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Experiments with Fertilizers and Field Crops on Important Soil Types of Middle Tennessee

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EXPERIMENTS WITH FERTILIZERS AND FIELD CROPS ON IMPORTANT SOIL TYPES OF MIDDLE TENNESSEE

INTRODUCTORY REMARKS

The prime purpose of the experiments in agronomy for the years 1909 and 1910 was, as in 1907 and 1908, to get information concerning the most important soil types of Middle Tennessee. The value of fertilizers, lime, and manure should be definitely known for each kind of soil, but previous to 1907, when this work was started, practically no reliable data from field trials had been gotten for this large and important agricultural section.

The same difficulties of untoward season, lack of uniformity in the fertility of plots, etc., mentioned in the previous report, were encountered in the last two years. In particular, however, was the work hampered in 1909 by the delay in getting the experiments started, owing to the uncertainty of the State appropriation for the purpose. However, many valuable data have been obtained. As in the past, most of the results have been gotten with the aid of only the common implements found on the farm and under the usual methods of culture. There is little doubt that in many instances improved implements and methods of culture would have resulted in higher yields than those which were obtained. The problems involved both in the rotation and cultivation of the important farm crops are numerous and well worthy of the investigation which it is hoped will be undertaken at an early date.

Special credit should be given for oversight of the operations to Mr. J. E. Converse in the counties of Cumberland, Overton, and Putnam; to Mr. W. N. Rudd in the counties of White, Warren, DeKalb, and Coffee; and to Mr. L. R. Neel in the counties of Giles, Humphreys, Lincoln, Maury, Montgomery, and Rutherford.

For the sake of convenience in reference, the experiments conducted on each of the three major agricultural areas have been kept separate and are arranged in alphabetical order according to the crops under test.

THE HIGHLAND RIM

The Highland Rim soils may be roughly divided into two large groups, one consisting of those derived from the decomposition of

limestone, and the other, those derived from a siliceous or "freestone" formation. Over large areas the former are readily distinguished by their very dark red or "mulatto" color. They are heavy silt loams, which are recognized as much more fertile and valuable than the gray-colored light silt loams of siliceous origin. Other areas of limestone origin consist of grayish or brownish loams which have red subsoils. The siliceous soils can be subdivided into several closely related classes, which may be distinguished by differences in both texture and color, the latter being especially pronounced in the subsoil, which varies from light red to yellow and gray. The investigation of these various soils has not progressed far enough to permit of accurate distinctions in all respects, but if the dark red soils be placed first in value, then the gray soils with red subsoils come next, followed by those with yellowish subsoil, while the least valuable and the most difficult to handle are the light gray, silty soils, which are known as "crawfishy" and which are apt to be in need of drainage.

In regard to adaptability to different crops: The dark red areas are especially well suited to wheat, corn, and various forage crops, including clover and grass. The gray soils are excellent for tobacco, peanuts, and various trucking crops; also for corn, wheat and other general farm crops, although clover and grass are satisfactorily obtained with some difficulty. It should be considered, however, that for all the Highland Rim uplands, manure, fertilizers, and lime are important aids to successful farming, as the data which follow amply show.

ALFALFA

I. ON DARK RED SOIL

The dark red soil of the Rim is, as stated, well suited to general farm crops. Under good management clover and grass are grown profitably, and within the last few years alfalfa has been made a decided success in different places, but particularly in the vicinity of Belvidere, Franklin County, where may be seen fields of 20 or more acres, which have been cut from one to five years. This success has been had chiefly on farms where live stock has played an important part in the improvement of the soil and where excellent methods of management have been followed for a number of years. Occasionally, however, alfalfa has been made to thrive on comparatively poor land, such as that used in the co-operative trials, which were undertaken both to demonstrate the methods successfully followed at the Station farm by Director Morgan, and also to get additional information as to the soil requirements. These demonstrations at two places near McMinnville, were conducted on a typical dark red soil of limestone origin, which had been impoverished by long continued cropping without the aid of more than meager quantities of either manure or other fertilizer. The large size of the plots, totaling 2½ acres in one place and 5 in the other, were sufficient

to attract general attention in the vicinity, especially as the crops were of excellent appearance and made fair yields, under the circumstances. All the fertilizer materials, including the ground limestone and the manure, were applied broadcast in the summer of 1909, and were thoroughly worked into the soil. The land had been previously plowed and was kept free from weeds by repeated harrowing throughout the summer. This is especially important as crab grass is a most serious enemy to alfalfa and is the prime cause of many failures. In addition to cleaning the land of weeds, the tillage maintains a good supply of moisture and promotes the accumulation of nitrates, so that at seeding time, preferably late in August or early in September, all the soil conditions will be favorable to the rapid germination and growth of the alfalfa. Late seeding, after the middle of September, may be successful because of very favorable soil and weather conditions, but is always attended with considerable risk, since small plants are easily frozen out during the winter. In these instances the seed was sown a little late, September 13, 1909, but an excellent stand was obtained. A high rate of seeding is important because the inroads made on the stand by disease, weeds, etc., are often excessive, so that 24 or more pounds per acre are recommended. The seed may be sown broadcast, and in order to insure even distribution cross seeding is advisable.

Both series, one on the farm of Mr. W. T. Blue, and the other on Judge Marion Smith's place, McMinnville, are practically duplicate experiments. Manure and lime were assumed to be necessary, but the quantity of ground limestone to use for best results was an important question to be settled. In each series, two plots, one without manure, fertilizer, or lime, and the other manured at the rate of 12 tons of stable manure per acre, were left without inoculation, but inoculated soil from an old alfalfa field was sown broadcast over the balance of the plots and well harrowed in. The necessity of inoculation was very forcibly shown by the failure without it to get more than a sickly growth of alfalfa in similar trials started in 1907, in various parts of Middle Tennessee.

The season was fairly favorable. The original plan included the harrowing of the ground after each cutting and was carried out in part. This treatment, if the ground be not too dry, is an important means of holding crab grass and other weeds in check; otherwise the life of the field will be greatly shortened. A disk harrow, with disks set straight, or a weighted spike-tooth harrow, may be used; and the rough handling which the alfalfa will endure is surprising.

TABLE I.—*5-acre alfalfa experiment, on farm of Judge Marion Smith, McMinnville, Warren County—yields obtained in 1910, the first year after seeding*

Plot	Size of plot	Fertilizer, etc., per acre	Inoculation	Yield of hay per acre			
				First cutting	Second cutting	Third and fourth cuttings	Total
				Tons	Tons	Tons	Tons
1a	¼ Acre	None	Inoculated		0.27		0.27
1b	¼ Acre	None	Not inoculated				
1c	¼ Acre	12 tons yard manure	Inoculated		0.42		0.42
1d	¼ Acre	12 tons yard manure	Not inoculated				
2	1 Acre	12 tons yard manure, 2 tons ground limestone, 500 lbs. acid phosphate, 500 lbs. bone meal, 100 lbs. muriate of potash	Inoculated	1.00	0.65	1.56	3.53
3a	½ Acre	The same as plot 2, but 4 tons ground limestone	Inoculated	1.42	0.64	1.22	3.28
3b	½ Acre	The same as plot 2, but no phosphate	Inoculated	1.15	0.45	0.96	2.56
4	1 Acre	The same as plot 2, but 6 tons ground limestone	Inoculated	1.63	0.80	1.57	4.00
5a	½ Acre	The same as plot 2, but 8 tons ground limestone	Inoculated	1.73	0.79	0.81	3.33
5b	½ Acre	The same as plot 2, but no potash	Inoculated	1.96	0.82	0.49	3.37

TABLE II.—*2½-acre alfalfa experiment, on farm of W. T. Blue, near McMinnville, Warren County—yields obtained in 1910, the first year after seeding*

Plot	Size of plot	Fertilizer, etc., per acre	Inoculation	Yield of hay per acre			
				First cutting	Second cutting	Third cutting	Total
				Tons	Tons	Tons	Tons
1a	⅛ Acre	None	Inoculated	Record not available			
1b	⅛ Acre	None	Not inoculated				
1c	⅛ Acre	12 tons yard manure	Inoculated			Very little	Very little
1d	⅛ Acre	12 tons yard manure	Not inoculated				
2	½ Acre	12 tons yard manure, 2 tons ground limestone, 500 lbs. acid phosphate, 500 lbs. bone meal, 100 lbs. muriate of potash	Inoculated		1.15	0.93	4.04
3a	¼ Acre	The same as plot 2, but 4 tons ground limestone	Inoculated		0.96	0.86	3.60
3b	¼ Acre	The same as plot 2, but no phosphate	Inoculated		0.61	0.64	2.72
4	½ Acre	The same as plot 2, but 6 tons ground limestone	Inoculated		1.01	0.38	3.19
5a	¼ Acre	The same as plot 2, but 8 tons ground limestone	Inoculated		0.47	0.60	3.75
5b	¼ Acre	The same as plot 2, but no potash	Inoculated		0.53	0.32	3.09

COMMENTS ON THE RESULTS

Allowance must be made in the interpretation of the results for some lack of uniformity in soil fertility, not only in these but also in all field trials, so that only the most certain and obvious conclusions will be drawn throughout the report.

Inoculation was plainly a necessity, as shown by the absence of nodules on the alfalfa roots of both sets of uninoculated plots, as well as by the pale color of the plants. On all others the plants were of excellent color and the nodules were abundant. A comparison of plots 1 c and 3 b shows the great value of lime. Strictly speaking, these plots can not be compared in this way because of the muriate of potash applied to the latter but not to the former, but the known abundance of potash in this type of soil, not to mention the relative excess of this element in the 12 tons of manure, justifies the comparison on the lime basis. In both sets the great value of phosphates is shown by the low yields on plot 3 b, which received neither bone meal nor acid phosphate. The average reduction in yield, when compared with plot 2, which received the phosphates, is more than 1 ton of hay per acre. As to the best amount of limestone, there is no evidence that more than 2 tons per acre is needed. Even if a smaller amount could have been used with equally good results at the outset, 2 tons can not be looked upon as an excessive quantity when it is to be the only application for a number of years. The results do not indicate any immediate need of potash, but under continued removal of hay a deficiency of this element may be manifested.

Owing to the large size of the plots, which were designed chiefly for demonstration purposes, all the information desired could not be gotten. In particular the question arises as to the effect of the fertilizers and lime without the aid of manure. All the answer that can be given now is, that on similar soils where this has been tried the alfalfa has been poor as compared with that where manure has been used in addition. We may conclude, therefore, that the successful culture of alfalfa on this type of soil depends on the following conditions:

1. Thorough preparation of the soil, begun some months previous to seeding.

2. The cleansing of the soil from weed seeds by frequent harrowing so that no weeds go to seed the summer previous to the seeding of the alfalfa.

3. A dressing of lime, either 1 ton of burnt lime or 2 tons of ground limestone per acre.

4. Heavy phosphating, as in the experiments reported.

5. At least moderately heavy manuring, to be done early in the season so that weed seeds may sprout and be gotten rid of before fall.

TABLE III.—*Alfalfa on gray soil of Highland Rim, on farm of Weaver Brothers, Warren County—yields obtained in 1910, the first year after seeding*

Plot	Fertilizer, etc., per acre	Yield of hay per acre			Notes taken June 7, 1910
		First cutting	Second cutting	Total	
		Tons	Tons	Tons	
1	900 lbs. acid phosphate 150 lbs. muriate of potash				Poor.
2	900 lbs. acid phosphate 50 lbs. muriate of potash 1 ton wood ashes	1.48		1.48	Short, poor stand, but color good.
3	18 tons yard manure 300 lbs. acid phosphate 50 lbs. muriate of potash 1 ton wood ashes	2.30	1.06	3.36	Color, growth and stand good. Almost free of oats.
4	600 lbs. bone meal 150 lbs. muriate of potash	1.66	0.69	2.35	Color and growth good. Oats rather abundant.
5	600 lbs. bone meal 50 lbs. muriate of potash 1 ton wood ashes	1.64	0.65	2.29	Too many oats for fair yields. Alfalfa good.
6	18 tons yard manure 300 lbs. acid phosphate 50 lbs. muriate of potash	2.32	1.60	3.92	Alfalfa excellent. Only a few oat plants.
7	30 tons yard manure 300 lbs. acid phosphate 50 lbs. muriate of potash	2.01	1.69	3.70	Alfalfa would have done well, but oats in great quantity.
8	1200 lbs. acid phosphate 200 lbs. muriate of potash	1.16	0.23	1.39	Alfalfa very poor. Lacks in color, growth, and stand.
9	3 tons yard manure 900 lbs. acid phosphate 150 lbs. muriate of potash 1 ton burnt lime	2.09	0.53	2.62	Color and growth good. No oats.
10	30 tons yard manure 300 lbs. acid phosphate 50 lbs. muriate of potash 1 ton wood ashes	2.13	1.72	3.85	A very fine plot, but oats heavy.
11	15 tons yard manure 650 lbs. acid phosphate 50 lbs. muriate of potash	3.19	1.36	4.55	Alfalfa excellent.
12	18 tons yard manure 900 lbs. acid phosphate 50 lbs. muriate of potash 1 ton wood ashes	3.34	1.08	4.42	Alfalfa excellent
13	1500 lbs. acid phosphate 50 lbs. muriate of potash 1 ton wood ashes	2.60	0.47	3.07	Alfalfa good.
14	900 lbs. acid phosphate 50 lbs. muriate of potash 1 ton wood ashes	2.85	0.53	3.38	Alfalfa good.

