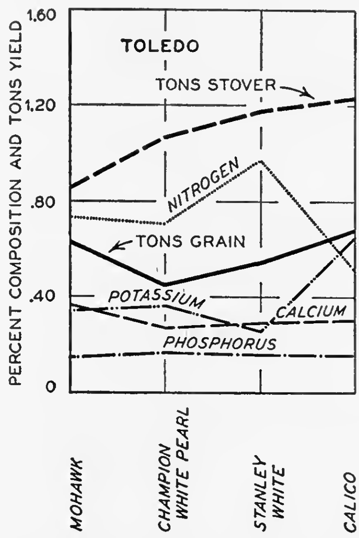

Fig. 6.—Composition of Mature Corn Stover of Different Varieties in Relation to Stover and Grain Yields, Toledo
(See also Table 13)

difference with reference to the occurrence of nitrogen and phosphorus in the leaves and in the stalks was probably due to the greater translocation of the phosphorus from the leaves to the developing grain. At DeKalb and Toledo, where grain yields were low, the phosphorus content of leaves was as great as or greater than that of stalks in all cases except two.

The soil conditions under which the varieties were grown appeared to exert a strong influence on the relative distribution of calcium and potassium in the separated parts of the stover. For all varieties of stover at Alhambra and Toledo the amount of calcium was higher in the leaves than in the stalks, while the reverse was always true for potassium. But on the younger and more fertile soils at Urbana and DeKalb, to which no limestone had been applied, the calcium content was consistently greater for the stalks than for the leaves, while in most cases the amount of potassium in the leaves exceeded that in the stalks. Only in the stover of Funk 90-Day and Funk 176A at Urbana and Rustler at DeKalb was the percentage of potassium significantly higher in the stalks than in the leaves.

Same Varieties Grown Under Different Conditions

Comparative data on yields and on the composition of stover for the same varieties grown under different conditions are reported in Tables 14, 15, and 16. To the differences in soil type and treatment, which are shown, should be added differences in climate which are known to exist but have not been measured. Since the relative influence of these various factors is not determinable for this work, the observed differences in yield and composition of stover must necessarily be attributed to the composite effect of climatic and soil factors.

Same Varieties at Urbana and Alhambra

Based on the average analyses of five varieties, the composition of mature corn stover was practically the same, except for potassium, at Urbana and Alhambra (Table 14). A comparison of analyses for an individual variety, however, reveals some important differences in composition which appear to be closely related to yields. The percentage composition of stover tends to bear a more definite relation to the yield of grain than to the yield of stover. In most cases in these tests the correlation between composition of stover and yield of grain was negative rather than positive since the higher yields of grain were usually associated with a lower percentage of the various nutrients in the stover for each variety.

In general, stover yields were greater, but grain yields less, at Alhambra than at Urbana, and as a result the stover-grain ratio was increased for all varieties except Champion White Pearl. Differences in the physical make-up of the stover on the two fields are indicated by the percentage of leaves, which was consistently higher at Alhambra. These fluctuations in yields, due to change in environment, were accompanied by marked differences in the composition of the stover. When grown at Alhambra, the stover of each variety contained higher percentages of potassium and calcium than did the same variety grown at Urbana, but the percentages of nitrogen and phosphorus were greater for only two or three varieties.

When the varieties grown at Alhambra are compared with the same individual varieties grown at Urbana, it is found that those of the medium-late-maturing group exhibit less pronounced differences in yields and in composition of stover than either the medium-early or the

TABLE 14.—COMPARISON OF FIVE VARIETIES OF CORN GROWN BOTH AT URBANA ON CARRINGTON SILT LOAM AND AT ALHAMBRA ON PUTNAM SILT LOAM, WITH RESPECT TO COMPOSITION OF MATURE STOVER

(*Treatment:* Urbana—residues and rock phosphate. Alhambra—residues, limestone, and rock phosphate)

Sample No.[a]	Variety	Composition of stover				Yield per acre		Leaves
		N	P	K	Ca	Stover	Grain	
		%	%	%	%	*lbs.*	*bu.*	%
1	Champion White Pearl	1.25	.219	.41	.32	3 143	42.0	24.9
24	Champion White Pearl	1.01	.142	.53	.38	4 227	62.0	31.1
2	Sommer Yellow Dent	.99	.166	.34	.32	3 044	54.8	25.7
19	Sommer Yellow Dent	1.11	.171	.54	.38	3 043	50.6	26.5
3	Reid Yellow Dent	.87	.127	.41	.34	3 006	56.6	26.9
20	Reid Yellow Dent	.87	.112	.61	.36	3 170	54.9	29.0
5	Funk 176A	1.00	.163	.62	.30	2 872	56.9	24.5
21	Funk 176A	.76	.177	.80	.39	3 082	41.9	25.4
6	Krug	.79	.121	.41	.31	2 611	75.1	23.4
18	Krug	.98	.189	.64	.35	2 919	43.3	29.6
	Average at Urbana	.98	.159	.44	.32	2 935	57.1	25.1
	Average at Alhambra	.95	.158	.62	.37	3 288	50.5	28.3

[a]The first of each pair of samples is from Urbana, the second from Alhambra.

TABLE 15.—COMPARISON OF SEVEN VARIETIES OF CORN GROWN BOTH AT URBANA ON CARRINGTON SILT LOAM AND AT DEKALB ON SAYBROOK SILT LOAM, WITH RESPECT TO COMPOSITION OF MATURE STOVER

(*Treatment:* residues and rock phosphate)

Sample No.[a]	Variety	Composition of stover				Yield per acre		Leaves
		N	P	K	Ca	Stover	Grain	
		%	%	%	%	lbs.	bu.	%
2	Sommer Yellow Dent	.99	.166	.34	.32	3 044	54.8	25.7
28	Sommer Yellow Dent	.84	.118	.29	.28	1 995	26.1	23.5
3	Reid Yellow Dent	.87	.127	.41	.34	3 006	56.6	26.9
27	Reid Yellow Dent	.98	.128	.32	.37	2 295	26.4	22.3
4	Funk 90-Day	.72	.091	.50	.28	2 147	71.6	25.8
30	Funk 90-Day	.93	.128	.29	.28	2 069	40.4	19.4
6	Krug	.79	.121	.41	.31	2 611	75.1	23.4
31	Krug	.82	.107	.31	.30	2 381	29.2	20.0
9	Golden Glow	.89	.134	.48	.31	1 705	38.9	27.4
32	Golden Glow	.85	.115	.39	.29	2 618	32.1	26.1
7	Rustler	1.04	.141	.35	.32	1 018	39.3	28.1
35[b]	Rustler	.67	.076	1.02	.28	1 900	46.3	23.7
8	Minnesota 13	.87	.114	.46	.31	1 432	55.6	32.3
33[b]	Minnesota 13	.71	.069	.49	.31	1 762	69.1	26.7
	Average at Urbana	.88	.128	.42	.31	2 137	56.0	27.1
	Average at DeKalb	.83	.106	.44	.30	2 146	38.5	23.1

[a]The first of each pair of samples is from Urbana, the second from DeKalb. [b]Samples 35 and 33 are from a deep phase of Saybrook silt loam.

TABLE 16.—COMPARISON OF THREE VARIETIES OF CORN GROWN AT URBANA, ALHAMBRA, AND DEKALB, WITH RESPECT TO COMPOSITION OF MATURE STOVER

Sample No.	Variety	Field	Treatment[a]	Composition of stover				Yield per acre		Leaves
				N	P	K	Ca	Stover	Grain	
				%	%	%	%	lbs.	bu.	%
3	Reid Yellow Dent	Urbana	RrP	.87	.127	.41	.34	3 006	56.6	26.9
20		Alhambra	RLrP	.87	.112	.61	.36	3 170	54.9	29.0
27		DeKalb	RrP	.98	.128	.32	.37	2 295	26.4	22.3
2	Sommer Yellow Dent	Urbana	RrP	.99	.166	.34	.32	3 044	54.8	25.7
19		Alhambra	RLrP	1.11	.171	.54	.38	3 043	50.6	26.5
28		DeKalb	RrP	.84	.118	.29	.28	1 995	26.1	23.5
6	Krug	Urbana	RrP	.79	.121	.41	.31	2 611	75.1	23.4
18		Alhambra	RLrP	.98	.189	.64	.35	2 919	43.3	29.6
31		DeKalb	RrP	.82	.107	.31	.30	2 381	29.2	20.0

[a]RrP = residues and rock phosphate. RLrP = residues, limestone, and rock phosphate.

late variety. A comparison of Sommer Yellow Dent and Funk 176A, however, shows that the response of varieties requiring the same length of season for maturity may be quite different when the environment is changed. Reid Yellow Dent, for example, requires 125 days from planting to denting as compared with 135 and 115 days respectively for Champion White Pearl and Krug. The stover of Reid Yellow Dent when grown at Alhambra contained practically the same amounts of nitrogen and calcium, slightly less phosphorus, but considerably more potassium than when grown at Urbana; while the differences for either Champion White Pearl, a later variety, or Krug, an earlier variety, were much greater not only in yields, but also in the nutrient content of the stover.

Same Varieties at Urbana and DeKalb

Comparisons of the same varieties grown at Urbana and at DeKalb are given in Table 15. The yield of stover was less at DeKalb for all except the early varieties; this reduction was marked with the medium-late varieties but only slight with the medium-early varieties. Grain yields were also greatly decreased except for Minnesota 13 and Rustler, which were grown on a more productive soil. All varieties grown at DeKalb showed a lower percentage of leaves and, with the exception of Minnesota 13, a greater stover-grain ratio than when grown at Urbana.

On the basis of yields DeKalb seemed more favorable for the early varieties, altho with Golden Glow the greater yield increase in stover was made at the expense of the grain. Differences between the yields of Funk 90-Day when grown at DeKalb and when grown at Urbana were less marked than those for Krug, but the yield of stover of either medium-early variety was not reduced at DeKalb as much as was that of the medium-late varieties, Sommer Yellow Dent and Reid Yellow Dent. The grain yields of these medium-late varieties however, were lowered more than the grain yield of Funk 90-Day but less than that of Krug.

The stover of Sommer Yellow Dent and the early varieties contained a lower percentage of nitrogen when grown at DeKalb than when grown at Urbana. The greater decrease in the nitrogen content of Rustler was undoubtedly due to the much larger increase in stover yield. With Reid Yellow Dent, Funk 90-Day and Krug, the greater nitrogen content of stover is out of proportion to the smaller yields.

All varieties except Reid Yellow Dent and Funk 90-Day, when grown at DeKalb had a lower phosphorus content of stover than at Urbana; the reductions in phosphorus content of 40 and 45 percent respectively for the stover of Minnesota 13 and Rustler were relatively greater than the increases in yields, especially of grain, of these two varieties. The stover of Funk 90-Day, a medium-early variety which at DeKalb produced 31.2 bushels less grain with no significant difference in yield of stover, contained 40 percent more phosphorus. On the other hand, the stover of the medium-late varieties, in spite of their marked reductions in yields, had no higher phosphorus content; in fact the stover of Sommer Yellow Dent had 30 percent less phosphorus at DeKalb than at Urbana.

The percentages of potassium and calcium in the stover of most varieties were lower when grown at DeKalb. Differences in the calcium content are perhaps too small to be significant, except for the stover of Sommer Yellow Dent and Rustler. The variations for potassium are, however, greater and represent real differences in composition. The response of Rustler to the conditions on the DeKalb field was exceptional. Despite much greater yields of stover and grain, the potassium content of stover for this variety at DeKalb was almost treble that at Urbana, even tho the amounts of nitrogen and phosphorus and also of calcium were markedly lower.

Same Varieties at Urbana, Alhambra, and DeKalb

Further study of the influence of environment on yields and on the composition of stover can be made from the data given in Table 16.

The relative length of season required for maturing these varieties is indicated by the respective number of days—125, 120, and 115—from planting to denting. With all varieties the percentage of leaves, also the yield of stover, was highest at Alhambra and lowest at DeKalb. Grain yields, however, were considerably higher at Urbana than Alhambra, while yields at DeKalb were only about half as great as those at Alhambra. Killing frosts around September 25, while not causing serious damage, no doubt interfered with the further development of the corn, especially on the DeKalb field, where the corn was planted one week later than at Urbana and 18 days later than at Alhambra.

Different varieties on the same field showed practically as much variation in composition of stover as the same variety showed when grown on different fields. This does not mean that differences associated with variety are greater than differences due to the combined influence of climate, soil type, and treatment; but rather it shows that much of the modification in yield and in composition of stover, with a change in environment, may be due to variety.

Forbes and associates,[7*] in discussing the mineral analyses of foods, note that "the inorganic products vary remarkably in accordance with the conditions of growth, especially as relating to soil, rainfall, and sunshine, also rapidity of growth and stage of maturity attained. The variation in organic constituents, however, is very much less than in mineral elements."

The Alhambra, DeKalb, and Urbana fields represent widely different soil and climatic conditions, some of which are noted on pages 188 to 196. Putnam silt loam, which occurs on the Alhambra field, is medium dark in color, strongly acid, and has an impervious subsoil that precludes satisfactory underdrainage. Unless weather conditions, especially with reference to rainfall, are unusually favorable, this soil is less productive, even with treatment, than either Saybrook silt loam at DeKalb or Carrington silt loam at Urbana. The continued use of limestone on the Alhambra field makes possible the use of sweet clover as a green-manure crop.

Saybrook and Carrington soils are both dark colored, well drained, and only medium acid in reaction, as they grow red clover without limestone in favorable clover years. Differences in the productive capacity of the soils on the three fields are, no doubt, affected to some degree by climatic conditions. Of the climatic factors the amount and distribution of rainfall, also length of growing season, are known to be important; other important climatic differences no doubt exist, altho specific information concerning them is not available.

Alberts,[1*] in studying the relation of time of planting corn to the time of silking, denting, and senescence, found that the early-maturing varieties develop more readily in cool weather than the late varieties and require a shorter time to reach the silk stage; moreover the leaves of the early-maturing varieties were found to dry up sooner after denting than those of the late-maturing varieties. The period from silking to denting, however, was approximately the same for all varieties even tho they required a variable growth period prior to silking. These observations help to explain differences in the adaptations of different varieties on the same field, also in the response of the same varieties on different fields.

The actual length of growing season—that is, from planting to the first killing frost in fall—at Alhambra was one week longer than at Urbana and nearly three weeks longer than at DeKalb. This represents the approximate differences in corn-planting dates on these fields in 1928. Average temperatures are highest at Alhambra, intermediate at Urbana, and lowest at DeKalb. Late-maturing varieties are best adapted to Alhambra, intermediate to Urbana, and early to DeKalb. The percentage of leaves, the yield of stover, and the proportion of stover to grain of all varieties were generally higher at Alhambra but lower at DeKalb, when compared with the same varieties grown at

Urbana; the only exceptions were that the stover-grain ratio for the late variety decreased at Alhambra, while the stover yields of the three early varieties increased at DeKalb.

In studying the relation of rainfall to yield of corn, Voorhees[20*] concludes that "effective rainfall is not a function of total rainfall (except when the latter is the limiting factor), but depends entirely upon the condition of the soil and the capacity of the crop for utilizing water." The total and monthly distribution of rainfall from April 1 to September 30 in 1928 is shown in Fig. 2. While the total rainfall was undoubtedly sufficient on all three fields, the distribution at DeKalb was somewhat unfavorable for corn. From April 15 to June 10 there was an actual shortage of rain, and from June 10 to July 5 an excessive amount.

Ordinarily corn suffers severely from drouth on Putnam silt loam unless rainfall is generous and well distributed thruout the growing season. In 1928 the rainfall at Alhambra was not only more than average for the season, but nearly 50 percent greater than the average during June, July, and August, and only two rainless periods of more than 10 days duration occurred in those three months. Probably the more serious of these was the one of 24 days which followed 3.5 inches of rain and extended from July 7 to 31. The relative effect of such a period on different corn varieties planted the same date would no doubt be markedly different since they would not likely be in the same stage of development, or at the same critical period, when water was deficient.

EFFECT OF SOIL TYPE AND FERTILIZER TREATMENT ON COMPOSITION OF MATURE CORN STOVER

It is a matter of common knowledge that soil types vary tremendously in productive capacity, and also that an individual type varies within limits in this respect, depending on the system of cropping and treatment as well as on seasonal conditions, which frequently vary considerably within short distances. What relation, if any, these differences in the producing capacity of a given soil type, whatever the cause, bear to the composition of mature corn stover was the chief problem in this phase of the work.

While Illinois is characterized by a humid temperate climate, the seasonal conditions prevailing in different parts of the state are rather variable. This fact makes it very difficult to study the effect of soil types thruout the area of their occurrence on the composition of corn stover. Thus, in many cases, comparisons of samples representing different soil types are not justified. On the other hand, widely different soil types ordinarily do not occur on the same experiment field, where they would likely be under the same seasonal conditions of rainfall, temperature, and other climatic factors. In the few cases where both soil and climatic conditions are similar for two experiment fields, comparable studies on the composition of corn stover could not be made because of the use of different corn varieties or soil treatments, or both. Reference to the specific conditions represented by the samples studied will therefore be made in connection with the data reported.

Effect of Different Soil Types Under Same Climatic Conditions

The effect of soil type on the composition of corn stover is shown by the data in Table 17. Each consecutive pair of samples was collected from different soil types on the same field. Since the variety and treatment, as well as the climatic conditions, are the same for each comparison, the differences in composition of stover, also in yields, represent the influence of soil type.

The apparent differences between Saybrook silt loam and the deep phase of this type on the DeKalb field are not very pronounced. Except for variations in depth, the descriptions of these two soils are almost identical. While the yields on the Saybrook silt loam, deep phase were greater by 1,065 pounds of stover and 26 bushels of grain per acre, the composition of the stover was not significantly different, except for calcium, from that grown on the Saybrook silt loam. The data for Samples 29 and 34 would indicate that while the soil type had a marked effect on yields, it had practically none in this case on the composition of stover. It should be noted, however, that the soil types compared are very similar in character.

The second comparison in Table 17 is between untreated soils, Drummer clay loam and Sidell silt loam, on the Sidell field. Drummer clay loam is rich in total nutrients, has a high content of available phosphorus, and requires no limestone to grow sweet clover. This soil yielded 1,514 pounds more stover and 20.2 bushels more grain per acre than Sidell silt loam, which is less fertile, lower in available phosphorus, and more acid in reaction. The stover grown on the Drummer clay loam contained .03 percent less nitrogen but more phosphorus, potassium, and calcium by .033, .48, and .03 percent respectively than the stover grown on the Sidell silt loam. These differences in composition, except that for calcium, are no doubt significant. Furthermore it appears that both phosphorus and potassium were assimilated in amounts greater than needed, or that growth was limited by the supply of available nitrogen.

TABLE 17.—INFLUENCE OF SOIL TYPE ON COMPOSITION OF MATURE CORN STOVER: DEKALB AND SIDELL FIELDS

Sample No.	Soil type	Composition of stover				Yield per acre	
		N	P	K	Ca	Stover	Grain
DeKalb field: Western Plowman, plots received residues and rock phosphate							
		%	%	%	%	*lbs.*	*bu.*
29	Saybrook silt loam	.84	.104	.40	.31	1 690	28.9
34	Saybrook silt loam, deep phase	.82	.116	.39	.23	2 755	54.9
Sidell field: Reid Yellow Dent, no treatment							
120	Drummer clay loam	.83	.115	.79	.24	3 620	40.8
121	Sidell silt loam	.86	.082	.31	.21	2 106	20.6

TABLE 18.—INFLUENCE OF SOIL TYPE ON COMPOSITION OF MATURE CORN STOVER: ALEDO, LAMOILLE, AND MINONK FIELDS
(*Variety:* Will County Favorite)

Sample No.	Soil type	Field	Composition of stover				Yield per acre	
			N	P	K	Ca	Stover	Grain
No treatment								
			%	%	%	%	*lbs.*	*bu.*
36	Grundy silt loam	Aledo	.78	.076	.58	.42	2 199	54.4
89	Muscatine silt loam	LaMoille	.62	.083	.85	.36	2 127	56.0
94	Grundy clay loam	Minonk	.52	.074	.60	.30	1 517	47.3
Residues, limestone, rock phosphate								
39	Grundy silt loam	Aledo	.57	.108	.67	.28	2 092	73.4
92	Muscatine silt loam	LaMoille	.96	.125	.58	.36	3 002	69.1
97	Grundy clay loam	Minonk	.75	.070	.40	.26	2 311	72.0

The soil types included in Table 18 occur on different experiment fields, hence under somewhat different climatic conditions. The differences in composition of stover, also yields, therefore cannot be accounted for merely by soil type but are due to both soil and climatic factors. Since the relative influence of each group of factors is not known, nor determinable for this work, the data in Table 18 are of little or no value in showing the specific effect of soil type on the composition of stover. They are therefore presented without discussion, excepting to say that the residues, limestone, and rock phosphate treatment not only increased yields but also modified the composition of the stover.

Effect of Single Materials in Standard Treatments

Residues (R over Check)

The so-called standard treatments, as noted previously on pages 192 and 193, are those for the grain system of farming and include: (1) residues; (2) residues and limestone; (3) residues, limestone, and rock phosphate; and (4) residues, limestone, rock phosphate, and kainit. To ascertain the effect of single materials on the composition of stover, samples from the residues-treated plots are compared with those from untreated plots; samples from the residues and limestone plots are compared with those from the residues plots, and so on. Thus the effect of limestone alone cannot be determined; this is also true for rock phosphate and kainit.

In addition to crop residues, such as cornstalks and straw[a] from wheat, oats, and clover, the residues-treated plots received the second crop of clover. Furthermore a leguminous green-manure crop, usually sweet clover, was seeded in the wheat on these plots to be plowed down for corn. Success with clovers, however, is rather variable, depending on the reaction of the soil type. Table 7 reports the clover growth without limestone on the soil types represented by the stover samples collected from the respective fields. Oblong and Toledo grow neither red nor sweet clover without limestone; Urbana (Davenport plots), Aledo, Joliet, Kewanee, Mt. Morris, and Sidell grow red but no sweet clover; while Carthage, Hartsburg, LaMoille, and Minonk grow sweet clover on the unlimed residues plots.