6. Inoculation at the rate of 300 to 400 pounds per acre of soil from an old alfalfa field.

7. Liberal seeding—24 to 30 pounds of the best seed per acre.

8. Thorough harrowing of the alfalfa after each cutting, but when the ground is not too dry.

2. ON GRAY SOIL

Alfalfa experiments were made on the Weaver Bros. farm near McMinnville, on a typical gray soil, which had previously received practically no manure or fertilizer and was considered to be decidedly poor, although the mechanical condition and drainage were excellent. All the plots save one were inoculated with soil from an old alfalfa field, but the alfalfa on the uninoculated plot was of good color and made excellent growth. This plot was located, however, at the end of the range and on somewhat lower ground than the others, from which it probably received surface water during heavy rains. No conclusion can therefore be drawn with regard to the need of inoculation. Because of volunteer oats on some of the plots, the yields from the first cutting are not altogether reliable, so that the second cutting gives the more important data.

The results indicate a somewhat different soil condition from that found in the red-land series. For example, manure and fertilizer without lime gave excellent crops, apparently equal to those obtained on the red land where lime was applied in addition to the other materials. Without either manure or lime, the mineral fertilizers gave either no cutting or a small one, but with lime (or ashes) the yield was decidedly increased, but did not equal that obtained where manure was used, the good effect of the latter being especially evident in the second cutting. A small experiment on a similar soil on the farm of Mr. Hinckley in the same county indicated that alfalfa might be grown to advantage. This crop can therefore be recommended for trial on gray-colored soil and the recommendations for the red land are advised.

CORN

In corn culture numerous problems are presented to the Tennessee farmer. There are questions with regard to varieties, fertilizers, methods of cultivation, the effect of cowpeas when planted with corn, and crop rotations. These questions require continued trials for a number of years to give reliable answers. In Table IV, V, VI, and VII are the data obtained on Rim soils in the past two seasons. When taken in connection with the results of the previous two years, and considered also in connection with other Station trials, they become of appreciable value. The outcome of the series to determine the effect of cowpeas when planted with corn is in harmony with several trials made at the Station farm, where peas planted at the same time as the corn have materially reduced the yield of the corn, but when planted at the last working caused no

appreciable decrease in yield. The results of the fertilizer experiments are in harmony with those of previous trials on these soils. A moderately heavy application of a complete fertilizer, high in both phosphoric acid and nitrogen, has thus far given the most profitable returns. The formulas referred to in Table IV are as follows:

FORMULA 1

1200 lbs. high-grade acid phosphate
100 " muriate of potash
480 " cotton-seed meal
This mixture analyzes approximately—
11 per cent available phosphoric acid
1¾ " " nitrogen
3 " " potash

FORMULA 2

1200 lbs. high-grade acid phosphate
100 " muriate of potash
720 " cotton-seed meal
This mixture analyzes approximately—
10 per cent available phosphoric acid
2½ " " nitrogen
3 " " potash

FORMULA 3

1200 lbs. high-grade acid phosphate
100 " muriate of potash
1440 " cotton-seed meal
This mixture analyzes approximately—
8 per cent available phosphoric acid
3½ " " nitrogen
2½ " " potash

The experiments in corn culture started in 1910, on Mr. Rudd's farm will require several years before satisfactory conclusions can be reached.

TABLE IV.—*Fertilizer experiments with corn, on soils of the Highland Rim*

Locality and soil	Plot	Fertilizer per acre	Yield per acre		Calculated increase from fertilizer		Cost of fertilizer per acre	Calculated profit* per acre from fertilizer	Remarks
			Grain	Stover	Grain	Stover			
			Bu.	Tons	Bu.	Tons			
Overton Co.	1	None	7.4	0.60					Date of seeding, June 10, 1910.
	2	135 lbs. Formula 1	16.0	0.70			$1.49	—$1.49	
	3	202 lbs. Formula 1	23.4	0.82	6.3		2.22	1.56	
Farm of	4	404 lbs. Formula 1	28.0	1.02	10.9	0.16	4.44	2.10	Plot 1 omitted from average of check plots (1, 7 and 12).
T. W. Carlock,	5	150 lbs. Formula 2	19.4	0.80	2.3		1.73	— 0.35	
Livingston	6	225 lbs. Formula 2	28.0	1.04	10.9	0.18	2.59	3.95	
Red soil	7	None	17.1	1.00					
from	8	450 lbs. Formula 2	29.1	1.02	12.0	0.16	5.18	2.02	
limestone	9	206 lbs. Formula 3	25.7	0.96	8.6	0.10	2.55	2.61	
formation	10	308 lbs. Formula 3	29.7	1.14	12.6	0.28	3.82	3.74	
	11	617 lbs. Formula 3	35.4	1.16	18.3	0.30	7.65	3.33	
	12	None	17.1	0.72					
Putnam Co.		None	28.9	0.88					Date of planting, May 5, 1910.
Farm of J. B. Barnes, Cookeville. Gray soil from siliceous formation	1, 2 & 3	150 lbs. acid phosphate 25 lbs. muriate of potash 266 lbs. cotton-seed meal	42.9	1.17	14.0	0.29	5.88	2.52	
	11, 12 & 13	150 lbs. acid phosphate 25 lbs. muriate of potash 107 lbs. nitrate of soda	45.3	1.29	16.4	0.41	5.10	4.74	
	15, 16, 17 & 19	300 lbs. acid phosphate 50 lbs. muriate of potash 266 lbs. cotton-seed meal	42.0	1.27	13.1	0.39	7.77	0.09	
	5, 6, 7 & 9	300 lbs. acid phosphate 50 lbs. muriate of potash 107 lbs. nitrate of soda	44.0	1.15	15.1	0.27	6.99	2.07	

*Corn valued at 60c per bu.

TABLE V.—*Corn alone versus corn and cowpeas, on gray soil of Highland Rim, Warren County, 1909*

Plot	Fertilizer	Cowpeas (Whips)	Yield of corn per acre		Remarks
			Grain	Stover	
			Bu.	Tons	
17	None	Sown broadcast at last working of corn.	15.2	0.95	Corn planted June 9, 1909. Land well prepared.
18	None	Drilled in when corn planted.	6.2	0.88	"A typical gray soil of north Warren County."
19		No cowpeas sown.	8.4	0.71	
14	300 lbs. acid phosphate	Sown broadcast at last working of corn.	20.3	1.18	Two plots planted only to cowpeas yielded on the average 1280 pounds of hay per acre.
15	300 lbs. acid phosphate	Drilled in when corn planted.	11.5	1.28	
16	300 lbs. acid phosphate	No cowpeas sown.	16.8	1.20	
11	300 lbs. acid phosphate 50 lbs. muriate of potash	Sown broadcast at last working of corn.	21.3	1.26	Both were fertilized with acid phosphate at rate of 300 lbs. per acre.
12	do.	Drilled in when corn planted.	11.4	1.16	
13	do.	No cowpeas sown.	21.4	0.70	

TABLE VI.—*Variety trials of corn on Highland Rim soils*

Locality and soil	Variety	Date of planting	Yield per acre		Remarks
			Grain	Stover	
			Bu.	Tons	
Montgomery Co. Farm of P. L. Harned, Carbondale. Red soil from limestone formation.	Iowa Silver Mine	1908	22.3	1.04	Season rather unfavorable—latter part dry.
	Leaming	do.	22.6	0.66	
	Boone County White	do.	14.3	1.22	
	Hickory King	do.	17.1	1.20	
	Webb's Improved Watson	do.	18.9	2.22	
	Huffman	do.	9.0	2.65	
Humphreys Co Farm of A. B. Simpson, Waverly. Gray-colored flat land.	Iowa Silver Mine	July 5, 1909	22.8		Planted after spring oats, or too late for good yields.
	Reid's Yellow Dent	do.	19.7		
	Hickory King	do.	14.0		
	(Local variety)	do.	8.1		
	Webb's Improved Watson	do.	9.7		

TABLE VI.—*Variety trials of corn on Highland Rim soils*—Continued

Locality and soil	Variety	Date of planting	Yield per acre		Remarks
			Grain	Stover	
			Bu.	Tons	
Humphreys Co. Farm of J. W. Tubb, Waverly. Gray-colored flat land.	Iowa Silver Mine	May 26, 1909	15.7	0.73	
	Boone County White	do.	25.7	0.99	
	Hickory King	do.	30.9	1.09	
	Webb's Improved Watson	do.	25.6	1.15	
	Huffman	do.	23.9	1.63	
	(Local variety)	do.	17.4	0.86	
Overton Co. Farm of T. W. Carlock, Livingston. Red soil from limestone formation.	Boone County White	June 10, 1909	13.7	0.76	
	Hickory King	do.	17.7	0.84	
	Ledbetter's	do.	9.7	0.90	
	Early White	do.	8.3	0.36	
	White Flint	do.	9.7	0.58	
Warren Co. Farm of Mr. Baker, McMinnville. Red soil from limestone formation.	Leaming	May 2, 1910	37.1	0.78	Fair upland.
	Reid's Yellow Dent	do.	16.1	0.69	
	Albemarle	do.	20.7	0.84	
	Hickory King	do.	34.6	1.15	
Warren Co. Farm of Weaver Bros., McMinnville. Gray soil with light red subsoil.	Iowa Silver Mine	1910	53.6		Each variety planted at rate of 6000 stalks per acre.
	Leaming	do.	49.0		
	Reid's Yellow Dent	do.	50.2		
	Albemarle	do.	30.1		
	Hickory King	do.	50.2		
	Pride of Oklahoma	do.	48.6		
	Improved Klondike	do.	45.2		
Warren Co. Farm of G. W. Hinkley. Typical gray soil of north Warren Co.	Leaming	June 9, 1909	24.6	0.86	
	Albemarle	do.	23.4	1.13	
	Hickory King	do.	22.7	0.80	
	Webb's Improved Watson	do.	36.6	1.26	
	Hannah	do.	25.0	1.08	
	Red Cob	do.	18.5	1.48	
	Shoe Peg	do.	24.6	0.99	

TABLE VII.—*Experiments in corn culture, on farm of W. N. Rudd, Warren County, 1910*

Section	Plot	Plowing, etc.	Cultivation	No. of stalks per acre	Yield of grain per acre	Remarks
					Bu.	
1	1	Plowed twice and thoroughly prepared each time.....	Not cultivated after planting, but weeds scraped off with hoe	4000	44.5	This series was planned somewhat differently, but owing to the season the plan could not be fully carried out. Hickory King corn used throughout.
1	2	Same as Plot 1, Section 1..	Same as Plot 1, Section 1..	5000	44.1	
1	3	Same as Plot 1, Section 1..	Same as Plot 1, Section 1..	6000	29.5	
2 & 3	1	Same as Plot 1, Section 1..	Well cultivated	6000	51.3	
2 & 3	2	Same as Plot 1, Section 1..	Well cultivated	6000	41.9	
2 & 3	3	Same as Plot 1, Section 1..	Well cultivated	6000	43.8	
4	1	Not plowed until just before planting.	Well cultivated	6000	45.5	
4	2	Same as Plot 1, Section 4..	Well cultivated	6000	44.5	
4	3	Same as Plot 1, Section 4..	Well cultivated	6000	47.1	
5 & 6	1	Plowed twice and thoroughly prepared each time.....	Well cultivated	4000	41.9	
5 & 6	2	Same as Plot 1, Section 1..	Well cultivated	5000	32.9	
5 & 6	3	Same as Plot 1, Section 1..	Well cultivated	6000	35.3	

COWPEA-WHEAT ROTATION EXPERIMENTS

Experiments in a rotation of cowpeas and wheat, both crops grown each year, were started on various types of soil in 1907. The objects were, to determine the relative values of different phosphates, to test the value of cowpeas, both when turned under and when removed as hay, on the production of wheat, and to find out the value of lime under each of the various conditions presented. These experiments have given valuable information in spite of the fact that they were not continued as long as was desirable.

The series reported in Tables VIII, IX, and X, was conducted on a typical gray soil of Warren Couty, with light red subsoil, on the farm of the Weaver Bros. The alfalfa experiments reported in Table III were made on an adjoining range. This soil is very poorly supplied with both phosphoric acid and lime, but is not acid by the usual laboratory test. The range for the cowpea-wheat experiments was very carefully selected for uniformity of both fertility and drainage, and the appearance of the growing crops indicated that it was well suited to the purpose. Neither manure nor fertilizer had been previously used, so far as could be learned. One-half of all the plots was limed at the outset of the experiments at the rate of 1 ton of burnt lime to the acre.

The trials have been carried on for three years, with the production of six crops, three each of cowpeas and wheat. The yields of cowpea hay were not accurately gotten for every plot each year, so that many of the data for this crop are only estimates based on the comparative growth on the plots, some of which, as indicated in the table, were always carefully harvested. The yields of wheat were accurately gotten and furnish, therefore, the more reliable information.

TABLE VIII.—*A series of experiments in a cowpea-wheat rotation, on farm of Weaver Brothers, Warren County—yields obtained for each of last two years*

Plot	Year	Fertilizer per acre	Disposition of cowpea crop	Yield of cowpea hay per acre		Yield of wheat per acre			
						Unlimed		Limed	
				Unlimed	Limed	Grain	Straw	Grain	Straw
				Tons	Tons	Bu.	Tons	Bu.	Tons
1	1908	None	Turned under	0.12	0.11	6.4	0.37	11.0	0.61
	1909	None	Turned under	0.26†	0.26†	2.7	0.16	3.8	0.23
6	1908	50 lbs. muriate of potash	Turned under	0.12†	0.11†	7.1	0.45	6.2	0.40
	1909	50 lbs. muriate of potash	Turned under	0.26†	0.26†	6.3	0.38	4.4	0.26
5	1908	300 lbs. acid phosphate	Turned under	0.18†	0.30†	18.1	0.93	19.8	0.97
	1909	300 lbs. acid phosphate	Turned under	0.53†	0.73†	14.8	0.89	17.7	1.06
3	1908	300 lbs. acid phosphate + 50 lbs. muriate of potash	Turned under	0.18	0.30	19.5	1.00	18.8	0.93
	1909	do.	Turned under	0.53	1.11	16.3	0.98	15.6	0.93
9	1908	200 lbs. steamed bone meal + 50 lbs. muriate of potash	Turned under	0.27	0.29	16.0	0.86	18.1	0.98
	1909	do.	Turned under	0.53†	0.73†	15.9	0.95	15.7	0.94
8*	1908	50 lbs. muriate of potash	Turned under	0.27	0.23	13.0	0.67	11.3	0.58
	1909	50 lbs. muriate of potash	Turned under	0.30	0.23	11.0	0.66	6.7	0.40
4	1908	300 lbs. acid phosphate + 50 lbs. muriate of potash	Removed	0.18	0.25	17.8	0.95	17.3	0.92
	1909	do.	Removed	0.53	0.73	11.6	0.69	13.1	0.79
11*	1908	50 lbs. muriate of potash	Removed	0.41	0.39	15.0	0.91	18.3	1.11
	1909	50 lbs. muriate of potash	Removed	0.54	0.87	9.0	0.54	9.8	0.59
7*	1908	50 lbs. muriate of potash	Removed	0.27	0.20	10.3	0.57	7.5	0.44
	1909	50 lbs. muriate of potash	Removed	0.30	0.23	8.0	0.48	3.8	0.23
2	1908	None	Removed	0.12	0.11	6.6	0.38	11.1	0.62
	1909	None	Removed	0.26	0.26	3.1	0.19	4.7	0.28
10	1908	None	None grown			8.1	0.45	8.0	0.44
	1909	None	None grown			2.9	0.17	2.8	0.17

*Plots 7 and 8 each received 900 lbs. per acre of phosphate rock and plot 11 received 600 lbs. per acre of steamed bone meal in 1907, at the outset of the experiments.
†Estimated from comparative appearance of growing crop.

TABLE IX.—*Summary of yields of both cowpea hay and wheat on farm of Weaver Brothers, Warren County—average yields per acr for three years, 1907 to 1910*

Plot	Fertilizer per acre—average annual application, except as indicated	Disposition of cowpea crop	Yield of cowpea hay		Yield of wheat			
					Unlimed		Limed	
			Unlimed	Limed	Grain	Straw	Grain	Straw
			Tons	Tons	Bu.	Tons	Bu.	Tons
1	None	Turned under	0.21	0.28	5.2	0.30	10.3	0.60
6	50 lbs. muriate of potash	Turned under	0.21	0.28	7.6	0.45	7.9	0.48
	Average of check plots		0.21	0.28	6.4	0.38	9.1	0.54
5	300 lbs. acid phosphate	Turned under	0.47	0.66	17.3	0.97	20.6	1.16
3	300 lbs. acid phosphate 50 lbs. muriate of potash	Turned under	0.47	0.78	16.6	0.93	19.0	1.06
	Average of acid phosphate plots		0.47	0.72	17.0	0.95	19.8	1.11
9	200 lbs. steamed bone meal 50 lbs. muriate of potash	Turned under	0.50	0.65	17.3	0.99	18.7	1.08
8	900 lbs. phosphate rock* 50 lbs. muriate of potash	Turned under	0.41	0.37	12.3	0.69	13.3	0.76
4	300 lbs. acid phosphate 50 lbs. muriate of potash	Removed	0.47	0.64	14.9	0.84	16.5	0.92
11	600 lbs. steamed bone meal* 50 lbs. muriate of potash	Removed	0.72	0.85	15.7	0.94	17.1	1.02
7	900 lbs. phosphate rock* 50 lbs. muriate of potash	Removed	0.41	0.36	10.6	0.57	8.8	0.56
2	None	Removed	0.21	0.28	5.3	0.30	10.3	0.60

*Only one application of phosphate, at the outset of the experiments.

TABLE X.—*Financial outcome from the phosphates in the series on the farm of Weaver Brothers, Warren County—average annual results per acre for three years*

Plot	Phosphate—average annual application	Disposition of cowpea crop	Annual cost of phosphate	Calculated increase of wheat from phosphate				Calculated profit from phosphate	
				Unlimed		Limed			
				Grain	Straw	Grain	Straw	Unlimed	Limed
				Bu.	Tons	Bu.	Tons		
5	300 lbs. acid phosphate	Turned under	$2.40	10.9	0.59	11.5	0.62	$ 8.50	$ 9.10
3	300 lbs. acid phosphate	Turned under	2.40	10.2	0.55	9.9	0.52	7.80	7.50
	Average for acid phosphate		2.40	10.6	0.57	10.7	0.57	8.15	8.30
9	200 lbs. steamed bone meal	Turned under	3.00	10.9	0.61	9.6	0.54	7.90	6.60
8	300 lbs. phosphate rock*	Turned under	1.20	5.9	0.31	4.2	0.22	4.70	3.00
4	300 lbs. acid phosphate	Removed	2.40	9.6	0.53	7.3	0.39	10.32†	9.42†
11	200 lbs. steamed bone meal	Removed	3.00	9.4	0.56	7.9	0.48	12.52†	11.74†
7	300 lbs. phosphate rock*	Removed	1.20	5.3	0.26	0.0	0.03	6.62†	— 0.24†

*900 lbs. per acre applied at the outset of the experiments.
†Increase of cowpea hay included.

COMMENTS ON THE RESULTS

Table IX, which gives a summary of the crop production for the three years, and Table X, which offords a financial comparison, show plainly that whether used with or without liming both acid phosphate and bone meal far surpassed the phosphate rock, with regard either to yield of grain or to financial returns. For either material the increase in yield over the production on the phosphate rock plots would much more than have paid for the phosphate. The comparisons are fair because there were two plots for each of the sources of phosphoric acid. The excellent financial returns from the steamed bone meal, whether used with or without liming, are noticeable. On plot 11 the heavy dressing of 600 pounds per acre of meal at the beginning of the trials was followed with especially favorable returns. Superior effects from a single heavy application of this material, as compared with annual light applications of either bone meal or acid phosphate, have been observed by the writer several times in cases of very poor soils and are worthy of consideration.

The effect of liming was to increase the production of both cowpeas and wheat, but, as compared with the gain on the unphosphated plots, both of the bone meal plots and the phosphate rock plot (8), where the cowpeas were turned under show a falling off in every case of about 1½ bushel per acre and on plot 7, where rock was applied and the cowpeas were removed annually, liming made no increase in yield of wheat and a scarcely noticeable increase of hay. In short, under liming acid phosphate was able to hold up the yields better than the other materials.

The slight increase in yield of wheat produced by turning under the cowpea crop, as compared with those where it was removed for hay, is noticeable.

The series reported in Table XI, was conducted for two years on a typical dark red soil of limestone origin. In this case, a worn and greatly impoverished knoll was purposely selected. Both the appearance of the soil and of the growing crops indicated exceptional uniformity in fertility throughout the range. On each of the four plots the cowpeas were turned under each year in preparation for the wheat. The results indicate that neither phosphate rock nor a light application of bone meal was profitable under the circumstances, whereas, acid phosphate practically doubled the yields and proved to be the economical material to use in the building up of this soil.

TABLE XI.—*Cowpea-wheat rotation, on farm of W. N. Story, Sparta, White County—average yield of wheat for two years, 1908 and 1909*

Plot	Fertilizer per acre—annual application, except for phosphate rock, which was applied only once.	Disposition of cowpea crop	Yield of wheat per acre			
			Unlimed		Limed	
			Grain	Straw	Grain	Straw
			Bu.	Tons	Bu.	Tons
4	300 lbs. acid phosphate 50 lbs. muriate of potash	Turned under	8.5	0.51	9.9	0.59
6	50 lbs. muriate of potash	Turned under	4.4	0.26	4.8	0.29
8	900 lbs. phosphate rock 50 lbs. muriate of potash	Turned under	5.2	0.31	5.2	0.31
9	200 lbs. steamed bone meal 50 lbs. muriate of potash	Turned under	6.3	0.37	6.2	0.36

A third series, which was conducted on a dark red soil of limestone orgin on the farm of T. W. Carlock, Overton County, is reported in Table XII. The turning under of the cowpea crop proved unprofitable. Liming appreciably increased the yield of wheat on 10 of the 12 plots, Nos. 11 and 12 at one end of the range showing a slight falling off under liming, due, perhaps, to a natural difference in the fertility of the two sides. Both acid phosphate and steamed bone meal again appear to surpass the phosphate rock.

TABLE XII.—*Experiments with different phosphates in a rotation of cowpeas and wheat, on farm of T. W. Carlock, Livingston, Overton County—second year, 1909 crop of wheat*

Plot	Fertilizer per acre—applied for cowpeas only	Disposition of cowpea crop	Yield of wheat per acre			
			Unlimed		Limed	
			Grain	Straw	Grain	Straw
			Bu.	Tons	Bu.	Tons
1	None	Turned under	2.5	0.19	3.4	0.22
2	None	Removed	3.2	0.23	4.5	0.28
3	300 lbs. acid phosphate 50 lbs. muriate of potash	Turned under	7.6	0.55	10.0	0.63
4	300 lbs. acid phosphate 50 lbs. muriate of potash	Removed	7.9	0.58	10.7	0.68
5	300 lbs. acid phosphate	Turned under	9.1	0.66	12.0	0.76
6	50 lbs. muriate of potash	Turned under	4.7	0.34	7.9	0.49
7	900 lbs. phosphate rock 50 lbs. muriate of potash	Removed	8.1	0.60	9.2	0.58
8	900 lbs. phosphate rock 50 lbs. muriate of potash	Turned under	7.2	0.53	9.5	0.61
9	300 lbs. acid phosphate 50 lbs. muriate of potash	Turned under	8.5	0.62	12.0	0.76
10	600 lbs. steamed bone meal 50 lbs. muriate of potash	Turned under	10.7	0.78	13.1	0.82
11	600 lbs. steamed bone meal 50 lbs. muriate of potash	Removed	12.0	0.88	11.7	0.75
12	None	No peas grown	8.9	0.65	7.3	0.47

IRISH POTATOES

Irish potatoes may be grown not only as a profitable money crop but also as a means of increasing soil fertility. Table XIII gives the fertilizer materials used and the yields per acre, together with the calculated profit from the fertilizers, in two trials on typical gray-colored soils of Warren County. As in previous experiments the results are favorable to heavy applications of both manure and fertilizer. In the series on the farm of Mr. Buchell the most profitable dressing per acre was 12 tons of sheep manure, applied broadcast, 600 pounds of acid phosphate, applied in the row, and 320 pounds of nitrate of soda, applied as a top-dressing along the row when the plants were up. At Mr. Hambleton's place, 12 tons of farmyard manure and 600 pounds of acid phosphate per acre gave most profit. Conclusions from the yield of a single plot are, of course, not safe, nor can the results of a single season be looked upon as affording more than an indication. The evidence furnished by the experimental results of the past four years, however, may be summed up for this type of soil as follows:

1. Heavy applications of 1000 or more pounds per acre of a high-grade complete fertilizer have been more profitable than light applications of one-half the quantity.

2. Farmyard manure, used at the rate of 12-15 tons per acre and valued at $1.00 a ton, has proved highly profitable when used by itself.

3. Farmyard manure when reinforced with acid phosphate, at the rate of about 50 pounds of the latter to a ton of the former, has given more profitable results than were obtained from the manure alone.

4. In several instances a heavy top-dressing of nitrate of soda (320 pounds per acre) in addition to the acid phosphate has proved a very profitable addition to the manure.

The value of the manuring given to the first crop of potatoes on the outcome of the fall-crop, or "second-crop," potatoes should not be overlooked, especially since the uncertainty of the moisture supply for the late crop has made it the general practice to rely on the manuring of the first crop. The results from Coffee County, reported in Table XIII, show that the residual value of the manure, as compared with the fertilizer without manure, may be considerable. In this case $1.25 per bushel was allowed the second crop, or seed potatoes, as compared with 40 cents per bushel for the first crop.

The method successfully followed by Mr. Rudd in growing both first and second-crop potatoes is recommended to the consideration of those interested in the culture of this crop.

TABLE XIII.—*Fertilizer experiments with Irish potatoes, on the gray silt loams of the Highland Rim.*

Locality and soil	Plot	Fertilizer per acre	Yield per acre		Cost of fertilizer per acre	Calculated value* per acre of increase from fertilizer	Remarks
			Total	Salable			
			Bu.	Bu.			Planted April 6, 1909. Variety, Bliss Triumph. Well-rotted and unleached sheep manure was applied broadcast after plowing and thoroughly harrowed into the ground. All fertilizers were applied in the row except the nitrate of soda, which was applied as a surface dressing along the rows after plants came up, except for plot 7, for which the nitrate was applied in the row along with the phosphate and potash.
Warren Co.	1	No fertilizer	24	4			
Farm of H. M. Buchells, 1 mile south of McMinnville	2	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda	112	48	$ 8.58	$ 9.02	
	3	Same as Plot 2	105	59	8.58	13.42	
	4	300 lbs. acid phosphate 50 lbs. muriate of potash 400 lbs. cotton-seed meal	82	71	9.78	17.02	
	5	Same as Plot 2, but ½ quantity	67	21	4.29	2.51	
	6	Same as Plot 2, but double quantity	158	91	17.16	17.64	
	7	Same as Plot 6	206	157	17.16	44.04	
	8	12 tons manure	196	140	12.00	42.40	
	9	12 tons manure 600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	286	251	29.16	69.64	
	10	12 tons manure 600 lbs. acid phosphate	248	208	16.80	64.80	
	11	12 tons manure 600 lbs. acid phosphate 320 lbs. nitrate of soda	286	254	26.40	73.60	
Warren Co.	1	No fertilizer	None	None			Planted March 7, 1910. Variety, Bliss Triumph, Dug June 27. All acid phosphate, muriate of potash, and cotton-seed meal was applied in row and mixed with soil before seed were dropped. The manure was applied broadcast previous to planting. The nitrate
Farm of James Hambleton, south of McMinnville	2	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda	142	131	8.58	35.82	
	3	Same as Plot 2	124	104	8.58	25.02	
	4	Same as Plot 2	156	146	8.58	41.82	
Gray silt loam with light red subsoil	5	300 lbs. acid phosphate 50 lbs. muriate of potash 400 lbs. cotton-seed meal	162	150	9.78	42.22	
	6	Same as Plot 2, but double quantity	194	187	17.16	49.64	
	7	Same as Plot 6	187	173	17.16	44.04	
	8	Same as Plot 6	157	136	17.16	29.24	
	9	12 tons yard manure	128	116	12.00	26.40	

	10	12 tons yard manure 600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	215	206	29.16	45.24	of soda was applied as follows: Plot 2, on surface. Plot 3, in row before planting. Plot 4, in two applications. Plot 6, on surface. Plot 7, in row before planting. Plot 8, in two applications. Plot 10, in row before planting. Plot 12, in row before planting.
	11	12 tons yard manure 600 lbs. acid phosphate	209	201	16.80	55.60	
	12	12 tons yard manure 600 lbs. acid phosphate 320 lbs. nitrate of soda	168	151	26.40	26.00	
	13	No fertilizer	32	20			
	14	300 lbs. acid phosphate 50 lbs. muriate of potash	93	82	3.78	21.02	
Coffee Co. Tullahoma Gray silt loam with yellowish subsoil	1	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda	30				Second crop potatoes planted in August, 1908. No fertilizer was applied directly for this crop but for first crop only.
	2	12 tons yard manure 300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda	69			48.75	
	3	Same as Plot 2	75			56.25	

*Salable potatoes, valued at 40c per bu.