A comparison of the composition of stover, also yields of stover

[a]The return of oat and wheat straw was discontinued. On most fields this change was made in 1921 for oat straw and in 1922 for wheat straw except as noted: *oat straw* at Carthage in 1922, at Urbana (Davenport plots) in 1923, at Oblong and Toledo in 1925; *wheat straw* at Aledo, Urbana (Davenport plots), and Toledo in 1923.

TABLE 19.—EFFECT OF RESIDUES ON COMPOSITION OF MATURE CORN STOVER
(Consecutively numbered samples represent same soil type and corn variety)

Sample No.	Treat-ment[a]	Field	Composition of stover				Yield per acre	
			N	P	K	Ca	Stover	Grain
			%	%	%	%	*lbs.*	*bu.*
13	0	Urbana (Davenport plots)..	.73	.070	.53	.46	2 725	49.6
14	R		.77	.074	.56	.36	2 994	50.8
36	0	Aledo..................	.78	.076	.58	.42	2 199	54.4
37	R		.66	.167	1.14	.28	2 492	68.6
56	0	Carthage...............	.76	.077	.39	.34	1 706	37.8
57	R		.78	.065	.39	.27	1 734	54.8
65	0	Hartsburg..............	.55	.105	.57	.33	1 958	43.0
66	R		.74	.062	.66	.33	3 144	78.0
75	0	Joliet..................	1.03	.079	.38	.22	1 751	9.0
76	R		.86	.055	.36	.20	1 684	7.9
80	0	Kewanee...............	.83	.059	.88	.51	2 192	74.0
81	R		.59	.041	.68	.31	2 459	74.6
89	0	LaMoille...............	.62	.083	.85	.36	2 127	56.0
90	R		.78	.077	.35	.30	2 639	60.8
94	0	Minonk................	.52	.074	.60	.30	1 517	47.3
95	R		.64	.061	.58	.27	2 545	68.6
99	0	Mt. Morris.............	.68	.062	.55	.32	1 882	35.7
100	R		.67	.061	.40	.28	2 221	46.4
104	0	Oblong.................	.74	.074	.30	.24	1 188	22.8
105	R		.58	.058	.35	.25	1 621	23.6
121	0	Sidell..................	.86	.082	.31	.21	2 106	20.6
122	R		.90	.075	.40	.27	2 857	24.6
126	0	Toledo.................	.58	.122	.48	.32	2 231	21.0
127	R		.50	.091	.37	.24	2 510	26.0
	0	Average of all........	.72	.080	.54	.34	1 965	39.3
	R	Average of all........	.71	.074	.52	.28	2 408	48.7

[a]0 = no treatment. R = residues.

and grain grown on the check and residues plots, is shown in Table 19. For each consecutively numbered pair of samples the soil type and variety of corn are the same. The average increases in yields for residues over no treatment were 443 pounds of stover and 9.4 bushels of grain per acre; while the average decreases in the amounts of nitrogen, phosphorus, potassium, and calcium in the stover were for residues over no treatment .01, .006, .02, and .06 percent respectively. Of these differences in composition, only that for calcium is significant.

The effect of residues on yields, and on the composition of stover is also shown by Fig. 7, in which the differences of "residues" over "check" are plotted as plus or minus values for each field. The yield of grain and stover was increased by residues on all fields except Joliet. The increases, however, in grain at Urbana (Davenport plots), Kewanee, and Oblong, and in stover at Carthage were too small to be

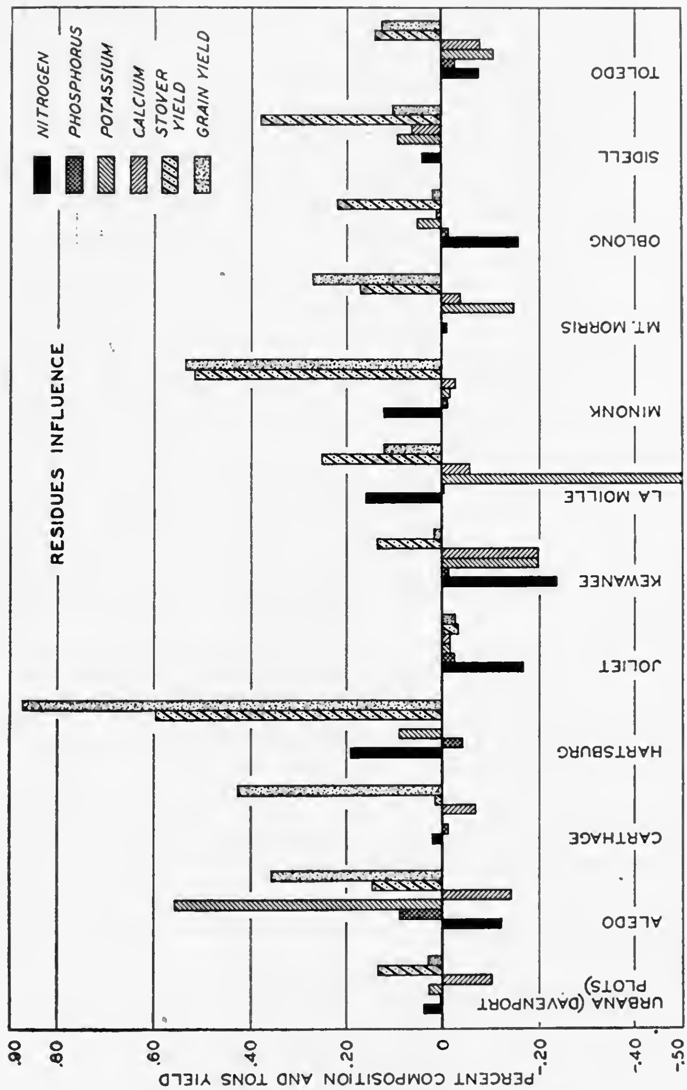

FIG. 7.—EFFECT OF RESIDUES ON COMPOSITION OF MATURE CORN STOVER AND ON YIELDS OF STOVER AND GRAIN: TWELVE ILLINOIS SOIL EXPERIMENT FIELDS

(Values = R over check)

significant. Of the twelve comparisons, six show an increase in the nitrogen content of stover, and six show a decrease, with one in each group differing .02 percent or less.

The greatest increases in the nitrogen content of stover for the residues treatment were obtained on those fields where the soil type will grow sweet clover on the residues plot, which has received no limestone. This is true especially for Grundy clay loam at Hartsburg, Drummer clay loam at Minonk, and to a lesser extent for Muscatine silt loam at LaMoille. While the nitrogen increase in stover was greater at LaMoille than Minonk, the increases in yields, both grain and stover, were very much smaller. The decreases in the percentage of nitrogen in the stover, except in that grown at Joliet, were associated with increases in yields, particularly of stover.

Ten of the twelve comparisons in Table 19 show a decrease in phosphorus content of stover, ranging from .001 to .043 percent, but these differences are significant in only five comparisons. At Hartsburg, where the yield of grain was increased 35 bushels per acre with residues, the decrease in the phosphorus content of the stover might be expected; but at Joliet, Kewanee, Oblong, and Toledo the differences in grain yields were much too small to account for the variation in phosphorus. These four fields also showed a decrease in the nitrogen content of stover grown on the residues plots.

With respect to potassium and calcium, definite changes in the composition of stover were shown in two-thirds of the comparisons between the residues and check samples. Residues, however, resulted in an increase of potassium three times and of calcium but once; the stover sample from late-planted corn at Sidell showing an increase in both potassium and calcium as well as nitrogen. At Aledo the potassium and phosphorus contents of stover from residues were double those from the check plot despite increased yields of stover and grain. Decreases in the amounts of potassium and calcium in the stover at Kewanee, LaMoille, Mt. Morris, Minonk, and Toledo, and of calcium at Aledo, Carthage, and Urbana were invariably associated with increased yields on the residues-treated plots.

Limestone (RL over R)

The initial application of limestone on all fields was at the rate of 4 tons to the acre, with 2 tons to the acre each rotation thereafter. This material was applied after plowing the clover sod for wheat. The total application of limestone on these fields has varied from 12,000 to 18,000 pounds to the acre, owing chiefly to differences in the length of time

TABLE 20.—EFFECT OF LIMESTONE ON COMPOSITION OF MATURE CORN STOVER
(Consecutively numbered samples represent same soil type and corn variety)

Sample No.	Treat-ment[a]	Field	Composition of stover				Yield per acre	
			N	P	K	Ca	Stover	Grain
			%	%	%	%	*lbs.*	*bu.*
14	R	Urbana (Davenport plots)..	.77	.074	.56	.36	2 994	50.8
15	RL		.99	.063	.81	.43	3 821	60.0
37	R	Aledo..................	.66	.167	1.14	.28	2 492	68.6
38	RL		.53	.196	1.01	.28	2 313	74.6
57	R	Carthage...............	.78	.065	.39	.27	1 734	54.8
58	RL		.75	.063	.38	.31	1 956	60.8
66	R	Hartsburg..............	.74	.062	.66	.33	3 144	78.0
67	RL		.76	.060	.66	.36	2 590	79.4
76	R	Joliet.................	.86	.055	.36	.20	1 684	7.9
77	RL		.91	.091	.32	.19	1 842	15.1
81	R	Kewanee................	.59	.041	.68	.31	2 459	74.6
82	RL		.67	.047	.65	.31	2 552	83.6
90	R	LaMoille...............	.78	.077	.35	.30	2 639	60.8
91	RL		.89	.101	.51	.30	3 057	67.3
95	R	Minonk.................	.64	.061	.58	.27	2 545	68.6
96	RL		.66	.063	.60	.22	2 343	70.6
100	R	Mt. Morris.............	.67	.061	.40	.28	2 221	46.4
101	RL		.71	.071	.47	.22	2 842	64.7
105	R	Oblong.................	.58	.058	.35	.25	1 621	23.6
106	RL		.67	.073	.44	.21	2 464	36.2
122	R	Sidell.................	.90	.075	.40	.27	2 857	24.6
123	RL		1.28	.101	.60	.29	3 240	32.5
127	R	Toledo.................	.50	.091	.37	.24	2 510	26.0
128	RL		.69	.078	.32	.29	2 468	30.6
	R	Average of all........	.71	.074	.52	.28	2 408	48.7
	RL	Average of all........	.79	.084	.56	.28	2 624	56.3

[a]R = residues. RL = residues and limestone.

the respective fields have been in operation rather than to differences in soil acidity or the lime needs of the crops grown.[a] No limestone, however, has been used since 1922 or 1923, when the regular applications of this material were temporarily discontinued until further need of it, as indicated by clover growth, should become apparent.

The effect of limestone on the composition of stover, also on grain and stover yields, is shown by Table 20 and Fig. 8.

The average increases in yield resulting from limestone are shown in Table 20 to have been 7.6 bushels of grain and 216 pounds of stover per acre. Altho the average composition of the stover grown on the

[a]For information as to the exact amount of limestone or other fertilizing materials applied to the individual plots from which the stover samples were collected, the reader is referred to Table 30 in the Appendix.

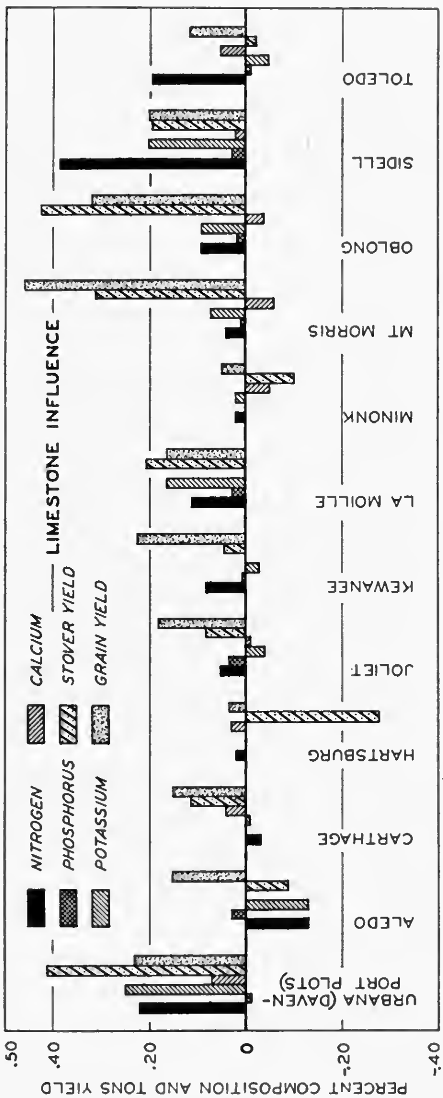

FIG. 8.—EFFECT OF LIMESTONE ON COMPOSITION OF MATURE CORN STOVER AND ON YIELDS OF STOVER AND GRAIN: TWELVE ILLINOIS SOIL EXPERIMENT FIELDS
(Values = RL over R)

residues-limestone plots was slightly higher than that from the residues plots, the only significant difference was in the nitrogen content.

Yields of grain were increased on all fields; those of stover on all except four. At Aledo and Toledo the decline in stover yields that was associated with the use of limestone was less pronounced, while the increase in grain yields was more marked than at either Hartsburg or Minonk. The soil types which occur on the Hartsburg and Minonk fields (Grundy clay loam and Drummer clay loam) are naturally well supplied with carbonates, so that the addition of limestone might be expected to have little or no value. Its influence on these two soils was not beneficial so far as yields, especially of stover, were concerned; while on neither soil was the composition of the stover changed appreciably by the limestone. Apparently it did not lessen the availability of the native phosphorus. No explanation can be given for the significant decrease in the nitrogen and potassium contents of stover at Aledo.

Rock Phosphate (RLrP over RL)

Rock phosphate has been used at the annual acre-rate of 500 pounds once each rotation before plowing the clover sod for wheat. The total applications of this material were evened up to 4 tons an acre, except on the Davenport plots, where they were equivalent to 13,200 pounds when discontinued. This occurred in 1923 at Hartsburg, LaMoille, Minonk, Mt. Morris, and Sidell; in 1924 at Aledo, Carthage, and Oblong; in 1925 at Urbana (Davenport plots) and Toledo; in 1926 at Joliet, and in 1928 at Kewanee.

The soil types occurring on these experiment fields show marked differences in their phosphorus content. The surface 6⅔ inches varies in phosphorus content from .035 percent in the Cisne silt loam at Toledo to .098 percent in the Drummer clay loam at Sidell. The variation for other strata is somewhat less. Of greater importance than the total content of phosphorus, however, is the amount of available phosphorus which, as determined by the Bray test for the untreated soils, is shown in Table 7. Those at Hartsburg and Minonk are ranked "high" in available phosphorus, those at Aledo and LaMoille as "medium," and those at the remaining fields as "low." The tests indicated somewhat smaller amounts of available phosphorus for the soil types at Joliet, Toledo, and Oblong than others in the low group.

Rock phosphate increased yields only slightly, 233 pounds of stover and 3.5 bushels of grain per acre, as an average on twelve fields. However, the percentages of both nitrogen and phosphorus in the stover were raised considerably with no marked change in the content of potassium and calcium. These results are shown in Table 21 and Fig. 9.

TABLE 21.—EFFECT OF ROCK PHOSPHATE, WHEN USED WITH LIMESTONE, ON COMPOSITION OF MATURE CORN STOVER
(Consecutively numbered samples represent same soil type and corn variety)

Sample No.	Treatment[a]	Field	Composition of stover				Yield per acre	
			N	P	K	Ca	Stover	Grain
			%	%	%	%	*lbs.*	*bu.*
15	RL	Urbana (Davenport plots)..	.99	.063	.81	.43	3 821	60.0
16	RLrP		1.11	.131	.88	.52	4 204	73.6
38	RL	Aledo....................	.53	.196	1.01	.28	2 313	74.6
39	RLrP		.57	.108	.67	.28	2 092	73.4
58	RL	Carthage................	.75	.063	.38	.31	1 956	60.8
59	RLrP		.71	.064	.33	.26	2 184	61.7
67	RL	Hartsburg...............	.76	.060	.66	.36	2 590	79.4
68	RLrP		.90	.064	.62	.37	3 344	82.0
77	RL	Joliet....................	.91	.091	.32	.19	1 842	15.1
78	RLrP		.78	.081	.30	.21	2 144	22.3
82	RL	Kewanee................	.67	.047	.65	.31	2 552	83.6
83	RLrP		.91	.080	.65	.36	3 122	86.2
91	RL	LaMoille................	.89	.101	.51	.30	3 057	67.3
92	RLrP		.96	.125	.58	.36	3 002	69.1
96	RL	Minonk..................	.66	.063	.60	.22	2 343	70.6
97	RLrP		.75	.070	.40	.26	2 311	72.0
101	RL	Mt. Morris..............	.71	.071	.47	.22	2 842	64.7
102	RLrP		.91	.116	.45	.22	2 768	70.0
106	RL	Oblong..................	.67	.073	.44	.21	2 464	36.2
107	RLrP		.71	.119	.34	.22	2 963	40.6
123	RL	Sidell....................	1.28	.101	.60	.29	3 240	32.5
124	RLrP		1.12	.119	.79	.27	3 440	36.0
128	RL	Toledo..................	.69	.078	.32	.29	2 468	30.6
129	RLrP		.71	.161	.32	.33	2 715	31.6
	RL	Average of all........	.79	.084	.56	.28	2 624	56.3
	RLrP	Average of all........	.85	.103	.53	.31	2 857	59.8

[a]RL = residues and limestone. RLrP = residues, limestone, and rock phosphate.

Reference to Fig. 9 shows that only on a few fields did the rock phosphate exert a negative influence on yield and composition. Of the five decreases in yield, four were for stover and of these only one represents a significant difference. On three fields, Carthage, Joliet, and Sidell, the percentage of nitrogen in the stover was decreased with the use of rock phosphate; in two cases, Joliet and Sidell, stover from late-planted corn was utilized for analysis. Substantial increases in yields of both grain and stover on these fields, however, were obtained with the phosphate treatment.

Only in the stover from the Aledo field was there an actual decrease in phosphorus content, and this was associated with decreased yields. While the untreated soil, Grundy silt loam, is ranked as medium in available phosphorus, the amount of phosphorus rendered available by

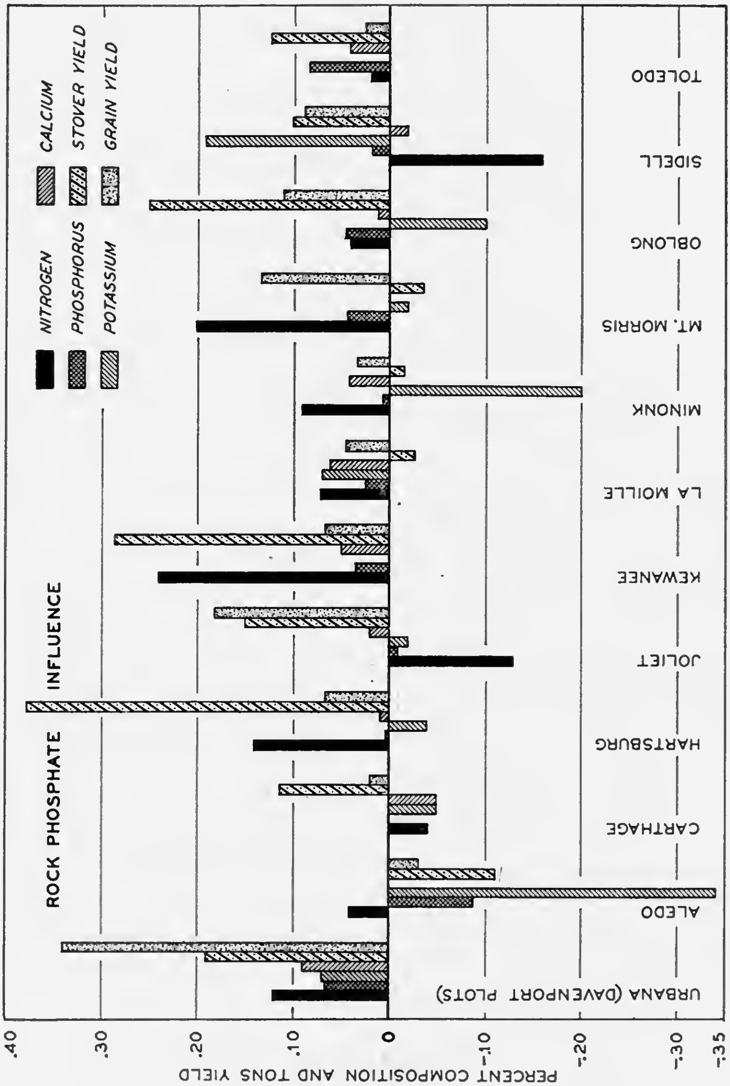

FIG. 9.—EFFECT OF ROCK PHOSPHATE ON COMPOSITION OF MATURE CORN STOVER AND ON YIELDS OF STOVER AND GRAIN: TWELVE ILLINOIS SOIL EXPERIMENT FIELDS

(Values = RLrP over RL)

the residues and limestone treatment is undoubtedly very much greater, so that the application of rock phosphate proved ineffective in changing either yields or the phosphorus content of the stover.

Where rock phosphate had been used in addition to residues and limestone, relatively few pronounced changes in the potassium and calcium contents of the stover resulted, altho some significant decreases, as well as increases in the amount of each element, were shown by the stover samples from the phosphated plots on several fields. These changes, however, in the composition of stover, resulting apparently from the rock-phosphate treatment, appear to bear no definite relationship to yields either of grain or of stover.