METHOD OF GROWING IRISH POTATOES

BY

W. N. RUDD

"My soil is a common gray-colored silt loam of Warren County, but has been somewhat improved by the use of manure and fertilizer. To prepare such ground I have used 12 to 15 tons of stable manure per acre, spread broadcast in early spring and disked in 4 to 5 inches deep, following with a spike-tooth harrow to pulverize the soil further. The ground is then plowed 8 to 10 inches deep. The previous disking and harrowing helps the plow to go deeper than it would otherwise and also puts fine soil in the bottom of the furrow. After plowing, the ground is harrowed and pulverized until in fine condition, and is then laid off in rows 28 to 30 inches wide with a shovel plow provided with wings, which are drawn in so that they do not add to the width of the furrow. The fertilizer, acid phosphate, is then applied in the row at the rate of 1200 pounds per acre. With a little practice it may be scattered uniformly by means of a bucket with holes punched in the bottom. After this application a calf-tongue plow is run in the bottom of the furrow, so that the fertilizer is mixed with the soil, and does not come into contact with the seed, which can now be dropped. For seed I prefer second-crop White Triumph. The large tubers are cut into four pieces, being cut from the seed to the stem end. One piece is dropped every 12 to 14 inches, and 9 to 10 bushels are required per acre. The seed is covered with the same plow used in laying off the rows, but the wings are spread to suit the width required. By driving the horse directly on top of the ridge made in laying off, it is transposed and the potatoes are nicely covered.

"As soon as the ground is dry enough after each rain the weeder is run over the ridges, which are leveled to some extent but not entirely. As soon as the plants break through the ground nitrate of soda is applied along the rows at the rate of 200 to 300 pounds per acre, but the leaves of the young plants must be dry to prevent their being injured. A deep working is now given with any long-toothed cultivator run close to the plants. This is followed by the weeder to leave the surface of the ground smooth. No other deep cultivation is given, but the weeder is used until the plants are 6 inches high. The weeds are kept down by the weeder and by a one-horse harrow, and if necessary the hoe should be used in order that neither weeds nor grass interfere with the crop.

"The second crop is a matter of much importance. For seed purposes it is important that the potatoes of the first crop remain in the ground some ten days after the vines are dead, so that they

may be fully matured. Only fair-sized tubers are used for seed, which are always cut, and should be planted as soon as possible after being dug. That they should be dried or seasoned is not at all necessary.

"An important condition to a successful second crop is a plentiful supply of moisture, and if the ground be dry the seed should be planted deeper than if it be wet. Also a thicker planting should be made than for the first crop.

"The preparation and cultivation are about the same as for the first crop. Fertilizer may be used, but the manure applied for the first crop should now be well incorporated with the soil and be effective on the second crop. If more manure be used it should be applied to the surface after planting in order to conserve the supply of moisture.

"To make the soil loose, which is of special importance in potato culture, I would highly recommend cowpeas to be grown and turned under, followed by rye as a winter cover."

In 1910, record was made by Mr. Rudd of the cost of growing both the first and second-crop potatoes by his method on a half acre of land. The statement is as follows:

FIRST CROP

Cost of raising first crop, planted March 8, 1910:	
6 tons manure, @ $1 per ton	$ 6 00
Disking, plowing and replowing	2 00
Harrowing and preparing ground	1 00
4½ bu. seed, @ $1.50 per bu.	6 75
Labor, 5 hands ½ day, @ 75c per day	1 87
600 lbs. acid phosphate, @ 80c	4 80
200 lbs. nitrate of soda, @ $3.00	6 00
Cultivating crop	1 50
Digging and hauling to market	10 00
Total cost first crop	$39 92
Proceeds of first crop:	
125 bu. marketable potatoes, @ 35c	$43 75
10 bu. unmarketable potatoes, @ 10c	1 00
Total from first crop	$44 75
Net profit first crop	4 83

First crop dug August 9, 1910

SECOND CROP

Cost of raising second crop on the same ground:	
Plowing ground	$ 1 00
Harrowing and preparing ground	50
3 hands planting 1 day, @ 75c each	2 25
Cultivating, 1 hand one day	75
600 lbs. acid phosphate, @ 80c	4 80
100 lbs. nitrate of soda	3 00
5 bu. seed, @ 35c	1 75
Digging crop	3 75
Total cost of second crop	$17 80

Proceeds of second crop:	
58 bushels potatoes, @ $1.25	$72 50
Net profit second crop	$54 66
Net profit first crop	4 83
Total profit on one-half acre	$59 49

MILLET HAY

Millet, either by itself or in a mixture with cowpeas, is a common hay crop in the Highland Rim counties. Fertilizer experiments, like those reported in Table XIV, have been carried out at some half dozen places during the past four years and have furnished valuable evidence not only as to the most profitable mixture for this crop but also as to the special soil requirements. The great value of acid phosphate used in conjunction with nitrate of soda is clearly evident. In the two series reported potash appears of doubtful value, whereas in previous trials it gave profitable returns and at least a light application in connection with the other materials is advised.

TABLE XIV.—*Fertilizer experiments with millet, on the gray soil of the Highland Rim*

Locality	Range	Phosphate and potash per acre	Application of nitrate of soda and yield of hay per acre						
			No nitrate	40 lbs. nitrate	80 lbs. nitrate	160 lbs. nitrate	240 lbs. nitrate	320 lbs. nitrate	Range average
			Tons	Tons	Tons	Tons	Tons	Tons	Tons
Warren Co Farm of W. N. Rudd, McMinnville 1909	1	None	0.10	0.17	0.24	0.26	0.22	0.22	0.20
	2	150 lbs. acid phosphate + 50 lbs. muriate of potash	0.32	0.48	0.72	0.84	1.00	1.02	0.73
	3	300 lbs. acid phosphate + 100 lbs. muriate of potash	0.6±	0.72	0.84	0.72	1.20	1.34	0.91
	4	300 lbs. acid phosphate	0.38	0.70	0.74	1.08	1.28	1.15	0.89
	5	600 lbs. acid phosphate + 100 lbs. muriate of potash	0.25	0.33	0.60	0.92	1.28	1.54	0.82
		Average	0.34	0.48	0.63	0.76	0.98	1.05	
Warren Co. Farm of W. W. King, Morrison 1909	1	None	1.18*	1.40	1.52	1.92	2.20	2.56	1.80
	2	150 lbs. acid phosphate + 100 lbs. muriate of potash	1.56	1.36	1.70	2.40	2.78	3.10	2.15
	3	300 lbs. acid phosphate + 100 lbs. muriate of potash	1.52	1.80	1.88	2.28	2.88	2.72	2.18
	4	300 lbs. acid phosphate	1.40	1.42	1.80	2.62	2.56	3.04	2.14
	5	600 lbs. acid phosphate + 100 lbs. muriate of potash	1.46	1.68	2.16	2.52	2.96	2.88	2.28
		Average	1.42	1.53	1.81	2.35	2.68	2.86	

*Average of three no-fertilizer plots

OATS

Tables XV and XVI give the results of a few fertilizer experiments with oats. In the former table the residual effects of the fertilizer applied to the previous crop (millet) are seen to be of importance.

Table XVI shows that nitrate of soda used alone may, as in the experiments with millet, increase the yield, but that acid phosphate or a mixture of acid phosphate and muriate of potash, along with the nitrate, gives by far the most profitable returns on soils of this character.

TABLE XV.—*Residual effects of acid phosphate and muriate of potash applied for millet, as shown in the yield of oat hay the year following, on farm of W. N. Rudd, Warren County*

Range	Acid phosphate and muriate of potash per acre	Application of nitrate of soda and yield of hay per acre. (Nitrate applied to both millet and oats)							Remarks
		No nitrate	40 lbs. nitrate	80 lbs. nitrate	160 lbs. nitrate	240 lbs. nitrate	320 lbs. nitrate	Range average	
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
1	None	730	990	1200	1600	1580	1210	1142	Millet, 1908.
2	150 lbs. acid phosphate 150 lbs. muriate of potash	1350	1640	2160	2380	3130	2690	2225	Oats, 1909.
3	300 lbs. acid phosphate 100 lbs. muriate of potash	1900	2360	2810	2520	2820	3220	2605	Acid phosphate and muriate of potash applied only in 1908.
4	300 lbs. acid phosphate	1450	1910	2680	2940	2810	3010	2470	
5	600 lbs. acid phosphate 100 lbs. muriate of potash	660	1230	1760	2520	2840	3280	2048	
	Average	1218	1626	2142	2392	2636	2682		

TABLE XVI.—*Fertilizer experiments with oats, on Highland Rim soils*

Locality and soil	Plot	Fertilizer per acre	Yield per acre		Remarks
			Grain	Straw	
			Bu.	Tons	
Putnam Co. Farm of T. C. Cooper, Cookeville Gray soil	1	No fertilizer	19.2	0.31	Nitrate applied as soon as oats appeared above ground, March 19.
	2	80 lbs. nitrate of soda	28.4	0.45	
	3	160 lbs. nitrate of soda	46.7	0.75	
				Hay Tons	
Warren Co. Farm of W. M. Lockwood, Morrison	10 & 13	No fertilizer		0.49	Nitrate applied March 30, 1909.
	1, 2, 5 & 12	300 lbs. acid phosphate 50 lbs. muriate of potash		0.72	
	3	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda		1.11	
	8	160 lbs. nitrate of soda		0.88	
	11	300 lbs. acid phosphate 150 lbs. nitrate of soda		1.21	

PEANUTS

Peanut growing is an important industry in some counties of the Highland Rim and could be greatly extended. Gray-colored and easily tilled silt loams, both bottom and upland, are used. The low lands give the largest yields, but the rather common practice of raising peanuts on the same land year after year has greatly reduced their fertility. Undoubtedly a judicious crop rotation would do much to improve this condition, and either manure or crops like grass and clover will be needed to replenish the soil with vegetable matter. At present fertilizers are little used and liming is seldom practiced.

Table XVII gives the results of two series conducted in the peanut section of Humphreys County. The experiments should be continued for a number of seasons and might well include methods of culture, crop rotations, and green manuring. Some interesting data have been obtained, however. The two series agree with respect to the direct effect of liming, which proved detrimental to the production of nuts, but appreciably increased the growth of tops. This does not exclude the possibility that lime will either act beneficially on other types of soil or be of much indirect value in peanut culture through its favorable effect on other crops, such as clover and grass.

In these trials acid phosphate was highly profitable, as it has been in other minor experiments in various localities on Rim soils, but the addition of either potash or a nitrogenous fertilizer was apparently not needed. The peanut is a leguminous plant, which gets much of the needed nitrogen from the air, but on very poor soils, such as Series B at Mr. Tubb's place, a little cotton-seed meal or nitrate of soda may possibly be used to advantage to give the plants a quick start.

Several tests have been made of the common varieties, such as Virginia White, both spreading and bunch types, Spanish and two kinds of Reds. Spanish is far more productive than any of the others and is strongly recommended for forage-crop purposes and also for home use, the flavor being superior to that of the other sorts. Favorable results have been obtained by the Station in the way of getting improved strains of several varieties by means of individual plant selection. In particular a stronger-hulled and slightly larger type of Spanish nut than that commonly grown has been gotten, and has been used in the co-operative trials. The selections of Virginia White are uniform and have outyielded the common sorts. There seems, therefore, to be good reasons for the belief that valuable results can be obtained in this direction.