Potash (RLrPK over RLrP)

Potash has been applied on the Illinois soil experiment fields chiefly in the form of kainit, except on the Davenport plots, where K_2SO_4 was used, and during the war period, when K_2CO_3 was substituted. The kainit was applied once per rotation before plowing the clover sod for wheat, at the annual acre-rate of 200 pounds or an equivalent amount of its substitute. Owing to differences in length of time the experiment fields have been in operation, the total applications of kainit have varied from 3,200 to 4,400 pounds per acre; the exact amount for the respective fields is given in Table 30 in the Appendix.

The effect of potash on stover composition and on yields is shown by the data in Table 22 and by Fig. 10. No comparisons are given for Carthage, since the potassium-treated plot, unlike the plots for the other standard treatments, on Series 200 of that field is represented by a different soil type. Potash, in 11 comparisons from as many fields, increased yields by an average of 150 pounds of stover and 4.9 bushels of grain per acre. The greatest increases were on the light-colored soils at Toledo and Oblong; while the only significant decreases were on the heavy, dark-colored soils, Grundy clay loam at Hartsburg and Drummer clay loam at Minonk. Both of the latter soil types are either neutral or very slightly acid in the surface. If, as suggested by Bauer[3*] (page 469 of work cited), large amounts of limestone tend "to prevent the formation of readily available potassium," it would appear that kainit should exert a beneficial rather than a detrimental effect on these soils.

The percentages of nitrogen and phosphorus in the stover were decreased by the potash treatment; while the calcium content was either decreased or unchanged. With increased yields, such changes in composition might be expected, as shown especially at Joliet, Mt. Morris, and Toledo. But on the clay loam soils, yields were reduced,

TABLE 22.—EFFECT OF POTASH (CHIEFLY KAINIT) ON COMPOSITION OF MATURE CORN STOVER
(Consecutively numbered samples represent same soil type and corn variety)

Sample No.	Treatment[a]	Field	Composition of stover				Yield per acre	
			N	P	K	Ca	Stover	Grain
			%	%	%	%	*lbs.*	*bu.*
16	RLrP	Urbana (Davenport plots)..	1.11	.131	.88	.52	4 204	73.6
17	RLrPK		1.21	.127	1.12	.43	4 248	81.2
39	RLrP	Aledo..................	.57	.108	.67	.28	2 092	73.4
40	RLrPK		.55	.115	.80	.29	2 200	77.6
68	RLrP	Hartsburg..............	.90	.064	.62	.37	3 344	82.0
69	RLrPK		.73	.046	.75	.32	3 220	68.8
78	RLrP	Joliet..................	.78	.081	.30	.21	2 144	22.3
79	RLrPK		.70	.066	.34	.23	2 379	28.1
83	RLrP	Kewanee...............	.91	.080	.65	.36	3 122	86.2
84	RLrPK		.69	.056	.97	.32	2 921	90.4
92	RLrP	LaMoille...............	.96	.125	.58	.36	3 002	69.1
93	RLrPK		1.04	.109	.75	.36	2 909	69.8
97	RLrP	Minonk................	.75	.070	.40	.26	2 311	72.0
98	RLrPK		.66	.053	.57	.26	2 222	66.7
102	RLrP	Mt. Morris.............	.91	.116	.45	.22	2 768	70.0
103	RLrPK		.81	.093	.69	.24	2 893	71.1
107	RLrP	Oblong.................	.71	.119	.34	.22	2 963	40.6
108	RLrPK		.81	.118	.57	.21	3 505	66.4
124	RLrP	Sidell..................	1.12	.119	.79	.27	3 440	36.0
125	RLrPK		1.15	.119	.95	.27	3 615	43.0
129	RLrP	Toledo.................	.71	.161	.32	.33	2 715	31.6
130	RLrPK		.62	.102	.83	.31	3 653	47.0
	RLrP	Average of all........	.86	.107	.55	.31	2 919	59.7
	RLrPK	Average of all........	.82	.091	.76	.29	3 069	64.6

[a]RLrP = residues, limestone, and rock phosphate. RLrPK = residues, limestone, rock phosphate, and potash.

and the amounts of nitrogen and phosphorus in the stover were lowered by the use of potash. On the other hand, the potash treatment increased the potassium content of stover in all cases, percentage of increase varying from 13 at Joliet to 160 at Toledo. At the same time yields also were increased except at Hartsburg and Minonk.

Combined Effect of Different Materials in Standard Treatments

The combined effect of the fertilizing materials on the composition of stover and on yields is ascertained by comparing the respective treatments with the checks. These comparisons are shown by a series of graphs (Figs. 11, 12, and 13) which are presented without a repetition of the data on which they are constructed.

With a few minor exceptions, the combined treatments—(1) residues and limestone; (2) residues, limestone, and rock phosphate; (3)

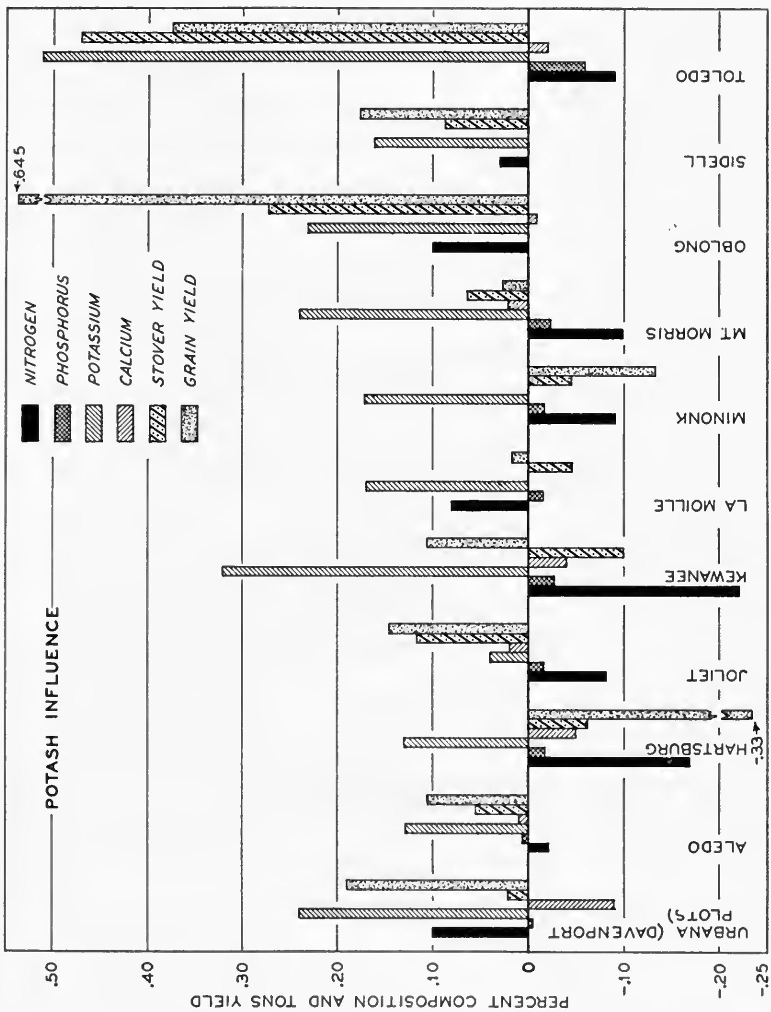

FIG. 10.—EFFECT OF POTASH, CHIEFLY KAINIT, ON COMPOSITION OF MATURE CORN STOVER AND ON YIELDS OF STOVER AND GRAIN: ELEVEN ILLINOIS SOIL EXPERIMENT FIELDS
(Values = RLrPK over RLrP)

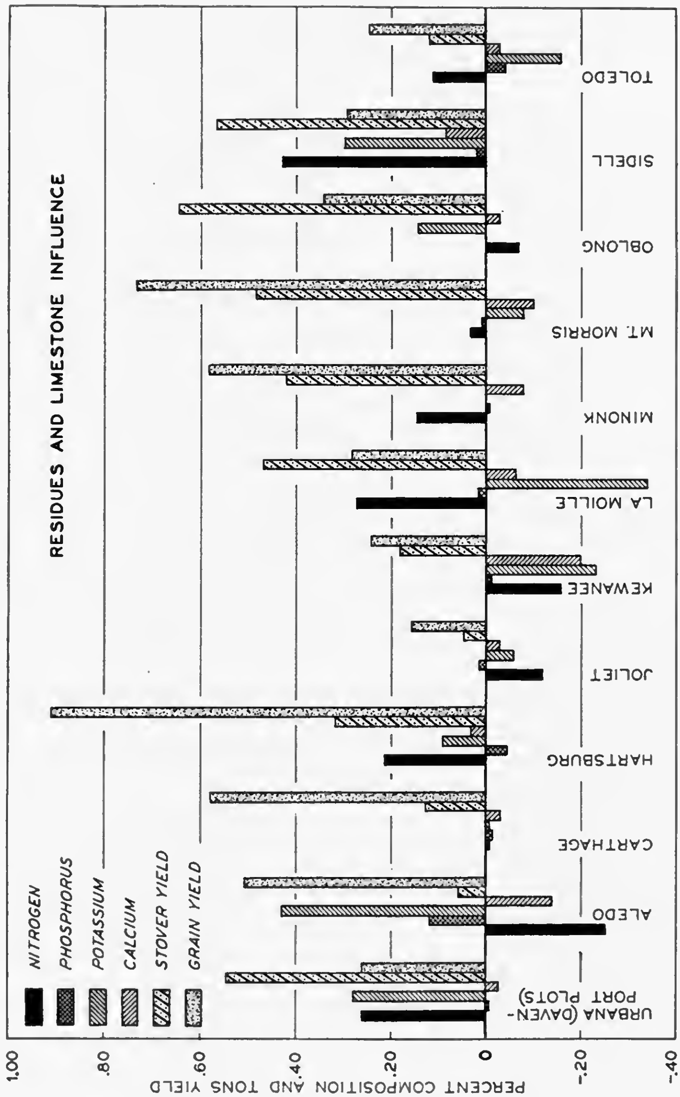

FIG. 11.—EFFECT OF RESIDUES AND LIMESTONE ON COMPOSITION OF MATURE CORN STOVER AND ON YIELDS OF STOVER AND GRAIN: TWELVE ILLINOIS SOIL EXPERIMENT FIELDS
(Values = RL over check)

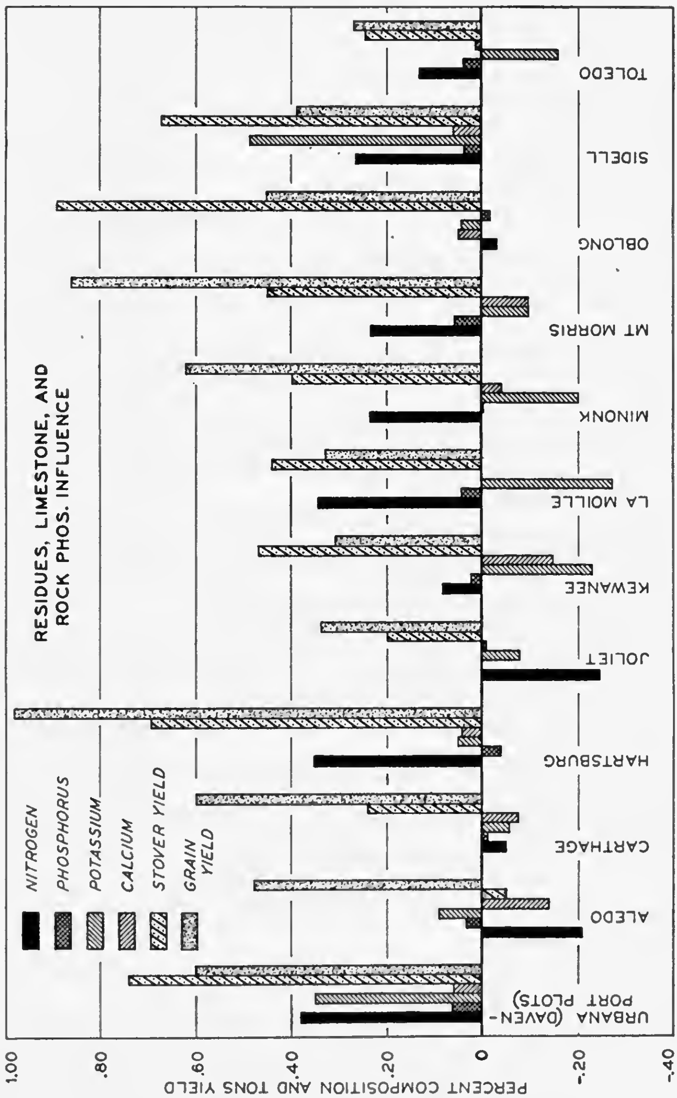

FIG. 12.—EFFECT OF RESIDUES, LIMESTONE, AND ROCK PHOSPHATE ON COMPOSITION OF MATURE CORN STOVER AND ON YIELDS OF STOVER AND GRAIN: TWELVE ILLINOIS SOIL EXPERIMENT FIELDS

(Values = RLrP over check)

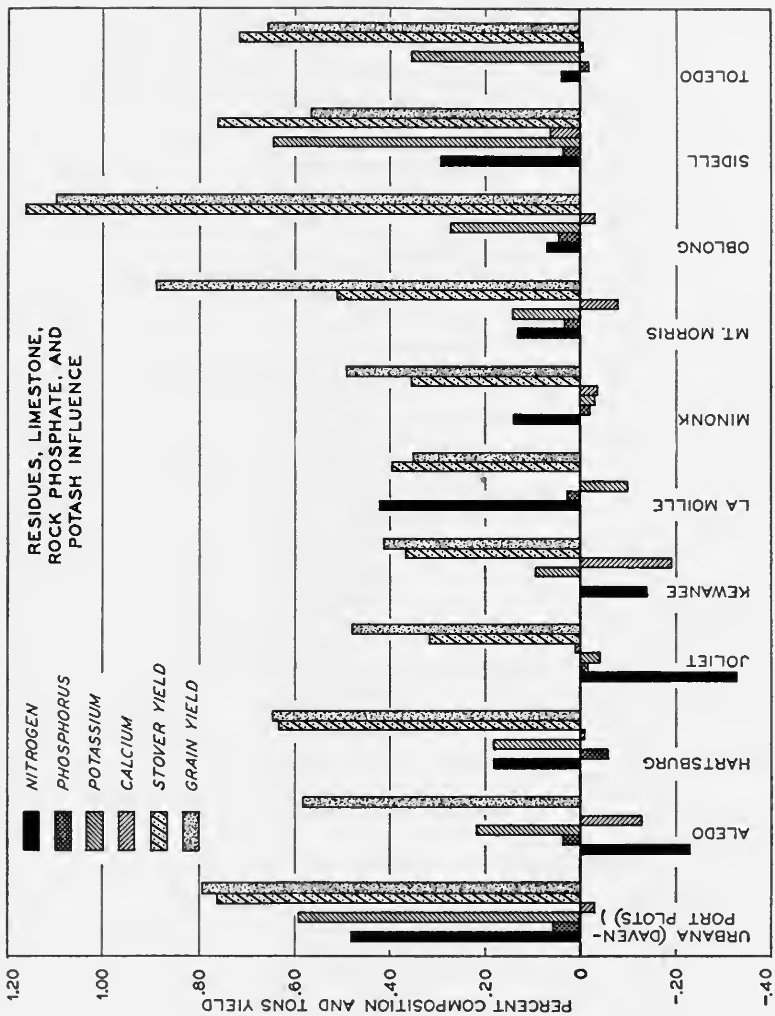

FIG. 13.—EFFECT OF RESIDUES, LIMESTONE, ROCK PHOSPHATE, AND POTASH ON COMPOSITION OF MATURE CORN STOVER AND ON YIELDS OF STOVER AND GRAIN: ELEVEN ILLINOIS SOIL EXPERIMENT FIELDS

(Values — RLrPK over check)

residues, limestone, rock phosphate, and kainit—increased yields of both grain and stover over the untreated checks. This was true in spite of the fact that the single materials in many cases exerted a negative influence on yields. Limestone, for instance, caused a reduction in the yield of stover at Aledo, Hartsburg, Minonk, and Toledo; rock phosphate depressed stover yields chiefly at Aledo; while kainit decreased the yields of both grain and stover at Hartsburg and Minonk.

The most pronounced change in the composition of stover, due to the combined treatments, was in the nitrogen content. This was followed in turn by potassium, phosphorus, and calcium. Of 35 comparisons for each nutrient, significant changes in the nitrogen, potassium, phosphorus, and calcium contents of the stover were shown in 34, 27, 23, and 19 comparisons respectively. These changes represent increased amounts of nitrogen in approximately two-thirds of the comparisons, increased amounts of phosphorus in three-fourths, potassium in three-fifths, and calcium in only one-fourth of the comparisons. In only seven instances did the changes in composition occur in the same direction with all nutrients; these were in the percentage increases caused by all treatments at Sidell and by the RLrP treatment on the Davenport plots, and in the decreases caused by the RL treatments at Carthage and Kewanee and the RLrP treatment at Carthage.

Examination of Figs. 11, 12, and 13 shows that decreases occurred in the nitrogen content of the stover at Aledo and Joliet under all the combined treatments; at Kewanee and Oblong under the RL treatments; at Carthage and Oblong under RLrP; and at Kewanee under RLrPK. It will be noted that these reductions in the nitrogen content of the stover were associated generally with marked increases in yield, both of grain and stover. The only exceptions to this apparent relationship had to do with the stover yields obtained at Aledo under all treatments and at Joliet under the RL treatment.

The phosphorus content of stover was reduced by all the combined treatments at Hartsburg; by RL and RLrPK at Toledo; and by RLrPK at Minonk. Grain yields for these treatments, however, were increased 36.4, 39.0, and 25.8 bushels per acre at Hartsburg; 9.6 and 26 bushels at Toledo, and 19.4 bushels at Minonk; stover yields also were increased in amounts varying from 237 to 1,422 pounds per acre. Even where the decreases in the percentage of phosphorus under the combined treatments were relatively small, large increases in yields were obtained.

The amount of potassium in the stover was decreased by all the combined treatments at LaMoille; by RL and RLrP at Kewanee, Mt. Morris, and Toledo; and by RLrP at Joliet and Minonk. On the other hand, all combined treatments at Aledo, Kewanee, Minonk, and Mt. Morris caused reductions in the amount of calcium in the stover; as did also RL at LaMoille and RLrP at Carthage. These reductions in the potassium and calcium contents of the stover were obviously due in large part to the effect of the yield increases that resulted from the different treatments. Except for the yields of stover obtained under the RLrP and RLrPK treatments at Aledo, yields were increased by all combined treatments on all fields.

Effect of Phosphorus Carriers With and Without Limestone

Rock Phosphate

The effect of rock phosphate when used with residues and limestone on the composition of mature corn stover has been shown by the data in Table 21 and also by Fig. 9. This section, including the data in Table 23, is concerned with a study of the effect of rock phosphate when used with and without limestone, on yields and on the composition of stover, particularly the phosphorus content. Information concerning the soil types involved in these comparisons is given on pages 188 to 191. The wide variations in the reaction of these types and the marked differences in their content of available phosphorus, should be noted especially.

After the total application of rock phosphate had reached 8,000 pounds per acre, the plots on the main series of the Aledo, Hartsburg, and Toledo fields, represented by Grundy silt loam, Grundy clay loam, and Cisne silt loam respectively, were divided in 1924 in order to make possible further phosphorus studies. On one half of all plots in each series it was indicated that the "original soil treatment was continued." The application of limestone and rock phosphate, however, and the return of all residues except cornstalks, had previously been discontinued. The supplementary phosphorus studies were begun on the other half of the plots.

Thus Samples 39, 68, and 129 represent plots on which the applications of rock phosphate had reached 8,000 pounds per acre and were then discontinued; while Samples 44, 73, and 135 represent the other half of these respective plots, where the phosphate applications were continued. The additional 3,000 pounds per acre of rock phosphate was applied as follows: 1,000 pounds in the spring of 1924, 500 pounds before oats in the spring and 1,000 pounds before wheat in the fall of 1926, and 500 pounds in the spring of 1928. The same distribution of the phosphate was made on the RrP plots represented by Samples 42, 71, and 133.

TABLE 23.—EFFECT OF ROCK PHOSPHATE, USED WITH AND WITHOUT LIMESTONE, ON COMPOSITION OF MATURE CORN STOVER

Sample No.	Treat-ment	Field Soil type Corn variety	Composition of stover				Yield per acre		Total application per acre	
			N	P	K	Ca	Stover	Grain	Rock phosphate	Limestone
		Part I								
			%	%	%	%	lbs.	bu.	lbs.	lbs.
37	R	Aledo (Series 300)	.66	.167	1.14	.28	2 492	68.6	......	......
42	RrP	Grundy silt loam	.58	.075	.53	.36	1 935	70.6	3 000	......
38	RL	Will County Favorite	.53	.196	1.01	.28	2 313	74.6	......	16 000
39	RLrP		.57	.108	.67	.28	2 092	73.4	8 000	16 000
44	RLrP		.52	.105	.38	.31	2 575	77.2	11 000	16 000
66	R	Hartsburg	.74	.062	.66	.33	3 144	78.0	......	......
71	RrP	Grundy clay loam	.75	.053	.56	.36	3 269	85.0	3 000	......
67	RL	Reid Yellow Dent	.76	.060	.66	.36	2 590	79.4	......	16 000
68	RLrP		.90	.064	.62	.37	3 344	82.0	8 000	16 000
73	RLrP		.96	.086	.64	.41	3 660	83.4	11 000	16 000
127	R	Toledo	.50	.091	.37	.24	2 510	26.0	......	......
133	RrP	Cisne silt loam	.42	.130	.62	.25	2 357	24.0	3 000	......
128	RL	Champion White Pearl	.69	.078	.32	.29	2 468	30.6	......	13 000
129	RLrP		.71	.161	.32	.33	2 715	31.6	8 000	13 000
135	RLrP		.80	.200	.30	.34	2 177	33.8	11 000	13 000
		Part II								
25	R	Alhambra	.71	.120	.54	.29	3 306	48.7	......	......
26	RrP	Putnam silt loam	.80	.208	.51	.31	3 976	67.5	6 000	......
24	RLrP	Champion White Pearl	1.01	.142	.53	.38	4 227	62.0	6 000	16 000
46	R	Aledo (minor series)	.51	.038	.55	.28	1 909	69.8	......	......
52	RrP	Grundy silt loam	.53	.089	.55	.28	2 105	74.3	8 344	......
49	RL	Will County Favorite	.67	.054	.57	.28	2 066	72.0	......	12 000
53	RLrP		.57	.096	.52	.30	2 212	76.5	8 344	12 000

The data reported in the first part of Table 23 show that rock phosphate without limestone failed, in most cases, to change either the grain or stover yields significantly. The stover yield on Grundy silt loam, however, was decreased 557 pounds an acre by the phosphate treatment, whereas the grain yield on Grundy clay loam was increased by 7.0 bushels an acre. Where rock phosphate had been used with limestone prior to 1924, it increased the yields, especially of stover, at Hartsburg and Toledo, but decreased them at Aledo. The recent rock phosphate applications on the heavily limed plots have, however, increased the yields both of grain and of stover in all cases except the yield of stover at Toledo.