TABLE XVII.—*Fertilizer and liming experiments with peanuts*

1. On farm of W. W. C. Moore, Humphreys County, 1910

Plot	Fertilizer per acre	Yield per acre				Cost of fertilizer per acre	Calculated value* of increase in nuts from fertilizer		Remarks
		Unlimed		Limed					
		Nuts	Hay	Nuts	Hay		Unlimed	Limed	
		Bu.	Tons	Bu.	Tons				
1	No fertilizer	65.2		60.8					
2	300 lbs. acid phosphate	98.0	1.36	72.5	1.28	$2.40	$20.14	$17.13	
3	300 lbs. acid phosphate 50 lbs. sulphate of potash	56.3	1.55	48.7	2.00	3.78	— 1.05	— 3.78	Average of the duplicate sets.
4	300 lbs. acid phosphate 50 lbs. sulphate of potash 200 lbs. cotton-seed meal	93.3		82.5		6.78	9.32	7.36	
5	150 lbs. acid phosphate 50 lbs. sulphate of potash	90.0	1.36	55.6	1.60	2.58	7.58	4.91	
6	No fertilizer	47.4	1.36	36.0	1.60				
7	Same as Plot 2	79.0	1.40	80.0	1.36	2.40			
8	Same as Plot 3	64.0		40.5		3.78			
9	Same as Plot 4	65.2		54.7		6.78			
10	Same as Plot 5	59.0		62.5		2.58			

2. On farm of J. W. Tubb, Humphreys County, 1909

A 7	No fertilizer	38.0	1.11	33.4	1.06				Plots A 7-10, Virginia White variety.
8	300 lbs. acid phosphate	44.5	1.18	45.7	1.33	$2.40	$1.87	$6.21	
9	300 lbs. acid phosphate 50 lbs. muriate of potash	55.8	1.35	45.4	1.64	3.78	8.40	4.62	
10	300 lbs. acid phosphate 50 lbs. muriate of potash 80 lbs. nitrate of soda	53.4	1.49	49.8	1.53	6.18	4.32	5.20	
11	No fertilizer	74.0	0.56	81.7	1.00				Plots A 11-14, Spanish variety.
12	300 lbs. acid phosphate	94.3	0.86	76.5	0.92	2.40	11.60	— 2.40	
13	300 lbs. acid phosphate 50 lbs. muriate of potash	86.3	0.70	90.0	0.88	3.78	4.62	2.03	
14	300 lbs. acid phosphate 50 lbs. muriate of potash 80 lbs. nitrate of soda	87.3	0.76	85.7	0.88	6.18	2.92	— 3.38	
15	No fertilizer	71.3	1.78	61.2	1.89				Plots A 15 and 16, Red variety.
16	300 lbs. acid phosphate	64.3	1.83	54.7	2.12	2.40	— 2.40	— 2.40	
B 1	No fertilizer	26.9	1.27	22.8	1.19				Plots B 1-5, very poor land: Virginia White variety.
2	No fertilizer	34.0	1.26	19.6	1.10				
3	300 lbs. acid phosphate	34.7	1.26	16.4	1.26	2.40	0.54	— 2.40	
4	300 lbs. acid phosphate 50 lbs. muriate of potash	31.5	1.61	22.2	1.21	3.78	— 2.78	— 2.78	
5	300 lbs. acid phosphate 50 lbs. muriate of potash 80 lbs. nitrate of soda	42.7	1.67	29.8	0.91	6.18	1.87	— 0.16	

*Peanuts valued at 70c per bu.

SOY BEANS

The soy bean as a farm crop has recently been receiving attention throughout Tennessee. Although not equal in some respects to the cowpea, in others it is superior and deserving of the careful consideration of practical farmers. The early date at which some varieties may be matured in the summer and the lateness of the season at which they may be planted profitably for both hay and grain put them in a class by themselves. As examples, the Ito San variety when planted early may be ready to harvest by the latter part of July, and when planted at that date will mature before frost. This variety thrives, however, only on a comparatively rich soil. For contrast, Mamoth Yellow may be selected. In practically all the trials made at the Station, and elsewhere in the co-operative work, this variety has far outyielded Whip cowpeas in hay production and has been found to make exceptionally good yields on the very poor soils of the Rim, frequently twice the yield made by the Whips, but it requires nearly the whole season. The same fertilizers are recommended as for cowpeas, or, acid phosphate with a small amount of muriate of potash. In experiments made in West Tennessee, liming was especially helpful to soy beans, just as it was to cowpeas. Table XVIII gives some data obtained in variety and fertilizer trials on Rim soils.

TABLE XVIII.—*Variety trials and fertilizer experiments with soy beans on gray-colored soils of the Highland Rim*

Locality	Plot	Variety	Fertilizer per acre	Date of planting	Yield per acre		Remarks
					Beans	Hay	
					Bu.	Tons	
Humphreys Co. Farm of J. W. Tubb, Waverly	13	Ito San	None	May 29		1.16	Season of 1909.
	14	Ito San	300 lbs. acid phosphate	do.		1.17	Not threshed for grain.
	15	Haberlandt	None	do.		1.47	
	16	Haberlandt	300 lbs. acid phosphate	do.		1.60	This series on low land near creek.
	17	Hollybrook	None	do.	10.9	1.35	
	18	Hollybrook	300 lbs. acid phosphate	do.	8.3	1.17	
	19	Mammoth Yellow	None	do.	11.1	2.45	
	20	Mammoth Yellow	300 lbs. acid phosphate	do.	13.3	2.93	
Humphreys Co. Farm of A. B. Simpson, Waverly	1	Ito San	None	July 5	9.0		Season of 1909.
	2	Haberlandt	None	do.	14.2		
	3	Hollybrook	None	do.	7.1		
	4	Mammoth Yellow	None	do.	12.5		
	5	Whip cowpeas	None	do.	11.0		
Putnam Co. Farm of T. C. Cooper, Cookeville	A5	Hollybrook	None	May 5	12.0	1.60	Season of 1909.
	A6	Tokio	None	do.	16.0	2.50	Very poor gray silt loam.
	C3	Hollybrook	None	June 20		0.80	
	C1	Acme	None	do.	3.3	1.18	
	C2	Tokio	None	do.		1.72	
Putnam Co. Farm of D. T. Allison, Baxter	3	Mammoth Yellow	200 lbs. acid phosphate + 33 lbs. muriate of potash	July 6		1.24	Season of 1909.
	4	Whip cowpeas	do.	do.		0.68	Very poor gray silt loam.
	5	New Era cowpeas	do.	do.		0.46	
	7	Medium Yellow	do.	do.		0.50	
	9	Hollybrook	do.	do.		0.68	
	12	Haberlandt	do.	do.		0.76	
Putnam Co. Farm of Roy Jared, Boma	1	Mammoth Yellow	300 lbs. acid phosphate	June 23		1.36	Season of 1910
	2	Tokio	300 lbs. acid phosphate	do.		0.66	Gray silt loam.
	3	Mammoth Yellow	300 lbs. Thomas slag	do.		1.49	
	4	Tokio	300 lbs. Thomas slag	do.		0.96	
	5	Mammoth Yellow	None	do.		0.95	
	6	Tokio	None	do.		0.60	
	7	Mammoth Yellow	300 lbs. Thomas slag + 50 lbs. muriate of potash	do.		1.32	
	8	Mammoth Yellow	300 lbs. acid phosphate + 50 lbs. muriate of potash	do.		1.67	
	9	Mammoth Yellow	200 lbs. bone meal	do.		1.42	

TOBACCO

Fertilizer experiments with tobacco were made on three different farms in Montgomery County during the seasons of 1909 and 1910. The season of 1909 proved rather unfavorable for the work, and, as in 1908, the effects of fertilizers of any kind were not especially marked. In 1907, the same mixtures as used later gave highly profitable returns. Also excellent results were obtained in 1910, on the farm of C. E. Frye, Montgomery County, and are reported in Table

The experimental evidence obtained in the past four years on various Montgomery County soils, does not warrant the use of lime when applied directly and only for the tobacco crop. However, it may be of indirect value by producing larger crops of clover and grass, which enter into the usual rotation practiced by tobacco growers.

On account of the high returns per acre from tobacco rather heavy manuring and fertilizing is recommended. The following formula is suggested:

200 lbs. acid phosphate
50 " sulphate of potash
400 " cotton-seed meal
or 160 " nitrate or soda

On old lands a half dozen loads of manure per acre could be used in addition to advantage.

TABLE XIX —*Fertilizer experiments with tobacco on farm of C. E. Frye, Montgomery County—season of 1910*

Plot	Fertilizer per acre	Yield of leaf per acre				Cost of fertilizer per acre	From average of unlimed and limed plots—calculations per acre		
		Actual		Corrected for missing hills			Value of actual increase from fertilizer	Value of actual crop @ 10c per lb.	Calculated value of crop with perfect stand
		Unlimed	Limed	Unlimed	Limed				
		Lbs.	Lbs.	Lbs.	Lbs.				
1	6 tons farmyard manure	1300	960	1462	1024	$ 6.00	$36.30	$113.00	$124.30
2	6 tons farmyard manure 300 lbs. acid phosphate	1320	1240	1414	1268	8.40	51.30	128.00	134.10
3	6 tons farmyard manure 100 lbs. sulphate of potash	1480	1160	1586	1214	9.00	55.30	132.00	140.00
4	6 tons farmyard manure 300 lbs. acid phosphate 100 lbs. sulphate of potash	1600	1520	1756	1591	11.40	79.30	156.00	167.35
5	6 tons farmyard manure 400 lbs. cotton-seed meal	1520	1560	1591	1671	12.00	77.30	154.00	163.10
6	6 tons farmyard manure 300 lbs. acid phosphate 100 lbs. sulphate of potash 400 lbs. cotton-seed meal	1640	1720	1716	1759	17.40	91.30	168.00	173.70
7	None	667	867	667	889			76.70	77.80
8	300 lbs. acid phosphate 100 lbs. sulphate of potash 400 lbs. cotton-seed meal	1000	1320	1125	1350	11.40	36.30	116.00	128.70

THE CENTRAL BASIN

The Central Basin uplands are derived from limestone and are naturally much better supplied with plant food than other limestone soils in the State, so that they are deservedly held in high repute. In particular the supply of phosphate is apt to be excellent, although areas are being discovered which are somewhat deficient in this constituent, so that distinctions in this regard can be made between soils of somewhat different origin, as indicated by differences in both color and texture. The brown-colored loams are the best supplied with phosphate and are decidedly rich in this important element whenever derived wholly or in part from the decomposition of phosphate rock, which is often indicated by the pieces of phosphate which can be picked out of the soil or the subsoil. There are at least two types of Basin soils which have been found to be more or less in need of phosphate and which by chemical analysis contain only the moderate amounts of phosphoric acid found in limestone soils of other parts of the State. They are the red-colored soils such as are found in the vicinity of Murfreesboro, and certain grayish soils with reddish yellow subsoils, such as may be found in parts of Bedford County. The extent of these areas can not be known until a detailed survey be made. Both the potash and the lime supplies of all Basin soils must be rated as at least fair, but undoubtedly liming will prove profitable in certain cases, although in the majority of the co-operative trials it has not proved to be needed.

If the present productiveness of the Central Basin soils be compared with that of the past a marked decrease in fertility is evident. Even under farming methods, which are generally rated as excellent, production seems to be gradually but constantly decreasing and is a matter of concern to business men as well as farmers. To what shall this decrease be attributed? After careful investigation the writer is convinced that the lessening fertility is due to losses of soil nitrogen and of vegetable matter, owing in large part to erosion during heavy rains and in part to excessive grain growing, together with failure to care for the farmyard manure and the like. This poverty in nitrogen is shown especially in the wheat fields, which, although of fairly good appearance where clover was the preceding crop, are often thin and poor.

The crop rotations followed in this section, although well suited to the rich soils of former years, are not the best under the present circumstances. Grain crops have played a too important part and the legumes, the nitrogen gatherers, have not had the place which they deserve. A common rotation has been, for example, corn, wheat, clover and grass, wheat. If only the wheat he sold and the other crops,

supplemented by a liberal quantity of cotton-seed meal, be fed on the farm, the manure thus obtained will, if properly handled, do much toward maintaining the soil fertility. Unfortunately these conditions are seldom carried out. In the counties where cotton has been grown, the conditions are worse than elsewhere, due to the clean culture and to the removal or destruction of all the above-ground parts of the cotton crop and also to the little regard given to crop rotation. The following rotation is recommended in particular for the consideration of those engaged in live stock farming: Corn, followed by a winter cover crop, such as rye or crimson clover and rye, soy beans or cow-peas, wheat, clover and grass (2 years). This is a five-year rotation, which would be expected not only to give remunerative crops but also to do much toward increasing the productiveness of any of these soils.

ALFALFA

Alfalfa experiments similar to those reported on Highland Rim soils have been started on several farms in the Basin, but a satisfactory report can not now be made in regard to them. Both farmyard manure and soil inoculation can be recommended, however, and also the same method of soil preparation, seeding, etc., as advised for the Rim soils. The value of lime, phosphate, and potash remain to be proved. Without doubt the successful culture of alfalfa in the Basin is possible, and, for that matter, success has been achieved on a number of farms.

CORN

A few variety trials of corn are reported in Table XX. Two of the varieties in each set, Huffman and Webb's Improved Watson, are of distinctly Tennessee origin. The others are standard varieties, which have proved to be high yielders in Station trials, the results of which are published in Bulletin No. 89.

TABLE XX.—*Variety trials of corn on fertile Central Basin uplands*

Locality	Variety	Year grown	Yield per acre		Remarks
			Grain	Stover	
			Bu.	Tons	
Maury Co. Farm of Brown Bros., Spring Hill.	Iowa Silver Mine (2 plots)	1908	52.0	1.73	Season fair.
	Leaming (3 plots)	do.	50.8	2.52	Only one rate of planting.
	Webb's Improved Watson (9 plots)	do.	50.7	3.44	
	Huffman (4 plots)	do.	57.3	3.97	
Maury Co. Farm of T. C. Brooks, Hampshire.	Iowa Silver Mine	1910	74.1		Season good.
	Leaming	do.	68.8		Three rates of planting for each variety.
	Reid's Yellow Dent	do.	84.1		
	Boone County White	do.	86.9		Average of highest two reported.
	Albemarle Prolific	do.	89.5		
	Hickory King	do.	82.0		Varieties arranged according to length of season from earliest to latest.
	Cocke's Prolific	do.	88.6		
	Webb's Improved Watson	do.	84.9		
	Huffman	do.	94.5		

COWPEA-WHEAT ROTATION EXPERIMENTS

Experiments in a rotation of cowpeas and wheat similar to those made on Highland Rim soils have been conducted for two or more years at two places, one on the Brown Bros. farm at Spring Hill, Maury County, and the other on the farm of T. L. Smithson, in Giles County. At the former place the soil proved to be amply supplied with all forms of plant food, including lime, so that no effect from any of the materials applied could be detected. On Mr. Smithson's farm the experiments were begun in 1907, but the land had previously been cropped in cowpeas and wheat each year for five years. The yields in Table XXI are from the third experimental crop.