Altho wide variations in the nitrogen, potassium, and calcium contents of stover under various treatments are shown by the data in Table 23, this discussion will be limited primarily to the phosphorus differences. When used without limestone, rock phosphate produced no significant change in the phosphorus content of the stover grown at Hartsburg. This was also true where rock phosphate had been used with limestone prior to 1924; but where recent applications of rock phosphate had been made to a plot limed prior to 1924, the phosphorus content of the stover was raised from .064 percent to .086 percent. Rock phosphate, when used either with or without limestone, caused a great decrease in the phosphorus content of the stover at Aledo but produced a marked increase in the stover at Toledo. The continued use of rock phosphate at Aledo failed to increase the percentage of phosphorus in the stover, but at Toledo it resulted in a further significant increase.

The Grundy clay loam, Grundy silt loam, and Cisne silt loam of these fields are "high," "medium," and "low," respectively, in available phosphorus. In reaction these soil types are very slightly, medium, and very strongly acid. Altho these soil differences undoubtedly would influence the utilization of the applied phosphate, the differences in the phosphorus content of the corn stover under corresponding phosphate treatments on the Grundy silt loam and Grundy clay loam are not so great as might be expected. Evidence of the greater utilization of rock phosphate on the Cisne silt loam is provided by the increase of more than 40 percent in the phosphorus content of the stover when phosphorus was used alone and the doubling of its phosphorus content when phosphorus was used with limestone. The lighter applications of limestone at Toledo, together with a lower amount of available phosphorus prior to treatment, were no doubt important factors affecting the availability of the applied phosphate and the phosphorus content of the stover produced.

Comparison of the data for the RLrP and RL treatments indicates that limestone suppressed the availability of the applied phosphate on Grundy silt loam at Aledo (Series 300). However, the phosphorus content of the stover from the RLrP plots averaged 42 percent greater than that from the RrP plot. Equally heavy applications of limestone on the Grundy clay loam at Hartsburg, a nonacid soil high in available phosphorus, failed to decrease either yields or the phosphorus content of the stover.

It is difficult to offer a satisfactory explanation for this difference in the influence of limestone on the availability of rock phosphate when used on the Grundy silt loam and when used on the Grundy clay loam. These results are not in agreement with the tentative conclusions of Bauer[3*] (page 463 of work cited), who has attributed the lack of response to rock phosphate, particularly on the latter soil, to the retarding influence of limestone on the availability of the rock phosphate. Since this soil type is naturally well supplied with both total and available phosphorus and contains sufficient lime to grow sweet clover satisfactorily as a green-manure crop, little or no response from either limestone or rock phosphate, when used alone or together, could be expected.

Additional data to show the influence of rock phosphate on the composition of mature stover are reported in the second part of Table 23. While the Putnam silt loam is strongly acid and low in available phosphorus, it is more productive, either with or without treatment, than the Cisne silt loam. Not only were the yields for corresponding treatments greater on the former soil, but the nutrient content of the mature stover was higher, except for the amounts of phosphorus and potassium where rock phosphate was used with and without limestone respectively.

Rock phosphate without limestone at Alhambra increased yields and also the percentages of nitrogen and phosphorus in the mature stover; but when it was used with limestone, the stover yield was further increased and the yield of grain decreased. This reduction in grain yield appears to have been due to a phosphorus deficiency, since the nitrogen content of stover was 25 percent greater and that of phosphorus 30 percent less. These results would indicate that the limestone had caused the phosphorus to become less available. The different effect of limestone on the availability of rock phosphate at Alhambra and Toledo seems to bear a definite relation not only to the character of the soils but also to the proportion of rock phosphate and limestone applied. The Putnam silt loam received 16,000 pounds of limestone per acre and 6,000 pounds of rock phosphate; whereas the

Cisne silt loam received 13,000 pounds of limestone and 8,000 or 11,000 pounds of rock phosphate.

The soil type and basal treatments are similar on both Series 300 and the minor series at Aledo. The system of cropping and the total applications of limestone and of rock phosphate, however, have been very different. Samples 46, 49, 52, and 53 from the minor series are not, therefore, duplicates of the samples for corresponding treatments on Series 300. A comparison of the yields on the two series reveals no striking differences. The same is true with reference to the composition of stover, so far as nitrogen and calcium are concerned. The phosphorus content of the stover, however, shows wide variation not only between different treatments on the same series, but also for the same treatment on the two series. With potassium, the percentage was uniform for the stover on the minor series but quite variable for that on Series 300.

The amount of phosphorus in the mature stover grown on the R and RL plots of Series 300 was three and one-half to four times as great as that for the corresponding treatments on the minor series. While this variation is thought to have been due primarily to soil differences, there is no direct evidence to offer in support of this assumption. Unfortunately no specific information concerning the reaction or phosphorus content of the soil on the individual plots of the two series is available, or obtainable, at present.

Rock phosphate, when applied alone or with limestone on the minor series, increased both the yields and the phosphorus content of the stover. These effects are just the opposite of those reported for the corn grown on Series 300 at Aledo. Almost three times as much rock phosphate was used for the RrP treatment on the minor series as on Series 300; and while the amounts of phosphate are comparable for the RLrP treatment on the two series, the applications of limestone were 4,000 pounds per acre less on the minor series. Here again the amount of limestone used in relation to the total application of rock phosphate appears to have been an important factor in the utilization of phosphorus.

Superphosphate

The effect of superphosphate, when used with and without limestone, on the composition of mature corn stover is shown in Table 24. The data for corresponding treatments on the Aledo, Hartsburg, and Toledo fields, reported in the first part of Table 24, appear to be directly comparable. The comparison of different treatments on the same field may be questionable in view of the treatment prior to the

TABLE 24.—EFFECT OF SUPERPHOSPHATE, USED WITH AND WITHOUT LIMESTONE, ON COMPOSITION OF MATURE CORN STOVER

Sample No.	Treat-ment	Field Soil type Corn variety	Composition of stover				Yield per acre		Total application per acre	
			N	P	K	Ca	Stover	Grain	Super-phosphate	Limestone
			Part I							
			%	%	%	%	*lbs.*	*bu.*	*lbs.*	*lbs.*
37	R	Aledo (Series 300)	.66	.167	1.14	.28	2 492	68.6	......	......
41	RsP[a]	Grundy silt loam	.50	.076	.43	.36	2 030	64.4	1 200	......
38	RL	Will County Favorite	.53	.196	1.01	.28	2 313	74.6	......	16 000
43	RLsP		.53	.207	.75	.32	2 335	72.8	1 200	16 000
66	R	Hartsburg	.74	.062	.66	.33	3 144	78.0	......	......
70	RsP[a]	Grundy clay loam	.83	.082	.50	.36	3 150	82.0	1 200	......
67	RL	Reid Yellow Dent	.76	.060	.66	.36	2 590	79.4	......	16 000
72	RLsP		.74	.051	.82	.35	2 770	88.4	1 200	16 000
127	R	Toledo	.50	.091	.37	.24	2 510	26.0	......	......
132	RsP[a]	Cisne silt loam	.49	.173	.38	.25	1 813	16.2	1 200	......
128	RL	Champion White Pearl	.69	.078	.32	.29	2 468	30.6	......	13 000
134	RLsP		.71	.142	.35	.29	3 113	37.8	1 200	13 000
			Part II							
46	R	Aledo (minor series)	.51	.038	.55	.28	1 909	69.8	......	......
50	RsP	Grundy silt loam	.53	.113	64	.27	2 361	73.2	3 066	......
49	RL	Will County Favorite	.67	.054	.57	.28	2 066	72.0	......	12 000
51	RLsP		.58	.170	.59	.31	2 233	74.9	3 066	12 000

[a]Check plot prior to 1924.

phosphate application; also because of the manner in which the superphosphate and limestone have been used.

The superphosphate, where applied on unlimed soils, was used with "residues" on a plot which prior to 1924 was an untreated check; whereas the superphosphate with limestone has been applied to a residues-limestone plot. "Residues," therefore, had been used only five years in the former case, as compared with fifteen to eighteen years in the latter. While it is not clear just what significance should be attached to this difference, obviously it should not be ignored when comparisons are made.

Superphosphate and limestone were not applied during the same period on the RLsP plots; the superphosphate has been used on plots which already had received 13,000 to 16,000 pounds of limestone per acre up to 1920. These amounts of limestone represent excessive liming, which, however, extended over several rotations whereas the limited superphosphate applications were made over a five-year period. In each case, superphosphate has been used since 1924 at the annual acre-rate of 200 pounds applied twice in the rotation ahead of wheat and first-year corn. The total application of superphosphate prior to the time when the stover samples were collected was 1,200 pounds per acre on each field.

In spite of the similarity in soil type and in the basal treatments on Series 300 and the minor series at Aledo, the data from these two series are not to be regarded as duplications. Alfalfa was grown on the minor series from 1910 to 1915, with no residues returned until 1919. Also, the total applications of superphosphate have been two and one-half times as great on the minor series as on Series 300, whereas the amount of limestone has been only three-fourths as much. This situation is similar to that noted previously in connection with the study of the effect of rock phosphate on the composition of the stover grown on the two series.

Superphosphate without limestone depressed the yields of both grain and stover at Toledo and on Series 300 at Aledo; but when used on Grundy clay loam at Hartsburg and on the minor series at Aledo, which is also on Grundy silt loam, yields, except for the stover at Hartsburg, were increased. Increased yields were accompanied by marked increases in the phosphorus content of the stover, while the decreased yields on Series 300 at Aledo were associated with very large reductions in all nutrients except calcium. At Toledo, where the soil is very strongly acid, the use of superphosphate produced no significant changes in the composition of the stover except in regard to phosphorus. Altho the phosphorus content of the stover was nearly doubled, the yields of stover and grain declined more than one-fourth and one-third respectively.

When used on heavily limed plots, superphosphate increased stover and grain yields on all plots except on Series 300 at Aledo. The composition of the stover, except for the phosphorus or potassium in each sample, was, however, but slightly modified. The amount of phosphorus in the stover grown on Cisne silt loam was raised from .078 percent to .142 percent. The change in phosphorus content was even greater for the stover grown on the minor series at Aledo; in fact the percentage of phosphorus was trebled. In the other cases no significant change in the phosphorus content of the mature stover was produced by the superphosphate-limestone treatment.

Rock Phosphate and Superphosphate Compared

The data in Table 25, showing comparative effects of rock phosphate and superphosphate when used with and without limestone, on the composition of mature corn stover, are for the most part a repetition of those given in Tables 23 and 24. The conditions under which these comparisons were made have already been discussed and will not be repeated. At Oblong the limestone was applied in 1925, while the phosphates were used in the fall of 1926 and the spring of 1928. This comparison for the deep phase of Cisne silt loam could be objected to because of the dissimilar treatment of the soil prior to the time the phosphates were applied. On the Muscatine silt loam at Kewanee limestone was applied at the rate of 8,000 pounds per acre in 1915 and 1919, while the use of phosphorus carriers was not begun until 1921.

On the basis of yields, rock phosphate has generally been superior to superphosphate when these materials have been used without limestone; the chief exceptions were for stover on the Grundy silt loam at Aledo. The increases for rock phosphate were considerably greater on the Cisne silt loam, a very strongly acid soil low in available phosphorus than on the Grundy clay loam, which is nonacid and high in phosphorus, both total and available.

In general the phosphorus content of the stover grown on soils treated with rock phosphate was somewhat less than that of the stover grown on the plots treated with superphosphate. The differences were .029 percent at Hartsburg, .043 percent at Toledo, and .024 percent at Aledo on the minor series. The differences at Kewanee and on Series 300 at Aledo were too small to be significant. These lower amounts of phosphorus in the stover grown where rock phosphate was used do not necessarily indicate less available phosphorus, but should be

TABLE 25.—COMPARISON OF SUPERPHOSPHATE AND ROCK PHOSPHATE, USED WITH AND WITHOUT LIMESTONE, ON COMPOSITION OF MATURE CORN STOVER

Sample No.	Treatment	Field / Soil type / Corn variety	Composition of stover				Yield per acre		Total application per acre	
			N	P	K	Ca	Stover	Grain	Phosphate	Limestone
			%	%	%	%	lbs.	bu.	lbs.	lbs.
41	RsP[a]	Aledo (Series 300)	.50	.076	.43	.36	2 030	64.4	1 200	......
42	RrP	Grundy silt loam	.58	.075	.53	.36	1 935	70.6	3 000	......
43	RLsP	Will County Favorite	.53	.207	.75	.32	2 335	72.8	1 200	16 000
44	RLrP		.52	.105	.38	.31	2 575	77.2	11 000	16 000
70	RsP[a]	Hartsburg	.83	.082	.50	.36	3 150	82.0	1 200	......
71	RrP	Grundy clay loam	.75	.053	.56	.36	3 269	85.0	3 000	......
72	RLsP	Reid Yellow Dent	.74	.051	.82	.35	2 770	88.4	1 200	16 000
73	RLrP		.96	.086	.64	.41	3 660	83.4	11 000	16 000
132	RsP[a]	Toledo	.49	.173	.38	.25	1 813	16.2	1 200	......
133	RrP	Cisne silt loam	.42	.130	.62	.25	2 357	24.0	3 000	......
134	RLsP	Champion White Pearl	.71	.142	.35	.29	3 113	37.8	1 200	13 000
135	RLrP		.80	.200	.30	.34	2 177	33.8	11 000	13 000
50	RsP	Aledo (minor series)	.53	.113	.64	.27	2 361	73.2	3 066	......
52	RrP	Grundy silt loam	.53	.089	.55	.28	2 105	74.3	8 344	......
51	RLsP	Will County Favorite	.58	.170	.59	.31	2 233	74.9	3 066	12 000
53	RLrP		.57	.096	.52	.30	2 212	76.5	8 344	12 000
109	RLsP[a]	Oblong	.54	.185	.30	.26	1 879	22.0	800	4 000
111	RLrP[b]	Cisne silt loam, deep phase	.56	.137	.41	.20	2 414	35.8	1 600	4 000
		Mohawk								
86	RsP	Kewanee	.64	.068	1.09	.36	2 907	85.5	1 400	......
85	RrP	Muscatine silt loam	.54	.065	.96	.32	3 025	88.0	3 600	......
88	RLsP	Krug	.82	.077	.86	.36	3 447	104.1	1 400	16 000
87	RLrP		.82	.066	.93	.35	3 542	96.1	3 600	16 000

[a]Check prior to 1924. [b]Residues prior to 1924.

attributed at least in part to the increases in yields produced by this treatment.

When used with limestone, rock phosphate produced the greater yields at Aledo and Oblong, but superphosphate was first at Toledo and Kewanee. At Hartsburg the grain yield was favored by superphosphate and the stover yield by rock phosphate.

The relation of these differences in the phosphate response of corn, to the composition of the stover, particularly to the phosphorus content, is important in indicating the influence of limestone on the relative availability of rock phosphate and superphosphate. On the Grundy silt loam at Aledo (in both Series 300 and the minor series), the phosphorus content of the stover from the RLsP plot was higher than that from the RLrP plot. The differences of .102 and .074 percent of phosphorus in favor of the superphosphate are too great to be accounted for merely by the slightly smaller yields obtained with superphosphate than with rock phosphate. A comparison of the data showing the composition of the stover grown on both the limed and the unlimed phosphate plots, indicates clearly that limestone increased the availability of both rock and superphosphate when used on this soil. If, however, the limed plots were compared, one might conclude erroneously that the availability of rock phosphate was suppressed by limestone.

At Oblong the stover grown on the RLsP plot contained .185 percent of phosphorus and the stover grown on the RLrP plot .137 percent. The difference of .048 percent is relatively small in comparison with the differences in yields, which were greater by 535 pounds of stover and 13.8 bushels of grain for the RLrP treatment. In this case no comparison can be made with unlimed plots to determine whether limestone increased or suppressed the relative availability of either form of phosphate. When both yields and the composition of the stover are considered, rock phosphate appears to have been utilized better than superphosphate. The deep phase of Cisne silt loam at Oblong is a strongly acid soil and has received only 4,000 pounds of limestone per acre, so that the soil conditions there were probably more favorable for the utilization of rock phosphate.

While the phosphorus content of the stover was higher for the RLrP than for the RLsP treatment on Grundy clay loam and on Cisne silt loam, the differences of .035 and .058 percent are perhaps negligible in view of the differences in yields, especially of grain. On the Grundy clay loam at Hartsburg the increase in grain obtained with superphosphate and limestone was accompanied by a marked decrease in the phosphorus content of the stover; however, a decrease in grain under rock phosphate used with limestone resulted in a significant increase in the phosphorus content of the stover.

The situation at Toledo on Cisne silt loam was essentially the same as at Hartsburg on Grundy clay loam with respect to the effect of superphosphate used with limestone, in that with increased yields the amount of phosphorus in the stover declined. When the RLrP and RrP treatments are compared, yields for the former are seen to have been less by 180 pounds of stover, but more by 9.8 bushels of grain, while the phosphorus content of the mature stover was raised from .130 percent to .200 percent. These data certainly do not furnish any evidence that heavy liming has exerted a retarding influence on the availability of rock phosphate.

Bone, Rock, Slag, and Super Phosphates Compared

The effect of some less common phosphates, in comparison with rock and superphosphate, on the composition of corn stover and on yields is shown in Table 26. On the Aledo field, in the first part of this table, these phosphorus carriers are compared when used with limestone and without it, and here they may be studied under more comparable conditions than those reported in Tables 23, 24, and 25 and the second part of Table 26, since the soil, prior to the use of phosphates, was uniformly cropped and treated, and differences in the amounts of the various phosphates applied have been less pronounced. The phosphates were originally applied for wheat. In 1923 they were used for first-year corn; and since 1927 they have been applied twice in the rotation, ahead of wheat and first-year corn. With the last change the annual acre-rates of bone phosphate were reduced from 200 to 100 pounds; superphosphate from 333⅓ to 200 pounds; and rock phosphate from 666⅔ to 500 pounds. The rate for slag phosphate was maintained at 250 pounds. Total applications of these phosphates prior to the time stover samples were collected are shown in Table 26.

The soil type on which these phosphates were compared, Grundy silt loam, is medium acid in reaction and "medium" in available phosphorus. Limestone increased yields but slightly, but both the nitrogen and phosphorus contents of the mature stover were increased significantly by it. All phosphorus carriers when used without limestone increased yields, with the exception that slag phosphate did not increase grain yields, and the amount of phosphorus in the stover from the phosphorus plots varied from two to nearly four times as much as that contained in the stover from the residues plot. The yields for the various phosphates were somewhat greater with lime-

TABLE 26.—COMPARISON OF BONE, ROCK, SLAG, AND SUPER PHOSPHATES, USED WITH AND WITHOUT LIMESTONE, ON COMPOSITION OF MATURE CORN STOVER

Sample No.	Treatment	Composition of stover				Yield per acre		Total application per acre	
		N	P	K	Ca	Stover	Grain	Phosphate	Limestone
		Aledo field: Grundy silt loam, Will County Favorite							
		%	%	%	%	lbs.	bu.	lbs.	lbs.
46	R	.51	.038	.55	.28	1 909	69.8	......	......
49	RL	.67	.054	.57	.28	2 066	72.0	......	12 000
47	RbP	.49	.132	.63	.33	2 059	71.7	2 400	......
48	RLbP	.52	.130	.48	.34	2 319	78.3	2 400	12 000
50	RsP	.53	.113	.64	.27	2 361	73.2	3 066	......
51	RLsP	.58	.170	.59	.31	2 233	74.9	3 066	12 000
52	RrP	.53	.089	.55	.28	2 105	74.3	8 344	......
53	RLrP	.57	.096	.52	.30	2 212	76.5	8 344	12 000
54	R slag P	.53	.140	.49	.34	2 260	69.3	3 250	......
55	RL slag P	.51	.199	.44	.33	2 502	71.0	3 250	12 000
		Oblong field: Cisne silt loam, deep phase, Mohawk							
109	RLsP (check prior to 1924)	.54	.185	.30	.26	1 879	22.0	800	4 000
110	RLuP[a] (check prior to 1924)	.60	.131	.37	.21	2 073	21.0	800	4 000
111	RLrP (residues prior to 1924)	.56	.137	.41	.20	2 414	35.8	1 600	4 000
112	RLbP (RL prior to 1924)	.76	.160	.34	.26	2 759	40.8	800	15 000
113	RLrP (RLrP prior to 1924)	.83	.180	.35	.29	2 888	38.4	8 000	15 000

[a]Underacidulated phosphate.

stone than without it, with the exception that superphosphate with limestone failed to show an increase in yield of stover.

Where bone and rock phosphates were used, the phosphorus content of stover was no greater with limestone than without it. Superphosphate used with limestone raised the amount of phosphorus in the stover to .170 percent as compared with .113 percent for the phosphate alone. However, the yield increases for superphosphate were slightly less than those for either bone or rock phosphate. When compared with the R and RL treatments, slag phosphate, either with or without limestone, increased stover yields but not grain yields. Both treatments were effective in increasing the phosphorus content of the stover. The availability of the slag phosphate, however, was no doubt increased by the limestone, since the yields as well as the phosphorus content of the stover were greater when this phosphate was used with limestone than without it.

The comparisons reported in the second part of Table 26, showing the effect on the composition of mature stover and on yields of grain and stover, of different phosphates applied to the deep phase of Cisne silt loam, are presented without discussion. Differences in previous soil treatment and variations in the amounts of phosphate and limestone applied preclude satisfactory comparisons.

Effect of Gypsum

Gypsum Used With Rock Phosphate at Same Rate

The effect of gypsum on the composition of mature corn stover is shown by the data in Table 27. On Grundy silt loam, grayish phase, at Carthage, gypsum has been used with rock phosphate. These materials, used in three different amounts representing 100, 200, and 400 pounds per acre per year, were plowed down with sweet clover for corn. The soil had received 8,000 pounds of limestone per acre in 1912 and had grown alfalfa from then until 1920. Stover samples used for analyses were collected from the plots receiving the lowest and the highest amounts of gypsum and rock phosphate.

The results from the Carthage field would indicate that this soil responds to rock phosphate. The use of this material not only increased the yields of stover and grain, but raised the phosphorus content of the stover considerably. Sample 63 represents a phosphate application four times as great as Sample 61; however, the phosphorus content of Sample 63 was raised only 30 percent. This increase, moreover, was associated with decreased yields.

The gypsum, when applied with rock phosphate at the same rate,

TABLE 27.—EFFECT OF GYPSUM ON COMPOSITION OF MATURE CORN STOVER

Sample No.	Treatment[a]	Composition of stover				Yield per acre	
		N	P	K	Ca	Stover	Grain
Carthage field: Grundy silt loam, grayish phase, Krug							
		%	%	%	%	lbs.	bu.
60	RL	.58	.053	.43	.30	1 558	42.4
61	RLrP	.69	.093	.37	.30	1 902	50.4
62	RLrPG	.58	.069	.50	.29	1 865	45.6
63	RLrP	.53	.120	.49	.31	1 720	46.0
64	RLrPG	.60	.108	.41	.29	1 635	45.2
Hartsburg field: Grundy clay loam, Reid Yellow Dent							
69	RLrPK	.73	.046	.75	.32	3 220	68.8
74	RLrPKG	.99	.111	.78	.35	3 546	80.0
Toledo field: Cisne silt loam, Champion White Pearl							
130	RLrPK	.62	.102	.83	.31	3 653	47.0
136	RLrPKG	.34	.142	.94	.28	4 020	58.4

[a]*Samples 60* to *64* (Carthage field) were from plots receiving 8,000 pounds each of limestone per acre, with the following additional treatments: *Sample 61*, 1,000 pounds rock phosphate. *Sample 62*, 1,000 pounds each of rock phosphate and gypsum. *Sample 63*, 4,000 pounds rock phosphate. *Sample 64*, 4,000 pounds each of rock phosphate and gypsum.

Samples 69 and *74* (Hartsburg field) were from plots receiving 16,000 pounds of limestone per acre, with 8,000 pounds rock phosphate, 3,600 pounds kainit, 1,400 pounds gypsum.

Samples 130 and *136* (Toledo field) were from plots receiving 13,000 pounds of limestone per acre, plus the same additional treatments as *Samples 69* and *74*.

resulted in no increase in yield, and it caused a marked reduction in the phosphorus content of the stover. The differences in grain yields, and also in the phosphorus content of the stover, between samples from the gypsum and no-gypsum plots were greater where the smaller amounts were applied. While gypsum apparently limited the intake of phosphorus, the deleterious effect exerted was more noticeable with the lighter application, where a phosphorus deficiency no doubt existed. Where rock phosphate was used without gypsum, the absorption of phosphorus was perhaps in excess of the amount needed for growth, with the result that a greater accumulation of phosphorus occurred in the stover.

Gypsum Used With Full Treatment After Rock Phosphate Was Discontinued

On both the Hartsburg and Toledo fields, as shown in Table 27, gypsum was applied to plots treated with residues, limestone, rock phosphate, and kainit after the phosphate applications had reached 8,000 pounds per acre and were discontinued (1924). The gypsum used at the annual acre-rate of 200 pounds was applied twice per rotation before wheat and first-year corn. The total application of gypsum on each field was at the rate of 1,400 pounds per acre. The Grundy clay loam at Hartsburg, a nonacid soil high in available phosphorus, had received 16,000 pounds of limestone per acre, whereas the Cisne silt loam at Toledo, a very acid soil low in available phosphorus, had received only 13,000 pounds.

Data in Table 21 show that the Hartsburg soil was more responsive than the Toledo soil to the phosphate treatment when both the stover and grain yields were considered. The change in the phosphorus content of stover, however, was more pronounced on the Cisne silt loam than on the Grundy clay loam. The reverse was true for nitrogen, which perhaps is associated with differences in the response to lime shown by the two soils. Liming stimulated sweet-clover growth on the Cisne silt loam, and it appears to have increased very greatly the availability of the phosphorus. It is likely that this action represents both a direct and an indirect effect of the limestone, especially on the applied phosphate.

The addition of gypsum to the RLrPK plots after the application of rock phosphate had been discontinued increased stover and grain yields markedly. Grain yields were increased more than those of stover; also, the increase at Toledo was greater than that at Hartsburg. Gypsum also affected the composition of the stover, the nitrogen and phosphorus contents being modified more than the amount of potassium or calcium. Both nitrogen and phosphorus in the stover were increased at Hartsburg, but only the phosphorus at Toledo, where the nitrogen content of the stover was reduced almost one-half. The increase for phosphorus where gypsum had been used with rock phosphate was nearly four times as great for stover on the Grundy clay loam as on the Cisne silt loam. However, the actual phosphorus content of stover grown on the latter soil was 28 percent higher.

As noted previously, the use of kainit appeared to reduce the phosphorus content of the stover on both soils—from .064 percent to .046 percent on Grundy clay loam and from .161 percent to .102 percent on Cisne silt loam. Yields, however, were decreased on the former soil, but increased on the latter. The use of gypsum not only increased yields, but raised the phosphorus content of the stover. The gain in phosphorus was more than enough to offset the reduction in phosphorus produced by the kainit on Grundy clay loam but not on Cisne silt loam.

Effect of Standard Treatments on Late-Planted Corn

Stover samples from both the Joliet and Sidell fields represent late-planted corn used in corn borer studies. The standard treatments, except for residues on Saybrook silt loam at Joliet, were effective in increasing both grain and stover yields. Gains in grain yields were considerably greater than those for stover, as indicated by the data in Table 28. These increases in yields on the Joliet field were accompanied by marked reductions in the nitrogen and phosphorus contents of the stover but with no significant change in the amount of either potassium or calcium. The deleterious effect of residues on yields, also on the composition of the stover, would suggest a deficiency of both nitrogen and phosphorus. Such deficiencies, however, should no doubt be attributed to soil variation in this particular case rather than merely to treatment.

On the Sidell field the standard treatments caused a substantial increase in the nitrogen and potassium contents of the stover, while all treatments except residues increased the content of phosphorus. The increases in calcium for different treatments when compared with the check varied only from .06 to .08 percent. The combined treatment of residues and limestone was the most effective in raising the nitrogen content of the stover, while the RLrP and RLrPK treatments were equally effective in increasing the amount of phosphorus. And, as

TABLE 28.—EFFECT OF TREATMENT IN CHANGING THE COMPOSITION OF STOVER FROM LATE-PLANTED CORN

Sample No.	Treatment[a]	Composition of stover				Yield per acre	
		N	P	K	Ca	Stover	Grain
	Joliet field: Saybrook silt loam, Western Plowman						
		%	%	%	%	*lbs.*	*bu.*
75	0	1.03	.079	.38	.22	1 751	9.0
76	R	.86	.055	.36	.20	1 684	7.9
77	RL	.91	.091	.32	.19	1 842	15.1
78	RLrP	.78	.081	.30	.21	2 144	22.3
79	RLrPK	.70	.066	.34	.23	2 379	28.1
	Sidell field: Sidell silt loam, Reid Yellow Dent						
121	0	.86	.082	.31	.21	2 106	20.6
141	5-15-5[b]	.78	.086	.34	.29	2 662	33.1
122	R	.90	.075	.40	.27	2 857	24.6
142	R and 5-15-5[b]	.85	.078	.46	.26	3 066	33.5
123	RL	1.28	.101	.60	.29	3 240	32.5
143	RL and 5-15-5[b]	1.12	.094	.75	.32	3 192	40.5
124	RLrP	1.12	.119	.79	.27	3 440	36.0
144	RLrP and 5-15-5[b]	1.14	.135	.65	.33	3 987	40.9
125	RLrPK	1.15	.119	.95	.27	3 615	43.0
145	RLrPK and 5-15-5[b]	1.12	.127	.79	.34	3 422	44.9

[a]The plots on the Joliet field from which samples were taken received 16,000 pounds of limestone, 8,000 pounds of rock phosphate, 3,200 pounds of kainit per acre, where these materials were applied. The plots on the Sidell field from which samples were taken received 18,000 pounds of limestone, 8,000 pounds of rock phosphate, and 3,600 pounds of kainit, where these materials were applied.
[b]For the 1928 corn crop 200 pounds per acre of 5-15-5 fertilizer was hill-dropped on the plots from which these samples were taken.

might be expected, the highest percentage of potassium in the stover was obtained where kainit was part of the treatment. Unlike the results obtained on Saybrook silt loam at Joliet, those on Sidell silt loam at Sidell show that full treatment of residues, limestone, rock phosphate, and kainit not only increased yields of both stover and grain, but raised the nitrogen, phosphorus, potassium, and calcium contents of the stover appreciably.

On half of the check plot and on the standard treated plots at Sidell, a 5-15-5 fertilizer, hill-dropped at the rate of 200 pounds per acre, was used for the 1928 corn crop. The use of this fertilizer produced marked increases in yield on nearly all plots; the chief exception was on the RLrPK plot. These increases in yield, however, were made at the expense of the nitrogen content of the stover on all plots except the one treated with RLrP, where the difference is probably not significant. The only significant change in the phosphorus content of the stover, that was due to the complete fertilizer, was where complete fertilizer was used as a supplement to the RLrP treatment. Even tho yields were increased by 4.9 bushels of grain and 547 pounds of stover per acre, the phosphorus content of the stover was raised from .119 percent to .135 percent. Where the additional fertilization was made on the RLrP and RLrPK plots, the potassium content of the stover was significantly decreased, but when used on the check and the RLrP and RLrPK plots, the calcium content was significantly raised. Only on the RL plot did the 5-15-5 fertilizer produce a significant increase in the amount of potassium in the stover.

SUMMARY AND CONCLUSIONS

Mature corn stover from 15 varieties of corn grown on 15 soil types under 21 soil treatments was collected from 16 Illinois experiment fields in 1928 and used for the studies herein reported. The varieties ranged from early maturing to late maturing and the soils from very low to high in productivity. The soil treatments varied from nothing to full treatment with residues, limestone, rock phosphate, and kainit, supplemented with a complete fertilizer.

Each sample, consisting of 10 stalks with their leaves and husks, was obtained from an area where both the soil type and the stand of corn were uniform. The sample was later separated for analysis into two portions, "stalks" and "leaves," the former including the stalks and leaf sheaths, and the latter the leaf blades and husks. The composition of each of the stover samples reported here is based on the separate analyses of stalks and leaves and the proportion that each part was of the whole sample.

Four elements—nitrogen, phosphorus, potassium, and calcium—were given primary consideration in this study of the composition of stover. Altho organic carbon and total ash were also determined, no analytical results for either are reported except in Table 33 in the Appendix. Except in the determinations for potassium and organic carbon, the analytical methods used were those of the Association of Official Agricultural Chemists.

Varietal Differences.—Studies to determine the relationship of variety of corn to the composition of mature corn stover were concerned first with different varieties grown under similar conditions, and second with the same varieties grown on different fields in order to determine the influence of environment in changing the composition of stover.

Where varieties are grown under similar conditions, variations in the composition of stover and in yields must be accounted for primarily by varietal differences. The nature and extent of the modifications in composition and yield with changes in environment appear to vary greatly with the variety, tho the response of different varieties requiring the same length of season in which to mature may be decidedly different.

Besides differing in yield, varieties may differ markedly in composition of mature stover owing to differences in their feeding power, or in their ability to translocate nutrients to grain, or both. Certain varieties appear to have greater power to assimilate nutrients than others, tho there seems to be no completely consistent relationship between this power and the length of season required for maturity.

In these tests, with a few exceptions, the amount of nitrogen in mature corn stover of different varieties exceeded the amount of potassium, which was followed in descending order by calcium and phosphorus. The marked differences in the percentages of nitrogen, phosphorus, and potassium were in contrast with the rather uniform calcium content of stover. The composition of stover was affected greatly by yields; but there appeared to be little or no relation between the composition of the stover from the different varieties and the relative length of season required to mature them. The total amount per acre of the various nutrients contained in the stover was more definitely reflected by the stover and grain yields than by merely the composition of the stover.

The nitrogen content of leaves was usually greater than that of stalks. The stalks, however, generally contained more phosphorus, except where grain yields were low, in which case the leaves were less depleted of their phosphorus. In the stover of all the varieties grown at Alhambra and at Toledo the amount of calcium was higher in the leaves than in the stalks, while the reverse was always true for potassium. But on the younger and more fertile soils at Urbana and at DeKalb, to which no limestone has been applied, the calcium content was considerably greater for stalks than for leaves, and in most cases the amount of potassium in the leaves exceeded that in the stalks.

Influence of Soil Type.—Soil type, in the two comparisons that were possible, had practically no direct effect on the composition of mature corn stover altho it exerted a marked influence on yields. Except for calcium, the differences in the composition of stover of the same variety grown on two different soil types at DeKalb were not significant, but at Sidell all differences except that for calcium were significant. On each field the yields of stover and grain were greater on the more-fertile and less-acid soil, which is higher in available phosphorus.

The wide variations in climate in different parts of Illinois have made it very difficult to study the effect of soil types, thruout the area of their occurrence, on the composition of corn stover. Widely different soil types ordinarily do not occur on the same experiment field—therefore seldom under the same seasonal conditions of rainfall, temperature, and other climatic factors. Because of these and other limitations, comparisons that will show the effect of soil type on the composition of stover are indeed rare.

Influence of Soil Treatment.—The stover samples used to study the effect of soil treatment on the composition of stover were taken from plots on which the basal treatment was crop residues and green manures rather than animal manures. The effects of different phosphorus carriers, of gypsum, and of a 5-15-5 fertilizer used in addition to the standard treatments—all in the grain system of farming on the Illinois experiment fields—were studied.

On all fields except Joliet *residues* increased the yields of grain and stover. These greater yields on the residues plots were usually accompanied by definite reductions in the phosphorus content of the stover. This was generally true also for nitrogen, except on fields where the soil will grow sweet clover on the unlimed residues plot, in which case the nitrogen content was raised significantly. With potassium and calcium, definite changes in composition of the stover were shown in two-thirds of the comparisons between residues and check samples.

The general tendency of *limestone* was to raise the nitrogen, phosphorus, potassium, and calcium contents of the stover and to increase the stover and grain yields. The chief exceptions were in the stover yields on soils naturally well supplied with carbonates, where the addition of limestone might be expected to have little or no effect.

Rock phosphate, when used in addition to residues and limestone, increased yields only slightly. The percentages of nitrogen and phosphorus in the stover were, however, raised considerably, but there were relatively few pronounced differences in the contents of potassium and calcium. The changes in the composition of stover that were due apparently to the rock-phosphate treatment appeared to bear no definite relationship to yields.

Potash, chiefly as kainit, increased yields on all fields except those with heavy, dark-colored soils at Hartsburg and Minonk, and raised the potassium content of stover in all cases, the increase varying from 13 to 160 percent. The percentages of both nitrogen and phosphorus in the stover were reduced by the potash treatment, while the calcium content was either decreased or unchanged.

With a few minor exceptions, all soil treatments—RL, RLrP, and RLrPK—increased both stover and grain yields above those obtained with no treatment. The most pronounced changes in the composition of the stover, that were due to the combined treatments, were in the nitrogen content, followed in turn by potassium, phosphorus, and calcium. Of 35 comparisons for each nutrient, significant differences in the nitrogen, potassium, phosphorus, and calcium contents of stover were shown in 34, 27, 23, and 19 comparisons respectively. These differences represent increased amounts in approximately two-thirds of the nitrogen comparisons, three-fourths of the phosphorus, three-fifths of the potassium, and only one-fourth of the calcium comparisons.

The *form of phosphorus* used on the treated plots had a marked effect on the phosphorus content of the stover. On soils treated with rock phosphate the phosphorus content of the stover was usually much less than it was where superphosphate was used. In increasing yields, however, rock phosphate was generally the more effective. The use of limestone was no doubt less favorable for the utilization of rock phosphate than of superphosphate. Heavy liming, however, appeared in most cases to exert little or no retarding influence on the availability of the rock phosphate, even on Grundy clay loam, a soil naturally well supplied with lime. The possibility of such action appears to bear a definite relation not only to the character of the soil but also to the proportions of rock phosphate and limestone applied.

Where four different phosphates were used on Grundy silt loam at Aledo, yields were increased by all forms except slag, whether the phosphates were used with limestone or without it. The phosphorus content of the stover from these plots was from two to four times as great as that of the stover grown without phosphate. When the super and slag phosphates were used with limestone, the percentage of phosphorus in the stover was much greater than when these phosphates were used without limestone; with the bone and rock phosphates, the differences were not significant.

Gypsum, when used with residues, limestone, and rock phosphate, and applied at the same rate as the phosphate, caused no increase in yield but did cause a marked reduction in the phosphorus content of the stover. The deleterious effect of gypsum was more pronounced with light applications of gypsum and rock phosphate than with heavy applications. Where the lighter applications were made, a phosphorus deficiency appeared to exist.

The addition of gypsum to the RLrPK plots after the application of rock phosphate had reached 8,000 pounds and been discontinued, increased the phosphorus content of the stover, also yields, especially of grain, on both the Grundy clay loam at Hartsburg and the Cisne silt loam at Toledo. Altho the amounts of potassium and calcium in the stover were modified only slightly by the gypsum treatment, the nitrogen content was raised one-third in the stover at Hartsburg and reduced one-half in that at Toledo.

The use of a *5-15-5 fertilizer* as a supplement to the standard treatments usually increased yields but resulted in marked reductions in the nitrogen content of the stover. The only significant change in the percentage of phosphorus in the stover, that was due to the complete fertilizer, was where it was applied on the RLrP plot. The calcium content of stover was generally higher where the soil had received the additional fertilization than where it had not, but the additional treatment was effective in raising the amount of potassium only when it was used to supplement the RL treatments.

LITERATURE CITED

1. ALBERTS, H. W. Relation of time of planting corn to the time of silking, denting, and senescence. Jour. Amer. Soc. Agron. **18**, 375-380. 1926.
2. BAUER, F. C., SMITH, R. S., and SMITH, L. H. The Illinois soil experiment fields. Ill. Agr. Exp. Sta. Bul. 273. 1926.
3. ———— Response of soils to systems of soil treatment. Ill. Agr. Exp.
4. BRAY, R. H. A field test for available phosphorus in soils. Ill. Agr. Exp. Sta. Bul. 337. 1929.
5. DULEY, F. L., and MILLER, M. F. The effect of a varying supply of nutrients upon the character and composition of the maize plant at different periods of growth. Missouri Agr. Exp. Sta. Res. Bul. 42. 1921.
6. ———— ———— The effect of a varying moisture supply upon the development and composition of the maize plant at different periods of growth. Missouri Agr. Exp. Sta. Res. Bul. 76. 1925.
7. FORBES, E. B., BEEGLE, F. M., and MENSCHING, J. E. Mineral and organic analyses of foods. Ohio Agr. Exp. Sta. Bul. 255. 1913.
8. FREAR, WM. The composition of corn receiving different fertilizers. Pa. State Col. Rpt. 1887; Part II, Agr. Exp. Sta., pp. 42-50. 1888.
9. HIBBARD, P. L., and STOUT, P. R. Estimation of potassium by titration of the cobaltinitrite with potassium permanganate. Jour. Assoc. Off. Agr. Chem. **16**, 137-140. 1933.
10. HILLS, J. L., WHITE, B. O., and JONES, C. H. Effect of fertilization upon the composition of crops. Vt. Agr. Exp. Sta. Ann. Rpt. 11, pp. 146-150. 1898.
11. HORNBERGER, R. Chemische Untersuchugen Über das Wachsthum der Maispflanze. Landwirthschaftliche Jahrbücher Bd. **11**, 359-523. 1882. (Cited from Missouri Agr. Exp. Sta. Res. Bul. 42, p. 4. 1921.)
12. JONES, W. J. JR., and HUSTON, H. A. Composition of maize at various stages of its growth. Purdue Univ. Agr. Exp. Sta. Bul. 175. 1914.
13. KEITH, HELEN M. A bibliography of researches bearing on the composition and nutritive value of corn and corn products. Ill. Agr. Exp. Sta. Bul. 257. 1925.
14. LADD, E. F. Analysis of individual stalks of corn. N. Dak. Agr. Exp. Sta. Ann. Rpt. 14, pp. 39-40. 1904.
15. LATSHAW, W. L., and MILLER, E. C. Elemental composition of the corn plant. Jour. Agr. Res. **27**, 845-860. 1924.
16. SCHWEITZER, P. Study of the life history of corn at its different periods of growth. Missouri Agr. Exp. Sta. Bul. 9. 1889.
17. SCOVELL, M. A., and PETER, A. M. Experiments with corn. Ky. Agr. Exp. Sta. Bul. 26. 1890.
18. SNYDER, HARRY. Forage crops of high, medium, and low protein content. Minn. Agr. Exp. Sta. Bul. 101. 1907.
19. STUDENT. The probable error of a mean. Biometrika **6**, 1-25. 1908.
20. VOORHEES, J. F. A further study of effective rainfall. U. S. Mo. Weather Rev. **54**, 332-336. 1926.
21. WINTERS, ERIC JR., and SMITH, R. S. Determination of total carbon in soils. Jour. Indus. Engin. Chem. (Anal. ed. **1**, 202). 1929.
22. ———— and WIMER, D. C. A total carbon procedure. Jour. Amer. Soc. Agron. **23**, 280-285. 1931.
23. WOODS, C. D. Effect of different fertilizers upon the composition of corn. Conn. (Storrs) Agr. Exp. Sta. Ann. Rpt. 2, pp. 127-178. 1890.
24. ———— and GIBSON, H. B. Proximate composition of corn and stover of New England grown maize. Conn. (Storrs) Agr. Exp. Sta. Ann. Rpt. 3, pp. 112-119. 1891.