TABLE XXI.—*Experiments in a rotation of cowpeas and wheat, on the brown-colored loam of the Central Basin, on farm of T. L. Smithson, Giles County*

Plot	Fertilizer per acre—annual application for cowpeas only	Disposition of cowpea crop	Yield of cowpea hay per acre		Yield of wheat per acre				Remarks
			Unlimed	Limed	Unlimed		Limed		
					Grain	Straw	Grain	Straw	
			Tons	Tons	Bu.	Tons	Bu.	Tons	
1	None	None grown			8.9	0.53	7.3	0.44	The yields of cowpea hay are for the season of 1909. The yields of wheat are from the harvest of 1910. Each crop is the third of the kind in the series.
2	None	Turned under	0.87	0.91	14.4	0.87	15.3	0.92	
3	None	Removed	0.91	0.89	12.1	0.73	12.4	0.75	
4	300 lbs. acid phosphate 100 lbs. muriate of potash	Turned under	0.97	1.13	15.3	0.92	17.1	1.03	
5	300 lbs. acid phosphate	Removed	0.87	1.13	12.0	0.72	15.7	0.95	
6	300 lbs. acid phosphate	Turned under	1.02	0.96	15.0	0.90	16.3	0.97	
7	300 lbs. acid phosphate	Removed	0.77	0.92	12.8	0.77	13.1	0.79	
8	100 lbs. muriate of potash	Turned under	0.98	1.02	15.0	0.90	15.4	0.93	
9	100 lbs. muriate of potash	Removed	0.72	0.89	9.7	0.59	10.8	0.64	
10	600 lbs. acid phosphate 100 lbs. muriate of potash	Turned under	0.85	0.96	14.1	0.85	14.8	0.89	Cowpeas sown July 17, and harvested September 29.
11	300 lbs. acid phosphate 200 lbs. muriate of potash	Removed	0.98	0.96	14.7	0.88	14.3	0.85	
12	300 lbs. acid phosphate 100 lbs. muriate of potash	Turned under	0.77	1.04	13.3	0.80	16.3	0.98	
13	100 lbs. muriate of potash	Removed	0.62	1.02	9.8	0.59	13.2	0.79	

The exhaustive cropping to which this land has been subjected for the past eight years would be expected to deplete the soil supplies of plant food, so that if any element were not present in relative abundance the fact would be made evident under the conditions of the test. The results do not give evidence of deficiency of either potash or phosphoric acid, although there is a slightly higher yield of wheat, on the average, from the phosphated than from the unphosphated plots. The limed half of the range has uniformly produced a somewhat larger crop of both peas and wheat than the unlimed, so that liming would apparently be profitable. The turning under of the cowpea crop, as compared with its removal for hay, has increased the yield of wheat by 2.6 bushels per acre, but this would not be profitable as compared with the value of the crop for feeding purposes, and, for that matter, would not pay for the seed at the present high price of cowpeas. The yield of wheat on plot 1 would indicate that the cowpeas even when removed were of value, but other plots where only wheat was grown would be needed to establish this point. At several other places, however, a similar result has been obtained during the first few years, but at the Station farm the ultimate outcome was that the yields of wheat on the plots where the cowpeas were removed each year for hay were less than where none were grown. To feed the pea crop on the farm and return the manure to the land would, with little doubt, be the logical thing to do.

IRISH POTATOES

The importance of Irish potatoes, both first and second crop, in this part of the State, was not overlooked, but, owing to the peculiarities in the fertility of the soils where the experiments were tried, no conclusive results were obtained.

MILLET

Two series of fertilizer experiments similar to those conducted on Highland Rim soils are reported in Table XXII. The effect of nitrate is very marked in the series on Mr. Hix's farm in Bedford County and there is also an apparent increase produced by the acid phosphate, but this result should be verified by further trials. Almost no rain fell from the time of seeding, which was late, July 23, to the time of harvest, in the series carried out on Mr. Miller's farm in Rutherford County, but the yields indicate that the soil was in much need, not only of nitrogen, but also of phosphate. As this was a typical red soil the deficiency in phosphate is of special interest, and bears out the indications from other data that on land of this character acid phosphate may be used profitably.

TABLE XXII.—*Fertilizer experiments with millet on limestone soils of Central Basin*

Locality and soil	Range	Phosphate and potash per acre	Amount of nitrate of soda applied and yield of hay per acre							Remarks
			No nitrate	40 lbs. nitrate	80 lbs. nitrate	160 lbs. nitrate	240 lbs. nitrate	320 lbs. nitrate	Range average	
			Tons	Tons	Tons	Tons	Tons	Tons	Tons	
Bedford Co.	1	None	1.13	1.28	1.45	1.40	1.83	1.45	1.42	Season of 1909.
Farm of W. W. Hix, Shelbyville. Brown loam soil	2	300 lbs. acid phosphate	1.48	1.49	1.64	1.80	2.27	2.14	1.80	
	3	100 lbs. muriate of potash	1.34	1.46	1.71	1.70	2.08	2.36	1.78	
	4	300 lbs. acid phosphate 100 lbs. muriate of potash	1.67	1.91	1.49	2.07	2.71	2.65	2.19	
	5	150 lbs. acid phosphate 100 lbs. muriate of potash	1.63	1.81	2.08	1.97	2.51	2.41	2.07	
	6	600 lbs. acid phosphate 100 lbs. muriate of potash	lost	2.21	2.38	2.24	2.20	2.50	2.31	
		Average	1.45	1.69	1.87	1.86	2.27	2.25		
Rutherford Co.	1	None	0.88	0.83		0.92	0.92	0.93	0.90	Sown July 23, 1910, and harvested September 23. Little rain between dates of seeding and harvesting.
Farm of A. N. Miller, Christiana Red land	2	300 lbs. acid phosphate	1.27	1.36		1.32		1.71	1.42	
	3	300 lbs. acid phosphate 100 lbs. muriate of potash	1.02	1.17		1.51	1.48	1.72	1.38	
	4	150 lbs. acid phosphate 100 lbs. muriate of potash	1.15	1.22		1.27	1.25	1.38	1.25	
	5	600 lbs. acid phosphate 100 lbs. muriate of potash	1.50	1.63		1.84	1.90	2.14	1.80	
		Average	1.16	1.24		1.37	1.39	1.58		

OATS AND WHEAT

Four series of experiments, one for spring oats and three for wheat, with nitrate of soda applied as a top-dressing early in the spring, are reported in Table XXIII. In each series the nitrate appreciably increased the yield. Judging both from these results and from those obtained previously, an application of from 60 to 80 pounds of nitrate per acre may be used with profit for either of these crops when grown on rather impoverished soil. In the last series of the table, both phosphate and potash were tried, but without effect.

TABLE XXIII.—*Nitrate of soda on the small grains, wheat and oats, on Central Basin limestone soils*

Plot	Crop	Amount of nitrate per acre	Date of application	Yield per acre		Remarks
				Grain	Straw	
		Lbs.		Bu.	Tons	
1	Spring oats	None		36.5	0.46	On farm or Judd Gold, Gordonsville, Smith Co. Season of 1910.
2	do.	53	April 5	45.0	0.62	
3	do.	80	do.	43.7	0.55	
4	do.	107	do.	44.9	0.57	
1	Wheat	None	March	13.8	0.77	On farm of Wm. Thomas, Hickman, Smith Co. Season of 1910.
2	do.	53	do.	21.1	1.18	
3	do.	80	do.	20.0	1.12	
4	do.	107	do.	21.9	1.22	
1	Wheat	None	March	6.9	0.39	On farm of Robert Beard, New Middleton, Smith Co. Season of 1910.
2	do.	53	do.	8.4	0.47	
3	do.	80	do.	8.2	0.46	
4	do.	107	do.	10.2	0.57	
1	Wheat	None		10.5	0.47	On farm of Robert Beard, New Middleton, Smith Co. Season of 1909. Phosphate and potash tried, but without effect, in this series.
3	do.	160	March	13.7	0.62	
2	do.	None		10.0	0.45	
4	do.	160	do.	14.0	0.67	
6	do.	None		10.5	0.47	
5	do.	160	March	13.6	0.61	

SOY BEANS

Soy beans are especially well suited to the Central Basin soils. Undoubtedly there are a number of valuable varieties, which differ to a marked extent in both habit of growth and length of season required to reach maturity. Table XXIV furnishes some interesting data in regard to the effect of date of planting, both on the time required to reach maturity and the yield of grain, for six of the best varieties tested by the Station. In numerous trials Mamoth Yellow has proved its superiority for hay, but in the production of grain on fertile soils Haberlandt has frequently yielded as much as any other or more, as was the case in this series. The earliness of this variety is also in its favor. For further information in regard to the varieties, Bulletin No. 82 may be consulted.

TABLE XXIV.—*Variety trials of soy beans on Central Basin soil, on farm of A. N. Miller, Christiana, Rutherford County, 1910*

Plot	Variety	Date of planting	Date of harvesting	Yield of grain per acre	Remarks, etc.
				Bu.	
1	Ito San	June 17	September 15	13.0	2½-ft. rows used in all three plantings.
2	Haberlandt	do.	do. 17	17.5	
3	Hollybrook	do.	do. 28	16.5	
4	Acme	do.	do. 28	15.6	
5	Tokio	do.	October 10	12.0	
6	Mammoth Yellow	do.	do. 12	11.1	
7	Ito San	July 23	October 11	6.0	10 inches high.
8	Haberlandt	do.	do. 14	10.7	11 do.
9	Hollybrook	do.	do. 20	8.2	12 do.
10	Acme	do.	do. 20	6.6	21 do.
11	Tokio	do.	do. 20	6.6	14 do.
12	Mammoth Yellow	do.	do. 20	9.7	24 do.
13	Ito San	August 8	October 20	4.5	9-10 inches high.
14	Haberlandt	do.	do.	4.0	do.
15	Hollybrook	do.	do.	3.2	do.
16	Acme	do.	do.	1.3	do.
17	Tokio	do.	do.	4.5	do.
18	Mammoth Yellow	do.	do.	0.9	do.

MISCELLANEOUS HAY CROPS

Table XXV gives a suggestive series of results obtained from an early fall seeding of various crops, which were sown both individually and in simple mixtures. In this trial, red clover decidedly surpassed alsike; a mixture of red clover and tall oat grass outyielded either when sown alone and made the highest total yield of all; Culberson oats when sown alone were surpassed by a mixture of either red or alsike clover and oats; wheat and vetch surpassed rye and vetch, but in neither case was the vetch prominent. The effects of manuring were also very marked. Numerous trials made at the Station farm have been very favorable to an early fall seeding of tall oat grass, with which should be sown either red or alsike clover, depending on which succeeds best on the soil in question. Seeding may be done the latter part of August or the first week in September, but the soil should be well prepared and fairly fertile in order to insure satisfactory results. Under such conditions the combination is highly recommended.

TABLE XXV.—*Experimental hay crops on red soil of Central Basin, on farm of A. N. Miller, Christiana, Rutherford County*

Crop	Yield per acre				Remarks
	First cutting May 24	Second cutting July 14	Third cutting Sept. 20	Total for all cuttings	
	Tons	Tons	Tons	Tons	
Red clover	1.71	1.40	0.37	3.48	All crops were sown Sept. 14, 1909, and the harvests are those of the following year.
Alsike clover	1.07			1.07	
Red clover and Culberson oats	2.14	1.30	0.41	3.85	All plots received about 8 tons of manure per acre except as otherwise indicated.
Alsike clover and Culberson oats	1.98	0.42		2.40	
Culberson oats	1.88			1.88	
Tall oat grass	1.97	1.03	0.32	3.32	The first cutting of both red and alsike clover was increased by the volunteer oats from seed in the manure.
Red clover and tall oat grass	2.11	1.61	0.45	4.17	
Alsike clover and tall oat grass	1.91	1.11	0.30	3.32	
Wheat and vetch manured	2.05			2.05	
Wheat and vetch not manured	1.15			1.15	
Rye and vetch manured	1.78			1.78	The amount of vetch in all four plots when sown was almost negligible.
Rye and vetch not manured	0.70			0.70	

THE CUMBERLAND PLATEAU

The Cumberland Plateau is a large and practically undeveloped agricultural section. Two important factors which have had much to do with this condition are the poverty of the soil and lack of transportation facilities, railroads in particular. There are, however, many valuable considerations in favor of the Plateau, the most important being the ample rain-fall, so that crops seldom need suffer from drought; the easily tilled soil, the prevailing type of which is a fine sandy loam; the length of the growing season, which permits a great variety of crops to be grown; and the healthfulness of the climate. Not all of this section is by any means without adequate railroad facilities, and where such is the case the writer has great faith in the profitable development of the farming lands, which can now be bought cheap. The chief reason for this belief is that the handicap in the way of poverty of soil may be readily overcome by judicious methods of farming, which will include as necessities both liming and phosphating. The experimental results gotten in the last four years prove conclusively the great need of lime, phosphoric acid, and nitrogen, but that the supply of potash is relatively abundant, provided due care be taken to keep on the farm the residues from the straw, stover, grass, etc., produced.