APPENDIX

In the following tables will be found a complete summary of the data on all samples with reference to:

Field and plot sources.

Variety of corn, soil type, and treatment represented.

Stover and grain yields.

Ratios of stalks to leaves, and stover to grain.

Percentage composition of stover and its separated parts.

The amounts of nitrogen, phosphorus, potassium, and calcium contained per acre in the stover and in its separated parts.

TABLE 29.—SOURCES OF STOVER SAMPLES AND YIELDS OF STOVER AND GRAIN; ALSO RATIO OF STALKS TO LEAVES AND STOVER TO GRAIN: 16 ILLINOIS EXPERIMENT FIELDS, 15 SOIL TYPES, 15 CORN VARIETIES, 21 SOIL TREATMENTS
(Each sample consisted of 10 stalks with leaves and husks)

Sample No.	Variety	Plot	Treatment	Ratio of stalks to leaves (1)	Yield per acre		Ratio of stover to grain (1)
					Stover	Grain	
Urbana, S. Farm, Carrington silt loam					*lbs.*	*bu.*	
1	Champion White Pearl...	165-6W	RrP	3.01	3 143	42.0	1.50
2	Sommer Yellow Dent....	165-6W	RrP	2.89	3 044	54.8	1.11
3	Reid Yellow Dent.......	165-6W	RrP	2.72	3 006	56.6	1.06
4	Funk 90 Day...........	165-6W	RrP	2.88	2 147	71.6	.60
5	Funk 176A.............	165-6W	RrP	3.08	2 872	56.9	1.01
6	Krug..................	165-6W	RrP	3.27	2 611	75.1	.70
7	Rustler................	165-6W	RrP	2.56	1 018	39.3	.52
8	Minnesota 13...........	165-6W	RrP	2.10	1 432	55.6	.52
9	Golden Glow...........	165-6W	RrP	2.65	1 705	38.9	.87
Urbana, S. Farm, Sidell silt loam							
10	Reid Yellow Dent.......	165-6E*	RLrP	2.94	3 193	62.5	1.02
11	Reid Yellow Dent.......	162-3E*	RLrP	3.72	3 103	91.5	.68
12	Reid Yellow Dent.......	167-8E*	RLrP	2.11	3 263	38.4	1.70
Urbana, Davenport plots, Carrington silt loam, deep phase							
13	Reid Yellow Dent.......	501W	0	2.01	2 725	49.6	1.10
14	Reid Yellow Dent.......	502W	R	2.51	2 994	50.8	1.18
15	Reid Yellow Dent.......	504W	RL	2.13	3 821	60.0	1.27
16	Reid Yellow Dent.......	506W	RLrP	2.17	4 204	73.6	1.14
17	Reid Yellow Dent.......	508W	RLrPK	2.50	4 248	81.2	1.07
Alhambra, Putnam silt loam							
18	Krug..................	232S	RLrP	2.38	2 919	43.3	1.35
19	Sommer Yellow Dent....	233N	RLrP	2.77	3 043	50.6	1.20
20	Reid Yellow Dent.......	234N	RLrP	2.45	3 170	54.9	1.15
21	Funk 176A.............	234S	RLrP	2.94	3 082	41.9	1.47
22	Black Hawk............	237N	RLrP	2.66	3 133	49.5	1.26
23	Mohawk...............	237S	RLrP	2.89	3 581	48.8	1.47
24	Champion White Pearl...	231S	RLrP	2.22	4 227	62.0	1.36
25	Champion White Pearl...	229N	R	2.06	3 306	48.7	1.35
26	Champion White Pearl...	230N	RrP	2.19	3 976	67.5	1.18
DeKalb, Saybrook silt loam							
27	Reid Yellow Dent.......	304-5-6S	RrP	3.48	2 295	26.4	1.74
28	Sommer Yellow Dent....	304-5-6S	RrP	3.26	1 995	26.1	1.53
29	Western Plowman.......	304-5-6S	RrP	3.12	1 690	28.9	1.17
30	Funk 90 Day...........	304-5-6S	RrP	4.15	2 069	40.4	1.02
31	Krug..................	304-5-6S	RrP	4.00	2 381	29.2	1.63
32	Golden Glow...........	304-5-6S	RrP	2.83	2 618	32.1	1.63
DeKalb, Saybrook silt loam, deep phase							
33	Minnesota 13...........	324-5-6S	RrP	2.75	1 762	69.1	.51
34	Western Plowman.......	324-5-6S	RrP	3.12	2 755	54.9	1.00
35	Rustler................	324-5-6S	RrP	3.22	1 900	46.3	.82
Aledo, Grundy siltl oam							
36	Will County Favorite....	305W	0	1.64	2 199	54.4	.81
37	Will County Favorite....	306W	R	2.48	2 492	68.6	.73
38	Will County Favorite....	307W	RL	3.90	2 313	74.6	.62
39	Will County Favorite....	308W	RLrP	3.06	2 092	73.4	.57
40	Will County Favorite....	309W	RLrPK	3.20	2 200	77.6	.57
41	Will County Favorite....	305E	RsP	2.64	2 030	64.4	.63
42	Will County Favorite....	306E	RrP	2.51	1 935	70.6	.55
43	Will County Favorite....	307E	RLsP	3.08	2 335	72.8	.64
44	Will County Favorite....	308E	RLrP	3.05	2 575	77.2	.67
45	Will County Favorite....	309E	RLrPK	3.29	2 852	80.2	.71
46	Will County Favorite....	501	R	2.68	1 909	69.8	.55
47	Will County Favorite....	502	RbP	3.44	2 059	71.7	.57
48	Will County Favorite....	503	RLbP	3.59	2 319	78.3	.59
49	Will County Favorite....	504	RL	2.76	2 066	72.0	.57
50	Will County Favorite....	602	RsP	2.88	2 361	73.2	.64
51	Will County Favorite....	603	RLsP	3.13	2 233	74.9	.60
52	Will County Favorite....	702	RrP	2.75	2 105	74.3	.57
53	Will County Favorite....	703	RLrP	3.27	2 212	76.5	.58
54	Will County Favorite....	802	R slag P	3.18	2 260	69.3	.65
55	Will County Favorite....	803	RL slag P	2.79	2 502	71.0	.70

*These three samples were from plantings of different dates: Sample 10, May 21; Sample 11, May 1; Sample 12, June 13.

TABLE 29.—*Continued*

Sample No.	Variety	Plot	Treatment	Ratio of stalks to leaves (1)	Yield per acre		Ratio of stover to grain (1)
					Stover	Grain	
Carthage, Grundy silt loam, grayish phase					lbs.	bu.	
56	Krug..................	205	0	2.05	1 706	37.8	.90
57	Krug..................	206	R	2.40	1 734	54.8	.63
58	Krug..................	207	RL	2.97	1 956	60.8	.64
59	Krug..................	208N	RLrP	3.01	2 184	61.7	.71
60	Krug..................	701E	RL	2.56	1 558	42.4	.73
61	Krug..................	702E	RLrP	2.47	1 902	50.4	.75
62	Krug..................	703E	RLrPG	2.25	1 865	45.6	.82
63	Krug..................	706E	RLrP	3.01	1 720	46.0	.75
64	Krug..................	707E	RLrPG	2.73	1 635	45.2	.72
Hartsburg, Grundy clay loam							
65	Reid Yellow Dent.......	305W	0	2.37	1 958	43.0	.91
66	Reid Yellow Dent.......	306W	R	3.50	3 144	78.0	.81
67	Reid Yellow Dent.......	307W	RL	3.59	2 590	79.4	.65
68	Reid Yellow Dent.......	308W	RLrP	3.41	3 344	82.0	.82
69	Reid Yellow Dent.......	309W	RLrPK	4.00	3 220	68.8	.93
70	Reid Yellow Dent.......	305E	RsP	3.41	3 150	82.0	.76
71	Reid Yellow Dent.......	306E	RrP	2.88	3 269	85.0	.77
72	Reid Yellow Dent.......	307E	RLsP	3.97	2 770	88.4	.63
73	Reid Yellow Dent.......	308E	RLrP	3.24	3 660	83.4	.88
74	Reid Yellow Dent.......	309E	RLrPKG	3.18	3 546	80.0	.89
Joliet, Elliott silt loam							
75	Western Plowman.......	305W	0	3.72	1 751	9.0	3.89
76	Western Plowman.......	306W	R	4.68	1 684	7.9	4.26
77	Western Plowman.......	307W	RL	4.62	1 842	15.1	2.44
78	Western Plowman.......	308W	RLrP	3.18	2 144	22.3	1.92
79	Western Plowman.......	309W	RLrPK	3.78	2 379	28.1	1.69
Kewanee, Muscatine silt loam							
80	Krug..................	205W	0	1.52	2 192	74.0	.59
81	Krug..................	206W	R	2.88	2 459	74.6	.66
82	Krug..................	207W	RL	2.53	2 552	83.6	.61
83	Krug..................	208W	RLrP	2.55	3 122	86.2	.49
84	Krug..................	209W	RLrPK	2.62	2 921	90.4	.65
85	Krug..................	601W	RrP	3.13	3 025	88.0	.69
86	Krug..................	602W	RsP	2.27	2 907	85.5	.68
87	Krug..................	603W	RLrP	2.15	3 542	96.1	.74
88	Krug..................	604W	RLsP	2.16	3 447	104.1	.66
LaMoille, Muscatine silt loam							
89	Will County Favorite....	305N	0	2.32	2 127	56.0	.76
90	Will County Favorite....	306N	R	2.72	2 639	60.8	.87
91	Will County Favorite....	307N	RL	2.62	3 057	67.3	.91
92	Will County Favorite....	308N	RLrP	2.94	3 002	69.1	.87
93	Will County Favorite....	309N	RLrPK	2.92	2 909	69.8	.83
Minonk, Drummer clay loam							
94	Will County Favorite....	305	0	2.60	1 517	47.3	.64
95	Will County Favorite....	306	R	3.06	2 545	68.6	.74
96	Will County Favorite....	307	RL	2.97	2 343	70.6	.66
97	Will County Favorite....	308	RLrP	2.79	2 311	72.0	.64
98	Will County Favorite....	309	RLrPK	4.05	2 222	66.7	.67
Mt. Morris, Muscatine silt loam							
99	Will County Favorite....	205E	0	1.94	1 882	35.7	1.05
100	Will County Favorite....	206	R	3.06	2 221	46.4	.96
101	Will County Favorite....	207	RL	2.89	2 842	64.7	.88
102	Will County Favorite....	208	RLrP	2.73	2 768	70.0	.79
103	Will County Favorite....	209	RLrPK	2.65	2 893	71.1	.81
Oblong, Cisne silt loam, deep phase							
104	Mohawk...............	205S	0	1.26	1 188	22.8	1.04
105	Mohawk...............	206S	R	2.21	1 621	23.6	1.37
106	Mohawk...............	207S	RL	2.00	2 464	36.2	1.36
107	Mohawk...............	208S	RLrP	2.06	2 963	40.6	1.46
108	Mohawk...............	209S	RLrPK	2.36	3 505	66.4	1.05
109	Mohawk...............	201N	RLsP	2.14	1 879	22.0	1.71
110	Mohawk...............	205N	RLuP	2.02	2 073	21.0	1.97
111	Mohawk...............	206N	RLrP	2.34	2 414	35.8	1.35
112	Mohawk...............	207N	RLbP	1.98	2 759	40.8	1.35
113	Mohawk...............	208N	RLrP	2.04	2 888	38.4	1.50
114	Mohawk	209N	RLrPK	2.79	3 549	60.4	1.17

TABLE 29.—*Concluded*

Sample No.	Variety	Plot	Treatment	Ratio of stalks to leaves (1)	Yield per acre		Ratio of stover to grain (1)
					Stover	Grain	
Palestine, Onarga sandy loam					*lbs.*	*bu.*	
115	Mohawk	305	LeL	1.46	2 798	26.4	2.12
116	Mohawk	306	LeL, KCl	1.79	2 764	26.8	2.06
117	Mohawk	307	LeLsP, KCl	1.66	3 147	25.8	2 44
118	Mohawk	308	LeLrP, KCl	1.91	2 602	27.2	1.91
119	Mohawk	309	LeLrP, Kainit	1.58	3 184	26.4	2.41
Sidell, Drummer clay loam							
120	Reid Yellow Dent	101N	0	3.57	3 620	40.8	1.77
Sidell, Sidell silt loam							
121	Reid Yellow Dent	105N	0	2.92	2 106	20.6	2.04
122	Reid Yellow Dent	106N	R	3.03	2 857	24.6	2.32
123	Reid Yellow Dent	107N	RL	4.43	3 240	32.5	1.99
124	Reid Yellow Dent	108N	RLrP	3.12	3 440	36.0	1.91
125	Reid Yellow Dent	109N	RLrPK	3.08	3 615	43.0	1.68
Toledo, Cisne silt loam							
126	Champion White Pearl	205S	0	1.91	2 231	21.0	2.12
127	Champion White Pearl	206S	R	2.89	2 510	26.0	1.93
128	Champion White Pearl	207S	RL	1.92	2 468	30.6	1.61
129	Champion White Pearl	208S	RLrP	1.84	2 715	31.6	1.72
130	Champion White Pearl	209S	RLrPK	2.55	3 653	47.0	1.55
131	Champion White Pearl	201N	RL	2.46	2 602	37.4	1.39
132	Champion White Pearl	205N	RsP	2.64	1 813	16.2	2.24
133	Champion White Pearl	206N	RrP	2.57	2 357	24.0	1.96
134	Champion White Pearl	207N	RLsP	2.12	3 113	37.8	1.65
135	Champion White Pearl	208N	RLrP	2.12	2 177	33.8	1.29
136	Champion White Pearl	209N	RLrPKG	2.76	4 020	58.4	1.38
137	Champion White Pearl	801S	RLrP	2.70	2 140	18.1	2.36
138	Calico	801N	RLrP	2.32	2 463	27.0	1.82
139	Mohawk	802N	RLrP	2.05	1 727	25.0	1.38
140	Stanley White	803N	RLrP	2.27	2 354	21.7	2.17
Sidell, Sidell silt loam							
141	Reid Yellow Dent	105N	0 (Fertilized with 5-15-5 hill-dropped 200 lbs. per acre)	3.88	2 662	33.1	1.61
142	Reid Yellow Dent	106N	R (Fertilized with 5-15-5 hill-dropped 200 lbs. per acre)	2.79	3 066	33.5	1.83
143	Reid Yellow Dent	107N	RL (Fertilized with 5-15-5 hill-dropped 200 lbs. per acre)	3.33	3 192	40.5	1.57
144	Reid Yellow Dent	108N	RLrP (Fertilized with 5-15-5 hill-dropped 200 lbs. per acre)	2.80	3 987	40.9	1.95
145	Reid Yellow Dent	109N	RLrPK (Fertilized with 5-15-5 hill-dropped 200 lbs. per acre)	3.16	3 422	44.9	1.52

TABLE 30.—TOTAL APPLICATION OF FERTILIZING MATERIALS ON PLOTS FROM WHICH STOVER SAMPLES WERE TAKEN
(Pounds per acre)

Sample No.	Limestone[a]	Phosphate[b]	Kainit[c]	Gypsum
	lbs.	*lbs.*	*lbs.*	*lbs.*
1-9	1 000	14 000	.....	.....
10-12	6 000	14 000	.....	.....
15	16 600x	.....	.....	.....
16	16 600x	13 200	.....	.....
17	16 600x	13 200	3 000 (K_2SO_4)	.....
18-24	16 000	6 000	.....	.....
26	......	6 000	.....	.....
27-35	......	12 000	.....	.....
38	16 000	.....	.....	.....
39	16 000	8 000	.....	.....
40	16 000	8 000	3 600	.....
41	......	1 200s	.....	.....
42	......	3 000	.....	.....
43	16 000	1 200s	.....	.....
44	16 000	11 000	.....	.....
45	16 000	11 000	3 600	.....
47	......	2 400b	.....	.....
48	12 000	2 400b	.....	.....
49	12 000	.....	.....	.....
50	......	3 066s	.....	.....
51	12 000	3 066s	.....	.....
52	......	8 344	.....	.....
53	12 000	8 344	.....	.....
54	......	3 250sl	.....	.....
55	12 000	3 250sl	.....	.....
58	15 000	.....	.....	.....
59	15 000	8 000	.....	.....
60	8 000	.....	.....	.....
61	8 000	1 000	.....	.....
62	8 000	1 000	.....	1 000
63	8 000	4 000	.....	.....
64	8 000	4 000	.....	4 000
67	16 000	.....	.....	.....
68	16 000	8 000	.....	.....
69	16 000	8 000	3 600	.....
70	......	1 200s	.....	.....
71	......	3 000	.....	.....
72	16 000	1 200s	.....	.....
73	16 000	11 000	.....	.....
74	16 000	8 000	3 600	1 400
77	16 000	.....	.....	.....
78	16 000	8 000	.....	.....
79	16 000	8 000	3 200	.....
82	12 000	.....	.....	.....
83	12 000	8 000	.....	.....
84	12 000	8 000	3 200	.....
85	......	3 600	.....	.....
86	......	1 400s	.....	.....
87	16 000	3 600	.....	.....
88	16 000	1 400s	.....	.....
91	15 000	.....	.....	.....
92	15 000	8 000	.....	.....
93	15 000	8 000	3 400	.....
96	16 000	.....	.....	.....
97	16 000	8 000	.....	.....
98	16 000	8 000	3 600	.....
101	14 000	.....	.....	.....
102	14 000	8 000	.....	.....
103	14 000	8 000	4 400	.....
106	15 000	.....	.....	.....
107	15 000	8 000	.....	.....
108	15 000	8 000	4 000	.....
109	4 000	800s	.....	.....
110	4 000	800u	.....	.....
111	4 000	1 600	.....	.....
112	15 000	800b	.....	.....
113	15 000	8 000	.....	.....
114	15 000	8 000	4 000	.....
115	8 000	.....	.....	.....
116	8 000	.....	250 (KCl)	.....
117	8 000	360s	250 (KCl)	.....
118	8 000	3 900	250 (KCl)	.....
119	8 000	3 900	2 700	.....
123	18 000	.....	.....	.....
124	18 000	8 000	.....	.....
125	18 000	8 000	3 600	.....
128	13 000	.....	.....	.....
129	13 000	8 000	.....	.....
130	13 000	8 000	3 600	.....
131	4 000	.....	.....	.....
132	......	1 200s	.....	.....
133	......	3 000	.....	.....
134	13 000	1 200s	.....	.....
135	13 000	11 000	.....	.....
136	13 000	8 000	3 600	1 400
137-140	18 000	4 000	.....	.....
141[d]	......	.....	.....	.....
142[d]	......	.....	.....	.....
143[d]	18 000	.....	.....	.....
144[d]	18 000	8 000	.....	.....
145[d]	18 000	8 000	3 600	.....

[a]x = also 651 pounds of slaked lime.
[b]Rock phosphate was used except where otherwise noted: s = super, b = bone, sl = slag, u = underacidulated.
[c]Omaha salt (K_2CO_3) was substituted for kainit during the World War period.
[d]In 1928, 200 pounds of 5-15-5 fertilizer was applied for corn.

TABLE 31.—PERCENTAGES OF NITROGEN, PHOSPHORUS, POTASSIUM, AND CALCIUM IN SAMPLES OF MATURE CORN STOVER AND ITS SEPARATED PARTS

Sample No.	Nitrogen			Phosphorus			Potassium			Calcium		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	%	%	%	%	%	%	%	%	%	%	%	%
1	1.30	1.10	1.25	.225	.199	.219	.40	.44	.41	.32	.32	.32
2	.92	1.19	.99	.165	.170	.166	.31	.42	.34	.34	.28	.32
3	.84	.95	.87	.131	.116	.127	.42	.37	.41	.36	.28	.34
4	.69	.82	.72	.093	.085	.091	.53	.41	.50	.29	.26	.28
5	.99	1.05	1.00	.172	.137	.163	.65	.54	.62	.32	.25	.30
6	.73	.98	.79	.119	.126	.121	.40	.43	.41	.33	.26	.31
7	.99	1.16	1.04	.142	.138	.141	.33	.40	.35	.31	.33	.32
8	.86	.90	.87	.119	.103	.114	.42	.53	.46	.31	.32	.31
9	.89	.90	.89	.138	.123	.134	.49	.44	.48	.32	.28	.31
10	.82	.90	.84	.130	.117	.127	.60	.53	.58	.36	.27	.34
11	.87	.68	.83	.192	.096	.172	.68	.41	.62	.40	.29	.38
12	.95	.103	.98	.139	.133	.137	.48	.52	.49	.40	.28	.36
13	.46	1.27	.73	.059	.091	.070	.64	.30	.53	.35	.69	.46
14	.63	1.13	.77	.072	.080	.074	.63	.39	.56	.36	.37	.36
15	.87	1.25	.99	.054	.082	.063	.99	.44	.81	.42	.45	.43
16	.96	1.44	1.11	.125	.143	.131	1.05	.50	.88	.48	.62	.52
17	1.04	1.65	1.21	.123	.137	.127	1.33	.58	1.12	.42	.46	.43
18	1.01	.92	.98	.207	.146	.189	.69	.51	.64	.34	.38	.35
19	1.00	1.43	1.11	.177	.155	.171	.59	.42	.54	.37	.39	.38
20	.57	1.59	.87	.111	.116	.112	.67	.46	.61	.33	.43	.36
21	.74	.83	.76	.191	.134	.177	.90	.52	.80	.38	.40	.39
22	.79	.90	.82	.271	.197	.251	.62	.37	.55	.29	.51	.35
23	1.06	1.27	1.11	.225	.204	.220	.68	.51	.64	.37	.56	.42
24	.97	1.10	1.01	.139	.150	.142	.59	.41	.53	.32	.50	.38
25	.57	1.00	.71	.114	.131	.120	.57	.48	.54	.27	.34	.29
26	.75	.90	.80	.215	.192	.208	.59	.33	.51	.28	.39	.31
27	.94	1.11	.98	.126	.135	.128	.30	.38	.32	.39	.31	.37
28	.79	1.02	.84	.121	.108	.118	.27	.34	.29	.29	.26	.28
29	.77	1.04	.84	.096	.127	.104	.38	.45	.40	.31	.31	.31
30	.86	1.23	.93	.119	.165	.128	.26	.43	.29	.29	.22	.28
31	.78	.97	.82	.102	.125	.107	.31	.33	.31	.31	.25	.30
32	.80	.98	.85	.108	.133	.115	.36	.47	.39	.33	.18	.29
33	.65	.88	.71	.060	.094	.069	.49	.48	.49	.32	.29	.31
34	.80	.89	.82	.116	.118	.116	.40	.36	.39	.25	.17	.23
35	.63	.80	.67	.076	.078	.076	1.17	.53	1.02	.29	.23	.28
36	.56	1.14	.78	.051	.117	.076	.58	.59	.58	.34	.55	.42
37	.59	.83	.66	.174	.150	.167	1.41	.46	1.14	.29	.27	.28
38	.52	.58	.53	.212	.136	.196	1.15	.45	1.01	.28	.27	.28
39	.57	.59	.57	.114	.091	.108	.78	.32	.67	.28	.29	.28
40	.53	.63	.55	.117	.108	.115	.92	.42	.80	.29	.27	.29
41	.47	.59	.50	.068	.098	.076	.48	.29	.43	.40	.27	.36
42	.54	.68	.58	.064	.101	.075	.57	.42	.53	.41	.25	.36
43	.49	.65	.53	.230	.136	.207	.87	.40	.75	.34	.26	.32
44	.51	.54	.52	.106	.103	.105	.40	.30	.38	.33	.25	.31
45	.51	.58	.53	.147	.121	.141	.73	.42	.66	.31	.27	.30
46	.48	.59	.51	.029	.062	.038	.64	.32	.55	.30	.24	.28
47	.47	.56	.49	.141	.101	.132	.70	.37	.63	.34	.29	.33
48	.52	.50	.52	.140	.092	.130	.52	.32	.48	.35	.29	.34
49	.72	.54	.67	.055	.052	.054	.68	.27	.57	.30	.23	.28
50	.50	.61	.53	.119	.096	.113	.75	.34	.64	.26	.31	.27
51	.57	.60	.58	.189	.110	.170	.68	.31	.59	.31	.29	.31
52	.49	.64	.53	.091	.082	.089	.61	.40	.55	.28	.27	.28
53	.52	.74	.57	.093	.106	.096	.57	.37	.52	.30	.31	.30
54	.50	.61	.53	.150	.107	.140	.56	.27	.49	.35	.30	.34
55	.50	.52	.51	.225	.125	.199	.49	.29	.44	.34	.29	.33
56	.62	1.05	.76	.062	.108	.077	.40	.36	.39	.28	.46	.34
57	.71	.96	.78	.056	.088	.065	.42	.32	.39	.26	.29	.27
58	.69	.91	.75	.056	.083	.063	.40	.34	.38	.29	.37	.31
59	.72	.66	.71	.052	.100	.064	.33	.34	.33	.24	.32	.26
60	.48	.82	.58	.045	.075	.053	.44	.40	.43	.29	.33	.30
61	.64	.80	.69	.092	.095	.093	.36	.39	.37	.29	.33	.30
62	.49	.78	.58	.059	.092	.069	.54	.41	.50	.28	.32	.29
63	.48	.70	.53	.124	.109	.120	.56	.28	.49	.29	.37	.31
64	.52	.81	.60	.098	.134	.108	.46	.29	.41	.27	.34	.29

TABLE 31.—*Continued*

Sample No.	Nitrogen			Phosphorus			Potassium			Calcium		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	%	%	%	%	%	%	%	%	%	%	%	%
65	.41	.87	.55	.096	.127	.105	.59	.52	.57	.24	.55	.33
66	.67	.97	.74	.054	.088	.062	.71	.47	.66	.33	.33	.33
67	.72	.89	.76	.057	.070	.060	.70	.52	.66	.34	.44	.36
68	.90	.89	.90	.063	.068	.064	.68	.41	.62	.36	.40	.37
69	.68	.91	.73	.041	.064	.046	.82	.46	.75	.33	.30	.32
70	.80	.92	.83	.076	.103	.082	.53	.39	.50	.34	.41	.36
71	.69	.93	.75	.039	.094	.053	.60	.43	.56	.34	.43	.36
72	.72	.82	.74	.043	.084	.051	.90	.48	.82	.33	.41	.35
73	.97	.93	.96	.083	.095	.086	.70	.43	.64	.37	.52	.41
74	.94	1.13	.99	.104	.135	.111	.85	.56	.78	.35	.36	.35
75	.98	1.22	1.03	.064	.133	.079	.38	.40	.38	.23	.17	.22
76	.82	1.07	.86	.049	.085	.055	.34	.43	.36	.22	.11	.20
77	.87	1.10	.91	.082	.130	.091	.30	.42	.32	.20	.15	.19
78	.75	.89	.78	.075	.100	.081	.27	.40	.30	.23	.14	.21
79	.65	.87	.70	.061	.084	.066	.34	.36	.34	.25	.16	.23
80	.49	1.35	.83	.026	.110	.059	.98	.73	.88	.35	.76	.51
81	.50	.85	.59	.029	.075	.041	.77	.41	.68	.30	.33	.31
82	.60	.83	.67	.044	.053	.047	.74	.42	.65	.31	.31	.31
83	.90	.95	.91	.069	.107	.080	.71	.50	.65	.35	.40	.36
84	.60	.94	.69	.045	.085	.056	1.19	.40	.97	.29	.40	.32
85	.47	.76	.54	.059	.083	.065	1.14	.39	.96	.28	.43	.32
86	.54	.88	.64	.060	.085	.068	1.37	.47	1.09	.34	.39	.36
87	.67	1.14	.82	.048	.104	.066	1.11	.54	.93	.31	.45	.35
88	.66	1.16	.82	.062	.108	.077	1.06	.44	.86	.33	.44	.36
89	.54	.79	.62	.069	.117	.083	.90	.74	.85	.35	.39	.36
90	.66	1.09	.78	.065	.111	.077	.36	.33	.35	.29	.31	.30
91	.82	1.06	.89	.095	.116	.101	.55	.39	.51	.27	.39	.30
92	.91	1.09	.96	.122	.134	.125	.61	.48	.58	.33	.43	.36
93	.97	1.23	1 04	.106	.116	.109	.85	.46	.75	.35	.40	.36
94	.50	.58	.52	.077	.067	.074	.62	.55	.60	.29	.32	.30
95	.63	.68	.64	.061	.060	.061	.64	.40	.58	.28	.25	.27
96	.64	.71	.66	.063	.062	.063	.63	.52	.60	.20	.26	.22
97	.75	.74	.75	.076	.054	.070	.41	.38	.40	.27	.25	.26
98	.66	.66	.66	.053	.052	.053	.60	.47	.57	.27	.23	.26
99	.54	.96	.68	.049	.088	.062	.56	.52	.55	.30	.37	.32
100	.63	.80	.67	.059	.069	.061	.41	.37	.40	.29	.23	.28
101	.70	.73	.71	.072	.069	.071	.49	.40	.47	.23	.21	.22
102	.91	.91	.91	.115	.119	.116	.47	.41	.45	.21	.26	.22
103	.79	.86	.81	.088	.107	.093	.79	.43	.69	.25	.20	.24
104	.63	.88	.74	.068	.082	.074	.32	.27	.30	.21	.28	.24
105	.48	.80	.58	.051	.075	.058	.40	.25	.35	.22	.31	.25
106	.58	.84	.67	.069	.080	.073	.47	.39	.44	.18	.28	.21
107	.67	.79	.71	.122	.114	.119	.38	.26	.34	.19	.29	.22
108	.78	.87	.81	.116	.124	.118	.63	.42	.57	.20	.24	.21
109	.44	.75	.54	.202	.148	.185	.33	.23	.30	.25	.29	.26
110	.50	.79	.60	.130	.133	.131	.40	.31	.37	.20	.23	.21
111	.50	.70	.56	.148	.111	.137	.48	.25	.41	.18	.25	.20
112	.67	.93	.76	.156	.169	.160	.34	.33	.34	.23	.32	.26
113	.74	1.02	.83	.174	.192	.180	.35	.36	.35	.27	.34	.29
114	.71	.92	.77	.126	.127	.126	.57	.37	.52	.22	.26	.23
115	.74	1.32	.98	.132	.216	.166	.78	.86	.81	.46	.80	.60
116	.88	.98	.92	.110	.160	.128	.46	.50	.47	.39	.52	.44
117	.93	1.37	1.10	.145	.219	.173	.86	.82	.84	.49	.91	.65
118	.78	1.20	.92	.138	.234	.171	.52	.68	.58	.42	.71	.52
119	.80	1.19	.95	.094	.186	.130	.92	1.02	.96	.36	.67	.48
120	.78	1.03	.83	.109	.135	.115	.87	.52	.79	.24	.24	.24
121	.79	1.08	.86	.075	.102	.082	.30	.34	.31	.21	.22	.21
122	.80	1.20	.90	.068	.096	.075	.43	.32	.40	.28	.22	.27
123	1.28	1.27	1.28	.094	.132	.101	.64	.44	.60	.30	.25	.29
124	1.07	1.27	1.12	.108	.155	.119	.85	.61	.79	.27	.27	.27
125	1.11	1.28	1.15	.111	.145	.119	1.06	.60	.95	.28	.25	.27

Table 31.—*Concluded*

Sample No.	Nitrogen			Phosphorus			Potassium			Calcium		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	%	%	%	%	%	%	%	%	%	%	%	%
126	.46	.80	.58	.114	.138	.122	.49	.46	.48	.27	.42	.32
127	.43	.70	.50	.090	.092	.091	.39	.31	.37	.23	.26	.24
128	.57	.91	.69	.068	.096	.078	.35	.27	.32	.25	.37	.29
129	.62	.88	.71	.166	.153	.161	.36	.26	.32	.31	.37	.33
130	.53	.86	.62	.094	.122	.102	1.00	.40	.83	.30	.34	.31
131	.47	.66	.52	.056	.084	.064	.48	.37	.45	.24	.30	.26
132	.41	.69	.49	.181	.153	.173	.43	.26	.38	.23	.30	.25
133	.34	.64	.42	.132	.125	.130	.69	.43	.62	.24	.29	.25
134	.64	.85	.71	.135	.157	.142	.36	.32	.35	.26	.34	.29
135	.72	.96	.80	.200	.201	.200	.33	.24	.30	.32	.39	.34
136	.13	.93	.34	.140	.146	.142	1.11	.47	.94	.26	.34	.28
137	.62	.90	.70	.168	.176	.170	.38	.29	.36	.25	.33	.27
138	.43	.70	.51	.163	.138	.155	.79	.34	.65	.29	.32	.30
139	.59	1.03	.73	.144	.154	.147	.38	.27	.34	.34	.39	.36
140	.91	1.12	.97	.145	.177	.155	.26	.26	.26	.27	.33	.29
141	.70	1.08	.78	.085	.091	.086	.33	.40	.34	.29	.29	.29
142	.72	1.20	.85	.075	.086	.078	.48	.42	.46	.26	.25	.26
143	1.05	1.35	1.12	.092	.100	.094	.80	.57	.75	.33	.28	.32
144	1.10	1.27	1.14	.132	.142	.135	.67	.59	.65	.34	.29	.33
145	1.04	1.36	1.12	.124	.136	.127	.86	.55	.79	.35	.29	.34

TABLE 32.—AMOUNTS OF NITROGEN, PHOSPHORUS, POTASSIUM, AND CALCIUM IN MATURE CORN STOVER AND ITS SEPARATED PARTS
(Pounds per acre)

Sample No.	Nitrogen			Phosphorus			Potassium			Calcium			Calculated yield		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
1	30.7	8.6	39.3	5.31	1.56	6.87	9.4	3.5	12.9	7.6	2.5	10.1	2 360	783	3 143
2	20.8	9.3	30.1	3.73	1.33	5.06	7.0	3.3	10.3	7.7	2.2	9.9	2 261	783	3 044
3	18.5	7.7	26.2	2.88	.94	3.82	9.2	3.0	12.2	7.9	2.3	10.2	2 198	808	3 006
4	11.0	4.5	15.5	1.48	.47	1.95	8.4	2.3	10.7	4.6	1.4	6.0	1 593	554	2 147
5	21.5	7.4	28.9	3.73	.96	4.69	14.1	3.8	17.9	6.9	1.8	8.7	2 168	704	2 872
6	14.6	6.0	20.6	2.38	.77	3.15	8.0	2.6	10.6	6.6	1.6	8.2	1 999	612	2 611
7	7.3	3.3	10.6	1.04	.39	1.43	2.4	1.1	3.5	2.3	0.9	3.2	732	286	1 018
8	8.3	4.2	12.5	1.15	.48	1.63	4.1	2.5	6.6	3.0	1.5	4.5	970	462	1 432
9	11.0	4.2	15.2	1.71	.58	2.29	6.1	2.1	8.2	4.0	1.3	5.3	1 237	468	1 705
10	19.5	7.3	26.8	3.10	.95	4.05	14.3	4.3	18.6	8.6	2.2	10.8	2 383	810	3 193
11	21.3	4.5	25.8	4.69	.63	5.32	16.6	2.7	19.3	9.8	1.9	11.7	2 445	658	3 103
12	21.0	10.8	31.8	3.07	1.40	4.47	10.6	5.5	16.1	8.9	2.9	11.8	2 212	1 051	3 263
13	8.4	11.5	19.9	1.07	.82	1.89	11.7	2.7	14.4	6.4	6.2	12.6	1 820	905	2 725
14	13.5	9.6	23.1	1.54	.68	2.22	13.5	3.3	16.8	7.7	3.2	10.9	2 142	852	2 994
15	22.6	15.2	37.8	1.41	1.00	2.41	25.8	5.4	31.2	10.9	5.5	16.4	2 602	1 219	3 821
16	27.7	19.1	46.8	3.60	1.89	5.49	30.3	6.6	36.9	13.8	8.2	22.0	2 881	1 323	4 204
17	31.6	20.0	51.6	3.73	1.66	5.39	40.4	7.0	47.4	12.7	5.6	18.3	3 034	1 214	4 248
18	20.8	8.0	28.8	4.25	1.26	5.51	14.2	4.4	18.6	7.0	3.3	10.3	2 055	864	2 919
19	22.4	11.5	33.9	3.96	1.25	5.21	13.2	3.4	16.6	8.3	3.1	11.4	2 237	806	3 043
20	12.8	14.6	27.4	2.50	1.07	3.57	15.1	4.2	19.3	7.4	4.0	11.4	2 249	921	3 170
21	17.0	6.5	23.5	4.39	1.05	5.44	20.7	4.1	24.8	8.7	3.1	11.8	2 299	783	3 082
22	18.0	7.7	25.7	6.18	1.68	7.86	14.1	3.2	17.3	6.6	4.4	11.0	2 279	854	3 133
23	28.2	11.7	39.9	5.99	1.88	7.87	18.1	4.7	22.8	9.8	5.2	15.0	2 660	921	3 581
24	28.2	14.5	42.7	4.05	1.97	6.02	17.2	5.4	22.6	9.3	6.6	15.9	2 911	1 316	4 227
25	12.7	10.8	23.5	2.54	1.41	3.95	12.7	5.2	17.9	6.0	3.7	9.7	2 226	1 080	3 306
26	20.5	11.2	31.7	5.87	2.39	8.26	16.1	4.1	20.2	7.7	4.9	12.6	2 732	1 244	3 976
27	16.8	5.7	22.5	2.25	.69	2.94	5.4	2.0	7.4	7.0	1.6	8.6	1 783	512	2 295
28	12.1	4.8	16.9	1.85	.51	2.36	4.1	1.6	5.7	4.4	1.2	5.6	1 526	469	1 995
29	9.9	4.3	14.2	1.23	.52	1.75	4.9	1.9	6.8	4.0	1.3	5.3	1 279	411	1 690
30	14.3	4.9	19.2	1.98	.66	2.64	4.3	1.7	6.0	4.8	0.9	5.7	1 667	402	2 069
31	14.9	4.6	19.5	1.94	.60	2.54	5.9	1.6	7.5	5.9	1.2	7.1	1 905	476	2 381
32	15.5	6.7	22.2	2.09	.91	3.00	7.0	3.2	10.2	6.4	1.2	7.6	1 935	683	2 618
33	8.4	4.1	12.5	.77	.44	1.21	6.3	2.3	8.6	4.1	1.4	5.5	1 291	471	1 762
34	16.7	6.0	22.7	2.42	.79	3.21	8.3	2.4	10.7	5.2	1.1	6.3	2 085	670	2 755
35	9.1	3.6	12.7	1.10	.35	1.45	17.0	2.4	19.4	4.2	1.0	5.2	1 450	450	1 900
36	7.6	9.5	17.1	.70	.98	1.68	7.9	4.9	12.8	4.6	4.6	9.2	1 365	834	2 199
37	10.5	5.9	16.4	3.09	1.07	4.16	25.0	3.3	28.3	5.2	1.9	7.1	1 776	716	2 492
38	9.6	2.7	12.3	3.90	.64	4.54	21.2	2.1	23.3	5.2	1.3	6.5	1 840	473	2 313
39	9.0	3.0	12.0	1.80	.47	2.27	12.3	1.7	14.0	4.4	1.5	5.9	1 577	515	2 092
40	8.9	3.3	12.2	1.96	.57	2.53	15.4	2.2	17.6	4.9	1.4	6.3	1 676	524	2 200
41	6.9	3.3	10.2	1.00	.55	1.55	7.1	1.6	8.7	5.9	1.5	7.4	1 473	557	2 030
42	7.5	3.8	11.3	.89	.56	1.45	7.9	2.3	10.3	5.7	1.4	7.1	1 383	552	1 935
43	8.6	3.7	12.3	4.05	.78	4.83	15.3	2.3	17.6	6.0	1.5	7.5	1 762	573	2 335
44	9.9	3.4	13.3	2.06	.65	2.71	7.8	1.9	9.7	6.4	1.6	8.0	1 940	635	2 575
45	11.2	3.9	15.1	3.22	.80	4.02	16.0	2.8	18.8	6.8	1.8	8.6	2 189	663	2 852
46	6.7	3.1	9.8	.40	.32	.72	8.9	1.7	10.6	4.2	1.3	5.5	1 390	519	1 909
47	7.5	2.6	10.1	2.25	.47	2.72	11.2	1.7	12.9	5.4	1.4	6.8	1 595	464	2 059
48	9.4	2.5	11.9	2.54	.47	3.01	9.4	1.6	11.0	6.4	1.5	7.9	1 813	506	2 319
49	10.9	3.0	13.9	.83	.29	1.12	10.3	1.5	11.8	4.6	1.3	5.9	1 517	549	2 066
50	8.8	3.7	12.5	2.08	.58	2.66	13.1	2.1	15.2	4.6	1.9	6.5	1 752	609	2 361
51	9.7	3.2	12.9	3.20	.59	3.79	11.5	1.7	13.2	5.3	1.6	6.9	1 693	540	2 233
52	7.6	3.6	11.2	1.40	.46	1.86	9.4	2.3	11.7	4.3	1.5	5.8	1 542	563	2 105
53	8.8	3.8	12.6	1.57	.55	2.12	9.7	1.9	11.6	5.1	1.6	6.7	1 693	519	2 212
54	8.6	3.3	11.9	2.58	.58	3.16	9.6	1.5	11.1	6.0	1.6	7.6	1 720	540	2 260
55	9.2	3.4	12.6	4.14	.83	4.97	9.0	1.9	10.9	6.3	1.9	8.2	1 842	660	2 502
56	7.1	5.9	13.0	.71	.60	1.31	4.6	2.0	6.6	3.2	2.6	5.8	1 147	559	1 706
57	8.7	4.9	13.6	.69	.45	1.14	5.1	1.6	6.7	3.2	1.5	4.7	1 224	510	1 734
58	10.1	4.5	14.6	.82	.41	1.23	5.9	1.7	7.6	4.3	1.8	6.1	1 464	492	1 956
59	11.8	3.6	15.4	.85	.54	1.39	5.4	1.9	7.3	3.9	1.7	5.6	1 641	543	2 184
60	5.4	3.6	9.0	.50	.33	.83	4.9	1.8	6.7	3.3	1.4	4.7	1 120	438	1 558
61	8.7	4.4	13.1	1.24	.52	1.76	4.9	2.1	7.0	3.9	1.8	5.7	1 353	549	1 902
62	6.3	4.5	10.8	.76	.53	1.29	7.0	2.4	9.4	3.6	1.8	5.4	1 290	575	1 865
63	6.2	3.0	9.2	1.60	.47	2.07	7.2	1.2	8.4	3.7	1.6	5.3	1 291	429	1 720
64	6.2	3.5	9.7	1.17	.59	1.76	5.5	1.3	6.8	3.2	1.5	4.7	1 198	437	1 635