CANADIAN FIELD PEAS AND OATS

For the past few years Canadian field peas and Burt oats have been successfully grown for hay at the Station farm. The peas add materially to the feeding value of the hay, as do cowpeas in the common mixture of cowpeas and millet. The Canadian peas are closely related to the common garden peas and like them should be sown as early in the spring as possible. Both the altitude of the Plateau and the sandy nature of the soil are favorable to Canadian peas, and the mixture with oats is recommended for trial. A fair seeding per acre is 2 bushels of oats and 1 bushel of peas. In the co-operative trials there has been some evidence that soil inoculation is necessary in order to get the best results. 300 pounds of a garden soil, where garden peas show nodules on the roots, is sufficient for an acre, and may be either drilled in or sown broadcast and harrowed into the soil. In 1908, Mr. Converse made an experimental seeding of this mixture on the farm of Mr. J. S. Johns near Creston and noticed that the peas grew well in spots, where on examination nodules were found on the roots, but elsewhere none were discovered. In 1910, he obtained the following results on the same farm:

	Hay per acre
Without inoculation	1024 lbs.
With inoculation	1772 "

One-fourth-acre plots were used and each was fertilized with 150

pounds per acre of acid phosphate. The seeding was done March 12, and the crop was harvested the last of June.

CLOVER AND TALL OAT GRASS

Clover and grass have been little sown on the Plateau, but under proper conditions there seems to be no reason why they should not be grown profitably. Table XXVI gives some results obtained in a comparison of red and alsike clovers and tall oat grass. The value of both fertilizers and lime is evident for all three crops.

TABLE XXVI.—*Fertilizer trials both with and without lime on two kinds of clover and a grass. Results of first season, 1910, on farm of Jerry Morrow, Creston, Cumberland County*

Plot	Fertilizer per acre	Crop	Yield of hay per acre		Remarks
			Without lime	With lime	
			Tons	Tons	
4 & 6	600 lbs. acid phosphate 100 lbs. muriate of potash	Red clover	1.2	1.52	Date of seeding, April 1.
5	No fertilizer	Red clover	0.76		Date of harvesting, July 21.
7 & 9	600 lbs. acid phosphate 100 lbs. muriate of potash	Alsike clover	1.08	1.44	
8	No fertilizer	Alsike clover	0.44		
28 & 30	600 lbs. acid phosphate 100 lbs. muriate of potash	Tall oat grass	0.68	1.12	
29	No fertilizer	Tall oat grass	0.60		

COWPEA-WHEAT ROTATION EXPERIMENTS

Experiments in a rotation of cowpeas and wheat similar to those previously reported were started in 1908, on the farm of J. O. Noland, Pomona Road, Cumberland County. The yields of both crops have been very low for each of the two years; in fact, too low to permit the recommendation of this system of cropping. The yields of wheat for the past two years are given in Table XXVII. The unfavorable season of the 1910 crop probably had much to do with the very poor yields of that year. Liming produced a noticeable increase in both seasons. The effect of the different phosphates, although appreciable the first year, especially where lime was applied, seems of little consequence the second year. It may be noted that the applications of both phosphate rock and bone meal were not repeated the second year, and that the acid phosphate was applied in 2/3 the quantity, or at the rate of 200 pounds per acre, in 1909. The applications of muriate of potash were repeated the second year. The continuation of these trials for a few years would be expected to give definite and valuable conclusions with regard to the comparative values of the different phosphates for this soil.

TABLE XXVII.—*Experiments with different phosphates in a rotation of cowpeas and wheat, on farm of J. O. Noland, Pomona Road, Cumberland County*

Plot	Fertilizer per acre as applied in 1908	Disposition of cowpea crop	Yield of wheat per acre in 1909				Yield of wheat per acre in 1910			
			Unlimed		Limed		Unlimed		Limed	
			Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
			Bu.	Tons	Bu.	Tons	Bu.	Tons	Bu.	Tons
1	None	Turned under	4.3	0.33	9.3	0.57	6.6	0.46	11.6	0.81
2	None	Removed	3.7	0.28	7.2	0.44	4.6	0.32	8.4	0.59
3	300 lbs. acid phosphate, 50 lbs. muriate of potash	Turned under	5.3	0.38	11.9	0.61	5.6	0.39	10.0	0.70
4	300 lbs. acid phosphate, 50 lbs. muriate of potash	Removed	3.9	0.28	9.7	0.55	4.4	0.30	10.4	0.73
5	300 lbs. acid phosphate	Turned under	7.0	0.51	12.1	0.67	4.8	0.33	10.4	0.73
6	50 lbs. muriate of potash	Turned under	5.5	0.39	7.8	0.48	3.2	0.22	7.6	0.53
7	900 lbs. phosphate rock, 50 lbs. muriate of potash	Turned under	3.7	0.27	8.9	0.49	3.4	0.24	6.4	0.45
8	900 lbs. phosphate rock, 50 lbs. muriate of potash	Removed	4.8	0.35	8.6	0.48	4.6	0.32	6.8	0.48
9	600 lbs. steamed bone meal, 50 lbs. muriate of potash	Turned under	8.0	0.60	15.1	0.81	6.8	0.47	9.6	0.67
10	600 lbs. steamed bone meal, 50 lbs. muriate of potash	Removed	6.8	0.48	12.9	0.69	6.4	0.44	8.4	0.59
11	300 lbs. acid phosphate, 50 lbs. muriate of potash	Removed	4.8	0.35	10.3	0.57	5.6	0.39	7.6	0.53

IRISH POTATOES

Irish potatoes are in many respects adapted to the Plateau conditions and may be made a remunerative crop, which will at the same time indirectly increase the soil fertility through the heavy applications of manure and fertilizer which may be profitably used. Table XXVIII gives a report of six series of fertilizer experiments carried out in Cumberland County during the season of 1910. In all these trials fertilizers were used with profit and in a number of instances a heavy application, totaling 1000 pounds or more per acre, was more profitable than a less amount. As in former trials, little need of potash is in evidence, but acid phosphate is of fundamental importance. In the series on Mr. McCart's place the latter material was used with apparent profit as a reinforcement to manure. The data of these series do not furnish conclusive evidence in regard to the comparative worth of nitrate of soda and cotton-seed meal as carriers of nitrogen, but the profits are slightly in favor of the former material, which is at present a somewhat cheaper source of nitrogen than the latter. Owing to the increasing demand for cotton-seed meal for feeding purposes, the price is apt to go higher rather than lower, so that potato growers would do well to learn how to use nitrate to most advantage. This substance is very readily soluble in water, but is leached from the soil less readily than might be supposed. In fact, as trials made on both these and Highland Rim soils show, the nitrate gives excellent results even when mixed with the acid phosphate and muriate of potash and applied in the row before the seed are dropped. This method would of course give the greatest opportunity for the nitrate to be lost during leaching rains. If two applications be made in the usual manner, one just as the plants are appearing above ground and the other about ten days later, the second dressing may be of little or no value on account of dry weather immediately following. The evidence at present available indicates that the best plan is to apply all the nitrate at one time, but as a surface dressing as soon as the plants break through the ground.

As in the Highland Rim series, farmyard manure was used with very profitable returns. The scarcity of this material stands in the way of its general use, so that a light dressing reinforced by acid phosphate, or by both acid phosphate and nitrate of soda, is advised.

TABLE XXVIII.—*Fertilizer experiments with Irish potatoes on the fine sandy loams of the Cumberland Plateau*

Locality	Plot	Fertilizer per acre	Yield per acre		Cost of fertilizer per acre	Calculated value* per acre of increase from fertilizer	Remarks
			Total	Salable			
			Bu.	Bu.			
Cumberland Co. Farm of Richard Taylor, Creston	1	600 lbs. acid phosphate 100 lbs. muriate of potash 400 lbs. cotton-seed meal 80 lbs. nitrate of soda	127	112	$17.20	$ 5.30	Planted May 5, 1910. Dug October 26. Variety, Great Divide. All plots had practically perfect stands. Rows 3.6 ft. wide, and plants nearly 2 ft. apart in the row. Nitrate applied as a surface dressing except for Plot 16.
	2	600 lbs. acid phosphate 400 lbs. cotton-seed meal 80 lbs. nitrate of soda	185	173	14.20	38.80	
	3	No fertilizer	81	64			
	4	600 lbs. acid phosphate 100 lbs. muriate of potash 600 lbs. cotton-seed meal	164	150	18.00	23.50	
	5	600 lbs. acid phosphate 100 lbs. muriate of potash 240 lbs. nitrate of soda	157	148	15.60	24.90	
	6	600 lbs. acid phosphate 100 lbs. muriate of potash 200 lbs. cotton-seed meal 160 lbs. nitrate of soda	144	134	16.40	17.10	
	13	No fertilizer	78	69			
	14	600 lbs. acid phosphate 50 lbs. muriate of potash 600 lbs. acid phosphate	150	127	6.90	23.10	
	16	50 lbs. muriate of potash 160 lbs. nitrate of soda	157	134	11.70	21.80	Nitrate mixed with the phosphate and potash.
Cumberland Co. Farm of A. L. Garison, Crossville.	A1	300 lbs. acid phosphate 50 lbs. muriate of potash 300 lbs. cotton-seed meal	123	110	9.00	10.50	Season of 1910.
	2	300 lbs. acid phosphate 50 lbs. muriate of potash 150 lbs. cotton-seed meal	99	89	6.60	2.40	
	3	No fertilizer	73	63			
	4	600 lbs. acid phosphate 100 lbs. muriate of potash 600 lbs. cotton-seed meal	136	121	18.00	7.00	

	5	600 lbs. acid phosphate 100 lbs. muriate of potash 300 lbs. cotton-seed meal	124	111	$13.20	$ 6.80	
	6	300 lbs. acid phosphate 50 lbs. muriate of potash 120 lbs. nitrate of soda	116	102	7.80	7.70	
	7	600 lbs. acid phosphate 100 lbs. muriate of potash 240 lbs. nitrate of soda	143	131	15.60	14.40	
	8	300 lbs. acid phosphate 50 lbs. muriate of potash	96	84	4.20	2.30	
	9	900 lbs. acid phosphate 150 lbs. muriate of potash 900 lbs. cotton-seed meal	178	163	27.00	19.00	
	B1	400 lbs. acid phosphate 67 lbs. muriate of potash 525 lbs. cotton-seed meal	85	74	14.01	— 12.51	
	2	400 lbs. acid phosphate 67 lbs. muriate of potash 210 lbs. nitrate of soda	102	89	8.97	0.03	
		Same as B 1	134	121	14.01	10.99	
	3	400 lbs. acid phosphate 67 lbs. muriate of potash	93	83	5.61	0.39	
	4	No fertilizer	89	79			
	5	Same as B 4	94	85	5.61	1.39	
	6	Same as B 4	116	107	5.61	12.39	
	7	Same as B 1	153	139	14.01	19.99	
	8	800 lbs. acid phosphate 67 lbs. muriate of potash	157	138	17.61	15.89	
	9	525 lbs. cotton-seed meal					
Cumberland Co.	11 & 14	No fertilizer	37	35			
Farm of John Moore, Crossville.	1, 4 & 16	600 lbs. acid phosphate 100 lbs. muriate of potash	49	45	8.40	— 3.40	Season of 1910.
	8 & 13	100 lbs. muriate of potash 160 lbs. nitrate of soda	37	35	7.80	— 7.80	
	5 & 9	600 lbs. acid phosphate 160 lbs. nitrate of soda	86	82	10.20	13.30	
	3 & 7	600 lbs. acid phosphate 100 lbs. muriate of potash 160 lbs. nitrate of soda	78	74	13.20	6.30	
	10 & 12	600 lbs. Thomas slag 100 lbs. muriate of potash 160 lbs. nitrate of soda	82	79	13.20	8.80	

*Salable potatoes valued at 50c per bu.

TABLE XXVIII.—*Fertilizer experiments with Irish potatoes on the fine sandy loams of the Cumberland Plateau*—Continued

Locality	Plot	Fertilizer per acre	Yield per acre		Cost of fertilizer per acre	Calculated value* per acre of increase from fertilizer	Remarks
			Total	Salable			
			Bu.	Bu.			
	15 & 18	400 lbs. bone meal 100 lbs. muriate of potash 160 lbs. nitrate of soda	71	67	$13.80	$ 2.20	
Cumberland Co. Farm of H. C. Hughell, Pomona Road.	1	300 lbs. acid phosphate 50 lbs. muriate of potash 300 lbs. cotton-seed meal	171	153	9.00	44.50	This series was conducted on very poor land, which was put under a two-year rotation of cowpeas, rye and potatoes, four years ago (1907), so that this is the 2nd crop of potatoes.
	2	300 lbs. acid phosphate 50 lbs. muriate of potash 150 lbs. cotton-seed meal	134	117	6.60	28.90	
	3	No fertilizer	57	51			
	4	600 lbs. acid phosphate 100 lbs. muriate of potash 600 lbs. cotton-seed meal	211	190	18.00	54.00	
	5	600 lbs. acid phosphate 100 lbs. muriate of potash 300 lbs. cotton-seed meal	183	165	13.20	46.30	Plots 1-5 were limed at rate of 2 tons of burnt lime per acre in 1907.
	6	300 lbs. acid phosphate 50 lbs. muriate of potash 300 lbs. cotton-seed meal	157	140	9.00	38.00	Plots 6-10 were not limed.
	7	300 lbs. acid phosphate 50 lbs. muriate of potash 150 lbs. cotton-seed meal	117	100	6.60	20.40	
	8	No fertilizer	51	41			
	9	600 lbs. acid phosphate 100 lbs. muriate of potash 600 lbs. cotton-seed meal	184	163	18.00	40.50	
	10	600 lbs. acid phosphate 100 lbs. muriate of potash 300 lbs. cotton-seed meal	183	160	13.20	43.80	
Cumberland Co. Farm of James Smith, Crossville.	1	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda	193	180	9.00	11.50	Nitrate top-dressed in one application.
	2	Same as Plot 1	217	202	9.00	22.50	Nitrate mixed with phosphate and potash.
	3	Same as Plot 1			9.00		Nitrate top-dressed in two applications

New land, and manured previous to application of the fertilizers.	4	No fertilizer	155	139			
	5	300 lbs. acid phosphate 50 lbs. muriate of potash 400 lbs. cotton-seed meal	149	140	$10.60	—$10.10	
	6	600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	221	205	18.00	15.00	Nitrate top-dressed in one application.
	7	Same as Plot 6.....			18.00		Nitrate mixed with phosphate and potash.
	8	Same as Plot 6.....			18.00		Nitrate top-dressed in two applications.
	9	300 lbs. acid phosphate 50 lbs. muriate of potash	166	148	4.20	0.30	
	10	600 lbs. acid phosphate 160 lbs. nitrate of soda	167	152	10.20	— 3.70	Nitrate top-dressed in one application.
	11	600 lbs. acid phosphate 100 lbs. muriate of potash 400 lbs. cotton-seed meal 160 lbs. nitrate of soda	193	176	19.60	— 1.10	
	12	600 lbs. acid phosphate 100 lbs. muriate of potash 800 lbs. cotton-seed meal	179	164	21.20	— 8.70	
	13	600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	190	177	18.00	1.00	½ of nitrate mixed with phosphate and potash and ½ top-dressed.
Cumberland Co.	1	No fertilizer	110	90			Planted May 2, 1910.
Farm of J. M. Johnson, and F. H. McCart, Crossville. New land, limed in 1908—2 tons per acre. Had also been well phosphated in 1908.	2	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda	167	151	9.00	21.50	Nitrate top-dressed in one application.
	3	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda			9.00		Nitrate mixed with phosphate and potash.
	4	300 lbs. acid phosphate 50 lbs. muriate of potash 160 lbs. nitrate of soda	173	153	9.00	22.50	Nitrate top-dressed in two applications.
	5	300 lbs. acid phosphate 50 lbs. muriate of potash 400 lbs. cotton-seed meal	181	162	10.60	25.40	
	6	600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	228	199	18.00	36.50	Nitrate top-dressed in one application.