TABLE 32.—*Continued*

Sample No.	Nitrogen			Phosphorus			Potassium			Calcium			Calculated yield		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
65	5.6	5.1	10.7	1.32	.74	2.06	8.1	3.0	11.1	3.3	3.2	6.5	1 376	582	1 958
66	16.4	6.8	23.2	1.32	.62	1.94	17.4	3.3	20.7	8.1	2.3	10.4	2 445	699	3 144
67	14.6	5.0	19.6	1.15	.40	1.55	14.2	2.9	17.1	6.9	2.5	9.4	2 025	565	2 590
68	23.3	6.8	30.1	1.63	.52	2.15	17.6	3.1	20.7	9.3	3.0	12.3	2 584	760	3 344
69	17.6	5.7	23.3	1.06	.40	1.46	21.2	2.9	24.1	8.6	1.9	10.5	2 590	630	3 220
70	19.5	6.6	26.1	1.85	.74	2.59	12.9	2.8	15.7	8.3	2.9	11.2	2 434	716	3 150
71	16.7	7.8	24.5	.95	.79	1.74	14.6	3.6	18.2	8.3	3.6	11.9	2 426	843	3 269
72	15.9	4.6	20.5	.95	.47	1.42	19.9	2.7	22.6	7.3	2.3	9.6	2 214	556	2 770
73	27.1	8.0	35.1	2.32	.82	3.14	19.6	3.7	23.3	10.4	4.5	14.9	2 796	864	3 660
74	25.4	9.6	35.0	2.81	1.14	3.95	22.9	4.7	27.6	9.5	3.1	12.6	2 699	847	3 546
75	13.5	4.5	18.0	.88	.49	1.37	5.3	1.5	6.8	3.2	0.6	3.8	1 381	370	1 751
76	11.4	3.2	14.6	.68	.25	.93	4.7	1.3	6.0	3.1	0.3	3.4	1 388	296	1 684
77	13.2	3.6	16.8	1.24	.43	1.67	4.5	1.4	5.9	3.0	0.5	3.5	1 514	328	1 842
78	12.2	4.6	16.8	1.22	.51	1.73	4.4	2.1	6.5	3.8	0.7	4.5	1 632	512	2 144
79	12.2	4.3	16.5	1.15	.42	1.57	6.4	1.8	8.2	4.7	0.8	5.5	1 882	497	2 379
80	6.5	11.8	18.3	.34	.96	1.30	12.9	6.4	19.3	4.6	6.6	11.2	1 321	871	2 192
81	9.1	5.4	14.5	.53	.48	1.01	14.0	2.6	16.6	5.5	2.1	7.6	1 824	635	2 459
82	11.0	6.0	17.0	.80	.38	1.18	13.5	3.0	16.5	5.7	2.2	7.9	1 829	723	2 552
83	20.2	8.4	28.6	1.55	.94	2.49	15.9	4.4	20.3	7.9	3.5	11.4	2 242	880	3 122
84	12.7	7.6	20.3	.95	.69	1.64	25.2	3.2	28.4	6.1	3.2	9.3	2 115	806	2 921
85	10.8	5.6	16.4	1.35	.61	1.96	26.1	2.9	29.0	6.4	3.2	9.6	2 293	732	3 025
86	10.9	7.8	18.7	1.21	.76	1.97	27.6	4.2	31.8	6.9	3.5	10.4	2 018	889	2 907
87	16.2	12.8	29.0	1.16	1.17	2.33	26.9	6.1	33.0	7.5	5.1	12.6	2 420	1 122	3 542
88	15.6	12.6	28.2	1.46	1.18	2.64	25.0	4.8	29.8	7.8	4.8	12.6	2 357	1 090	3 447
89	8.0	5.1	13.1	1.03	.75	1.78	13.4	4.7	18.1	5.2	2.5	7.7	1 487	640	2 127
90	12.7	7.7	20.4	1.25	.79	2.04	7.0	2.3	9.3	5.6	2.2	7.8	1 930	709	2 639
91	18.1	9.0	27.1	2.10	.98	3.08	12.2	3.3	15.5	6.0	3.3	9.3	2 212	845	3 057
92	20.4	8.3	28.7	2.73	1.02	3.75	13.7	3.7	17.4	7.4	3.3	10.7	2 240	762	3 002
93	21.0	9.1	30.1	2.30	.86	3.16	18.4	3.4	21.8	7.6	3.0	10.6	2 168	741	2 909
94	5.5	2.5	8.0	.84	.28	1.12	6.8	2.3	9.1	3.2	1.4	4.6	1 095	422	1 517
95	12.1	4.3	16.4	1.17	.38	1.55	12.3	2.5	14.8	5.4	1.6	7.0	1 919	626	2 545
96	11.2	4.2	15.4	1.10	.37	1.47	11.0	3.1	14.1	3.5	1.5	5.0	1 752	591	2 343
97	12.8	4.5	17.3	1.29	.33	1.62	7.0	2.3	9.3	4.6	1.5	6.1	1 701	610	2 311
98	11.8	2.9	14.7	.94	.23	1.17	10.7	2.1	12.8	4.8	1.0	5.8	1 783	439	2 222
99	6.7	6.1	12.8	.61	.56	1.17	7.0	3.3	10.3	3.7	2.4	6.1	1 242	640	1 882
100	10.6	4.4	15.0	.99	.38	1.37	6.9	2.0	8.9	4.9	1.3	6.2	1 676	545	2 221
101	14.8	5.3	20.1	1.52	.50	2.02	10.4	2.9	13.3	4.9	1.5	6.4	2 112	730	2 842
102	18.4	6.8	25.2	2.33	.88	3.21	9.5	3.1	12.6	4.3	1.9	6.2	2 025	743	2 768
103	16.6	6.8	23.4	1.85	.85	2.70	16.6	3.4	20.0	5.3	1.6	6.9	2 099	794	2 893
104	4.2	4.6	8.8	.45	.43	.88	2.1	1.4	3.6	1.4	1.5	2.9	662	526	1 188
105	5.4	4.1	9.5	.57	.38	.95	4.5	1.3	5.8	2.5	1.6	4.1	1 115	506	1 621
106	9.5	6.9	16.4	1.13	.66	1.79	7.7	3.2	10.9	3.0	2.3	5.3	1 644	820	2 464
107	13.4	7.7	21.1	2.43	1.11	3.54	7.6	2.5	10.1	3.8	2.8	6.6	1 993	970	2 963
108	19.2	9.1	28.3	2.85	1.29	4.14	15.5	4.4	19.9	4.9	2.5	7.4	2 461	1 044	3 505
109	5.6	4.5	10.1	2.59	.89	3.48	4.2	1.4	5.6	3.2	1.7	4.9	1 281	598	1 879
110	6.9	5.4	12.3	1.80	.91	2.71	5.6	2.1	7.7	2.8	1.6	4.4	1 387	686	2 073
111	8.5	5.1	13.6	2.50	.80	3.30	8.1	1.8	9.9	3.1	1.8	4.9	1 692	722	2 414
112	12.3	8.6	20.9	2.86	1.56	4.42	6.2	3.1	9.3	4.2	3.0	7.2	1 833	926	2 759
113	14.3	9.7	24.0	3.37	1.83	5.20	6.8	3.4	10.2	5.2	3.2	8.4	1 937	951	2 888
114	18.5	8.6	27.1	3.29	1.19	4.48	14.9	3.5	18.4	5.7	2.4	8.1	2 611	938	3 549
115	12.3	15.0	27.3	2.19	2.45	4.64	13.0	9.8	22.8	7.7	9.1	16.8	1 662	1 136	2 798
116	15.6	9.7	25.3	1.95	1.59	3.54	8.2	5.0	13.2	6.9	5.2	12.1	1 773	991	2 764
117	18.3	16.2	34.5	2.85	2.59	5 44	16.9	9.7	26.6	9.6	10.8	20.4	1 965	1 182	3 147
118	13.3	10.7	24.0	2.36	2.09	4.45	8.9	6.1	15.0	7.2	6.3	13.5	1 708	894	2 602
119	15.6	14.7	30.3	1.84	2.29	4.13	18.0	12.6	30.6	7.0	8.3	15.3	1 953	1 231	3 184
120	22.0	8.2	30.2	3.08	1.07	4.15	24.6	4.1	28.7	6.8	1.9	8.7	2 826	794	3 620
121	12.4	5.8	18.2	1.18	.55	1.73	4.7	1.8	6.5	3.3	1.2	4.5	1 568	538	2 106
122	17.2	8.5	25.7	1.46	.68	2.14	9.3	2.3	11.6	6.0	1.6	7.6	2 150	707	2 857
123	33.8	7.6	41.4	2.49	.79	3.28	16.9	2.6	19.5	7.9	1.5	9.4	2 644	596	3 240
124	27.9	10.6	38.5	2.81	1.30	4.11	22.1	5.1	27.2	7.0	2.3	9.3	2 604	836	3 440
125	30.3	11.3	41.6	3.03	1.28	4.31	28.9	5.3	34.2	7.6	2.2	9.8	2 729	886	3 615

TABLE 32.—*Concluded*

Sample No.	Nitrogen			Phosphorus			Potassium			Calcium			Calculated yield		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
126	6.7	6.1	12.8	1.67	1.06	2.73	7.2	3.5	10.7	4.0	3.2	7.2	1 464	767	2 231
127	8.0	4.5	12.5	1.68	.59	2.27	7.3	2.0	9.3	4.3	1.7	6.0	1 866	644	2 510
128	9.3	7.7	17.0	1.10	.81	1.91	5.7	2.3	8.0	4.1	3.1	7.2	1 623	845	2 468
129	10.9	8.4	19.3	2.92	1.46	4.38	6.3	2.5	8.8	5.5	3.5	9.0	1 759	956	2 715
130	13.9	8.8	22.7	2.47	1.25	3.72	26.2	4.1	30.3	7.9	3.5	11.4	2 625	1 028	3 653
131	8.7	5.0	13.7	1.04	.63	1.67	8.9	2.8	11.7	4.4	2.3	6.7	1 849	753	2 602
132	5.4	3.4	8.8	2.38	.76	3.14	5.7	1.3	7.0	3.0	1.5	4.5	1 314	499	1 813
133	5.8	4.2	10.0	2.24	.83	3.07	11.7	2.8	14.5	4.1	1.9	6.0	1 697	660	2 357
134	13.5	8.5	22.0	2.85	1.57	4.42	7.6	3.2	10.8	5.5	3.4	8.9	2 113	1 000	3 113
135	10.6	6.7	17.3	2.96	1.40	4.36	4.9	1.7	6.6	4.7	2.7	7.4	1 478	699	2 177
136	3.8	10.0	13.8	4.13	1.56	5.69	32.7	5.0	37.7	7.7	3.6	11.3	2 949	1 071	4 020
137	9.8	5.2	15.0	2.62	1.02	3.64	5.9	1.7	7.6	3.9	1.9	5.8	1 561	579	2 140
138	7.4	5.2	12.6	2.81	1.02	3.83	13.6	2.5	16.1	5.0	2.4	7.4	1 722	741	2 463
139	6.9	5.8	12.7	1.67	.87	2.54	4.4	1.5	5.9	3.9	2.2	6.1	1 161	566	1 727
140	14.9	8.1	23.0	2.37	1.27	3.64	4.3	1.9	6.2	4.4	2.4	6.8	1 634	720	2 354
141	14.8	5.9	20.7	1.80	.50	2.30	7.0	2.2	9.2	6.1	1.6	7.7	2 115	547	2 662
142	16.3	9.7	26.0	1.69	.69	2.38	10.8	3.4	14.2	5.9	2.0	7.9	2 258	808	3 066
143	25.8	9.9	35.7	2.26	.74	3.00	19.6	4.2	23.8	8.1	2.1	10.2	2 456	736	3 192
144	32.3	13.3	45.6	3.88	1.49	5.37	19.7	6.2	25.9	10.0	3.0	13.0	2 937	1 050	3 987
145	27.1	11.1	38.2	3.23	1.12	4.35	22.4	4.5	26.9	9.1	2.4	11.5	2 602	820	3 422

TABLE 33.—TOTAL ASH AND ORGANIC CARBON IN SAMPLES OF MATURE CORN STOVER AND ITS SEPARATED PARTS

Sample No.	Total ash			Organic carbon		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	%	%	%	%	%	%
1	4.78	5.20	4.88	46.17	43.97	45.62
2	3.85	6.53	4.54	45.99	43.35	45.31
3	4.17	6.72	4.86	45.09	42.94	44.51
4	3.64	5.62	4.15	44.94	42.87	44.41
5	4.07	6.21	4.59	45.39	43.26	44.87
6	3.54	5.18	3.92	45.72	43.70	45.25
7	4.33	8.68	5.55	46.05	42.24	44.98
8	3.81	8.21	5.23	46.22	42.13	44.90
9	4.37	6.72	5.01	46.23	42.59	45.23
10	3.41	4.98	3.81	46.37	44.31	45.85
11	4.17	5.50	4.45	45.55	42.73	44.95
12	3.92	6.27	4.68	45.22	43.46	44.65
13	6.04	13.72	8.59	45.17	40.90	43.75
14	5.59	8.47	6.41	44.87	42.58	44.22
15	5.78	8.97	6.80	44.82	42.53	44.09
16	5.45	9.56	6.74	44.10	42.61	43.63
17	5.83	8.69	6.65	45.18	43.97	44.83
18	4.99	7.53	5.74	45.99	42.91	45.08
19	5.03	6.90	5.53	45.24	43.36	44.74
20	5.00	8.87	6.12	44.82	42.31	44.09
21	5.65	7.11	6.02	44.04	43.04	43.79
22	5.11	8.65	6.08	45.10	42.39	44.36
23	5.87	11.81	7.40	45.13	42.16	44.37
24	4.59	7.93	5.63	45.02	43.02	44.40
25	4.47	7.78	5.55	46.10	42.76	45.01
26	4.89	7.82	5.81	45.12	43.11	44.49
27	4.27	7.05	4.89	45.95	43.96	45.51
28	3.59	7.01	4.39	47.14	43.75	46.34
29	4.33	6.84	4.94	46.92	43.96	46.20
30	3.82	6.98	4.43	46.51	43.78	45.98
31	4.01	5.40	4.29	47.35	44.01	46.68
32	3.17	4.23	3.45	47.09	44.67	46.46
33	4.06	7.97	5.10	44.59	43.23	44.23
34	3.80	5.34	4.15	45.43	44.18	45.13
35	5.20	6.54	5.52	45.19	42.69	44.60
36	5.93	10.53	7.67	44.08	41.27	43.01
37	6.62	9.81	7.54	45.26	40.92	44.01
38	6.32	7.34	6.53	45.12	42.33	44.55
39	5.25	8.63	6.08	45.40	41.64	44.48
40	6.04	10.79	7.17	44.90	41.08	43.99
41	5.20	6.90	5.73	44.31	42.38	43.78
42	5.33	6.95	5.79	44.51	42.25	43.87
43	6.18	7.65	6.54	44.78	42.31	44.17
44	5.03	7.49	5.64	43.66	41.79	43.20
45	5.39	8.69	6.16	43.78	42.01	43.37
46	5.32	6.34	5.60	44.57	42.01	43.87
47	5.68	7.29	6.04	43.88	41.74	43.40
48	5.43	6.90	5.75	43.94	42.10	43.54
49	5.54	5.46	5.52	43.58	42.61	43.32
50	6.44	8.39	6.94	42.92	41.61	42.58
51	6.55	7.85	6.86	44.23	42.63	43.84
52	5.13	7.02	5.63	44.11	43.22	43.87
53	6.15	8.49	6.70	44.49	43.22	44.19
54	5.77	7.80	6.25	44.39	43.08	44.08
55	6.06	7.25	6.37	43.80	43.18	43.64
56	6.13	9.97	7.39	43.67	41.91	43.09
57	4.96	8.81	6.09	45.27	42.69	44.51
58	4.14	10.14	5.65	44.53	41.69	43.81
59	3.71	7.19	4.58	45.24	42.39	44.53
60	6.45	11.90	7.98	43.38	40.70	42.63
61	5.51	12.64	7.56	45.06	40.61	43.78
62	6.23	14.80	8.87	44.83	40.51	43.50
63	5.95	14.78	8.15	44.20	40.32	43.23
64	5.71	14.60	8.09	44.48	40.08	43.30

TABLE 33.—*Continued*

Sample No.	Total ash			Organic carbon		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	%	%	%	%	%	%
65	5.41	11.62	7.25	44.34	41.85	43.60
66	4.57	7.27	5.17	45.38	43.49	44.96
67	5.64	8.69	6.30	44.45	42.21	43.96
68	4.90	7.32	5.45	44.46	44.09	44.38
69	5.13	7.86	5.68	43.90	42.04	43.53
70	4.57	7.14	5.15	44.90	42.23	44.29
71	4.45	8.07	5.38	44.19	43.88	44.11
72	4.71	6.77	5.12	45.20	43.93	44.94
73	5.06	7.40	5.61	44.06	43.28	43.88
74	5.36	7.67	5.91	44.02	43.28	43.84
75	3.27	4.43	3.52	45.61	42.16	44.88
76	3.17	4.47	3.40	45.51	42.08	44.91
77	3.48	3.94	3.56	45.23	42.32	44.71
78	3.25	6.23	3.96	44.40	43.24	44.12
79	3.77	6.17	4.27	44.46	42.72	44.10
80	5.60	12.21	8.22	43.56	42.25	43.04
81	5.15	7.32	5.71	44.14	43.72	44.03
82	5.24	6.95	5.72	44.46	42.96	44.04
83	5.00	7.66	5.75	44.79	42.54	44.16
84	5.65	9.29	6.65	43.85	42.62	43.51
85	5.01	9.09	6.00	44.28	42.50	43.85
86	6.25	9.65	7.29	45.06	42.65	44.32
87	5.35	10.04	6.84	44.86	42.54	44.12
88	4.89	9.45	6.33	44.93	42.97	44.31
89	6.14	7.44	6.53	43.56	43.49	43.54
90	4.39	6.28	4.90	44.12	43.23	43.88
91	4.47	8.81	5.67	45.06	43.86	44.73
92	5.47	8.25	6.18	44.30	43.85	44.19
93	5.34	8.76	6.21	44.75	44.35	44.65
94	4.71	5.74	5.00	45.16	43.55	44.71
95	3.81	5.13	4.13	45.44	44.11	45.11
96	3.72	5.79	4.24	45.49	44.38	45.21
97	3.38	5.04	3.82	46.12	44.12	45.59
98	4.00	5.11	4.22	45.21	43.75	44.92
99	5.35	10.60	7.14	44.49	41.93	43.62
100	4.08	5.26	4.37	44.67	43.75	44.44
101	3.61	4.36	3.80	45.36	45.96	45.51
102	3.80	5.12	4.15	45.14	45.20	45.16
103	3.87	4.34	4.00	43.67	45.05	44.05
104	7.26	9.11	8.08	43.21	43.56	43.37
105	5.55	10.30	7.03	43.59	42.13	43.13
106	5.58	7.97	6.38	43.63	43.18	43.48
107	4.18	7.31	5.20	43.55	44.79	43.95
108	4.23	6.53	4.92	43.59	43.97	44.70
109	4.88	8.15	5.92	43.93	42.51	43.48
110	4.75	7.38	5.62	44.53	43.36	44.14
111	5.21	7.31	5.84	43.88	43.34	43.72
112	4.75	8.23	5.92	44.69	43.09	44.15
113	4.33	8.26	5.62	44.41	42.54	43.79
114	3.89	7.25	4.78	44.53	43.25	44.18
115	4.34	7.87	5.77	44.85	43.71	44.39
116	3.27	5.03	3.90	45.79	43.98	45.14
117	4.10	7.52	5.39	45.29	43.81	44.73
118	3.68	6.53	4.66	44.89	43.96	44.57
119	3.81	7.45	5.22	45.95	43.47	44.99
120	4.62	5.54	4.82	45.25	43.47	44.86
121	3.71	5.20	4.09	44.52	43.28	44.20
122	4.25	5.29	4.51	45.66	45.34	45.58
123	4.08	5.32	4.31	45.85	45.10	45.71
124	4.37	5.76	4.71	45.76	45.33	45.66
125	4.81	5.15	4.89	45.77	45.36	45.67

Table 33.—*Concluded*

Sample No.	Total ash			Organic carbon		
	Stalks	Leaves	Stover	Stalks	Leaves	Stover
	%	%	%	%	%	%
126	5.55	9.46	6.90	44.79	42.13	43.87
127	4.65	7.78	5.45	45.41	43.68	44.97
128	5.30	7.85	6.17	45.14	43.93	44.73
129	4.92	7.20	5.72	45.29	43.94	44.81
130	4.99	7.33	5.65	45.96	43.70	45.32
131	4.85	7.50	5.62	45.28	43.06	44.64
132	5.43	10.67	6.87	44.53	41.35	43.66
133	5.14	8.56	6.10	45.35	42.24	44.48
134	4.51	7.69	5.53	45.39	42.76	44.54
135	5.10	8.28	6.12	44.87	42.44	44.09
136	4.98	8.17	5.83	45.74	43.18	45.06
137	5.44	8.92	6.38	44.04	43.51	43.90
138	4.88	7.89	5.79	45.32	44.05	44.94
139	5.40	9.94	6.89	45.09	43.12	44.44
140	4.55	8.69	5.82	45.59	42.91	44.77
141	4.43	6.11	4.77	46.42	43.52	45.83
142	4.50	6.41	5.00	45.66	43.20	45.01
143	4.56	6.30	4.96	45.40	43.34	44.92
144	4.41	5.86	4.79	45.65	44.69	45.40
145	4.58	6.12	4.95	45.88	44.83	45.63

LIST OF TABLES AND CHARTS

TABLES PAGE

TABLES (continued) PAGE

FIGS. PAGE

7-37—4050—12124