*Salable potatoes valued at 50c per bu.

TABLE XXVIII.—*Fertilizer experiments with Irish potatoes on the fine sandy loams of the Cumberland Plateau*—Concluded

Locality	Plot	Fertilizer per acre	Yield per acre		Cost of fertilizer per acre	Calculated value* per acre of increase from fertilizer	Remarks
			Total	Salable			
			Bu.	Bu.			
	7	600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	200	173	18.00	23.50	Nitrate mixed with phosphate and potash.
	8	600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	194	169	18.00	21.50	Nitrate top-dressed in two applications.
	9	12 tons yard manure	212	193	12.00	39.50	
	10	12 tons yard manure 600 lbs. acid phosphate 100 lbs. muriate of potash 320 lbs. nitrate of soda	244	228	30.00	39.00	Nitrate top-dressed in two applications.
	11	12 tons yard manure 600 lbs. acid phosphate	237	213	17.40	44.10	
	12	12 tons yard manure 600 lbs. acid phosphate 320 lbs. nitrate of soda	242	223	27.00	39.50	Nitrate top-dressed in two applications.

*Salable potatoes valued at 50c per bu.

VARIETIES OF POTATOES

A series of variety trials are reported in Table XXIX. The Green Mountain is taken as the standard, or check, variety. The value of locally grown as compared with Northern-grown seed and, in the case of the Triumph variety, of second-crop seed, such as are grown in other parts of the State, is a matter of considerable importance, and it is hoped there will be ample data on this subject in the course of a few years. At present locally grown rather than Northern-grown seed are advised.

TABLE XXIX.—*Variety trials of Irish potatoes on Cumberland Plateau, on farm of J. M. Johnson, Crossville, Cumberland County, 1910*

Plot	Variety	Source of seed, etc.	Yield per acre		Remarks
			Total	Salable	
			Bu.	Bu.	
1	Green Mountain	Local	190	163	Plots planted May 1-4, 1910.
2	Green Mountain	Local (small)	185	152	
3	White Triumph	Local	59	41	
4	White Triumph	2nd crop, Warren Co.	101	75	Land new and had been previously limed and fertilized.
5	Red Triumph	Local	73	43	
6	Red Triumph	Northern-grown	20	15	
7	Early Rose	Local	161	140	
8	Green Mountain	Local	97	82	1000 lbs. per acre of a complete fertilizer used on all plots.
9	Green Mountain	Local (extra large)	121	107	
10	Burbank	Northern-grown	156	125	
11	White Mountain	Local	84	70	
12	Noxall	Local	155	139	
13	Carmen	Local	93	62	
14	Red Triumph	Tenn. 2nd crop	93	62	
15	Green Mountain	Local	154	131	

RESIDUAL EFFECT OF FERTILIZERS

When applied in large quanties, as in the experiments with potatoes described above, the residual effect of fertilizers may be of considerable importance, especially as phosphoric acid and potash even in water-soluble forms, are not lost to any appreciable extent by leaching. In Table XXX are some results which show plainly the effect of previous fertilizers on the production of oat hay. As this soil was a light sandy loam and naturally very poor in phosphoric acid the increases were probably due for the most part to the acid phosphate contained in the mixtures applied for the corn.

ROTATION OF CROPS

The judicious rotation of crops is recognized as an important means of increasing the productiveness of the soil. In particular leguminous crops exert a favorable effect on the crop which follows. Cowpeas, soy beans, and vetches are not, however, equal to the clovers, but, as the results reported in Table XXXI show, they are by no means to be ignored.

TABLE XXX.—*Residual effect of fertilizers as shown in yield of oat hay after three crops of corn grown with the aid of a complete fertilizer each year, on farm of Jerry Morrow, Creston, Cumberland County*

No. of plots averaged	Average annual application of fertilizer for corn—amount per acre	Yield of oat hay per acre	Calculated value* of increase	Remarks
		Lbs.		
2	None	880		Oats grown in 1910.
3	90 lbs. acid phosphate 66 lbs. cotton-seed meal 7½ lbs. muriate of potash	840	$2.30	
3	135 lbs. acid phosphate 99 lbs. cotton-seed meal 11¼ lbs. muriate of potash	1027	3.24	
3	270 lbs. acid phosphate 198 lbs. cotton-seed meal 22½ lbs. muriate of potash	1253	4.37	

*Oat hay valued at $10.00 per ton.

TABLE XXXI.—*Effect of previous cropping on the yield of oat hay, on farm of Jerry Morrow, Creston, Cumberland County*

No. of plots averaged	Annual application per acre previous to oats	Crop in 1907	Crop in 1908	Crop in 1909	Yield of oat hay per acre 1910
					Lbs.
2	No fertilizer	Corn	Corn	Corn	280
1	300 lbs. acid phosphate 50 lbs. muriate of potash 80 lbs. nitrate of soda	Corn	Corn	Corn	1280
1	300 lbs. acid phosphate 50 lbs. muriate of potash 80 lbs. nitrate of soda	Sorghum	Sorghum	Sorghum	1200
4	300 lbs. acid phosphate 50 lbs. muriate of potash 80 lbs. nitrate of soda	Corn	Corn	Soy beans	2205
2	300 lbs. acid phosphate 50 lbs. muriate of potash 80 lbs. nitrate of soda	Corn	Soy beans	Sorghum	1880

"NATURAL MEADOWS"

In addition to the uplands, attention has been directed to the fertilizer requirements and plant adaptability of the relatively small areas known as "natural meadows." These areas have not been looked upon as especially valuable because little aside from grass was found to grow satisfactorily upon them, although the dark-colored and humus-filled soil indicated great fertility. According to the chemical analyses made at the Station, these soils are very rich in nitrogen, but very poor in all the mineral elements of plant food. The field trials, which have been conducted for two seasons and are reported in Table XXXII, have demonstrated the great need of lime. Acid phosphate proved valuable in the production of both corn and millet and to a less extent for both sorghum and grass. There appears also to be a deficiency of potash which is shown in the production of various hay crops, but further trials will be necessary in order thoroughly to understand this soil.

TABLE XXXII.—*Experiments with fertilizers and two forms of lime on various crops when grown on a "natural meadow" of the Cumberland Plateau, on farm of James Smith, Crossville, Cumberland County*

Crop	Year	Plot	Fertilizer per acre, 1909 and 1910.	Lime (applied 1909)		Yield per acre			Remarks
				Form	Amount per acre	Corn		Hay	
						Grain	Stover		
					Tons	Bu.	Tons	Tons	
Corn	1910	14	None			4.3	0.25		
		15	None	Burnt	2	10.7	0.40		
		16	None	Ground limestone	4	11.9	0.75		
		13	None	do.	12	37.6	1.45		
		2	600 lbs. acid phosphate			17.9	0.58		
		3	do.	Burnt	2	32.1	1.04		
		4	do.	Ground limestone	4	30.4	1.29		
		1	do.	do.	12	42.9	1.40		
		6	600 lbs. acid phosphate + 100 lbs. muriate of potash			12.4	0.48		
		7	do.	Burnt	2	26.9	1.08		
		8	do.	Ground limestone	4	25.8	1.33		
		5	do.	do.	12	53.6	1.90		
		10	900 lbs. phosphate rock + 100 lbs. muriate of potash			16.1	0.60		
		11	do.	Burnt	2	25.0	1.00		
		12	do.	Ground limestone	4	19.7	0.90		
		9	do.	do.	12	46.4	1.83		
		18	400 lbs. bone meal + 100 lbs. muriate of potash			28.6	1.08		
		19	do.	Burnt	2	45.1	1.50		
		20	do.	Ground limestone	4	39.2	1.50		
		17	do.	do.	12	53.6	2.08		
		22	600 lbs. Thomas slag + 100 lbs. muriate of potash			32.1	1.50		
		23	do.	Burnt	2	42.9	1.83		
		24	do.	Ground limestone	4	25.0	1.17		
		21	do.	do.	12	23.3	1.17		
Millet	1909	11	None	Burnt	2			0.10	
		12	None	Ground limestone	4			0.27	
		10	None	do.	12			0.15	

			do.					
		2	do.	Burnt	2		2.70	
		3		Ground limestone	4		1.85	
		1	600 lbs. acid phosphate	do.	12		2.50	
		5	600 lbs. acid phosphate + 100 lbs. muriate of potash	Burnt	2		3.30	
		6	do.	Ground limestone	4		2.50	
		4	do.	do.	12		2.90	
		8	600 lbs. Thomas slag + 100 lbs. muriate of potash	Burnt	2		2.80	
		9	do.	Ground limestone	4		2.20	
		7	do.		12		2.95	
Millet	1910	34	None				0.30	
		35	None	Burnt	4		2.70	
		36	None	Ground limestone	8		3.05	
		33	None	do.	24		1.65	
		26	600 lbs. acid phosphate + 100 lbs. muriate of potash				2.40	
		27	do.	Burnt	4		4.25	
		28	do.	Ground limestone	8		4.10	
		25	do.	do.	24		4.00	
		30	600 lbs. Thomas slag + 100 lbs. muriate of potash				3.15	
		31	do.	Burnt	4		3.90	
		32	do.	Ground limestone	8		4.00	
		29	do.	do.	24		3.25	
Sorghum	1910	14	None					Partly cured in shocks.
		15	None	Burnt	2		5.00	
		16	None	Ground limestone	4		1.00	
		13	None	do.	12		5.12	
		2	600 lbs. acid phosphate				0.75	
		3	do.		2		3.25	
		4	do.		4		8.60	
		1	do.		12		5.70	
		6	600 lbs. acid phosphate + 100 lbs. muriate of potash				1.50	
		7	do.	Burnt	2		6.00	
		8	do.	Ground limestone	4		5.25	
		5	do.	do.	12		8.75	

TABLE XXXII.—*Experiments with fertilizers and two forms of lime on various crops when grown on a "natural meadow" of the Cumberland Plateau, on farm of James Smith, Crossville, Cumberland County*—Continued

Crop	Year	Plot	Fertilizer per acre, 1909 and 1910.	Lime (applied 1909)		Yield per acre			Remarks
				Form	Amount per acre	Corn		Hay	
						Grain	Stover		
					Tons	Bu.	Tons	Tons	
		10	900 lbs. phosphate rock, 100 lbs. muriate of potash					1.37	
		11	do.	Burnt	2			2.62	
		12	do.	Ground limestone	4			3.00	
		9	do.	do.	12			6.43	
		18	400 lbs. bone meal, 100 lbs. muriate of potash					3.75	
		19	do.	Burnt	2			8.75	
		20	do.	Ground limestone	4			7.50	
		17	do.	do.	12			11.00	
		22	600 lbs. Thomas slag, 100 lbs. muriate of potash					2.87	
		23	do.	Burnt	2			6.25	
		24	do.	Ground limestone	4			7.24	
		21	do.	do.	12			8.75	
Grass	1910	11	None	Burnt	2			1.90	Grass seed sown in fall of 1909 after the millet crop given in this table. No additional fertilizer was applied for the grass.
		12	None	Ground limestone	4			1.38	
		10	None	do.	12			2.85	
		2	600 lbs. acid phosphate	Burnt	2			2.20	
		3	do.	Ground limestone	4			1.63	
		1	do.	do.	12				
		5	600 lbs. acid phosphate, 100 lbs. muriate of potash	Burnt	2			2.75	
		6	do.	Ground limestone	4			2.25	
		4	do.	do.	12			2.25	
		8	600 lbs. Thomas slag, 100 lbs. muriate of potash	Burnt	2			2.55	
		9	do.	Ground limestone	4			1.52	
		7	do.	do.	12			2.15	

Varieties of grass	1910								All grass plots received lime except one plot of Timothy, which yielded about 1/10 of the limed plots.
Timothy			None					3.83	
Red top			None					2.48	
Kentucky blue			None					0.90	
English blue			None					0.90	
Italian rye			None					1.05	
Soy beans	1910	1	600 lbs. acid phosphate	Burnt	2			6.7	The yields of the soy bean plots are in tons per acre of green substance as cut and not cured.
		2	do.	Ground limestone	4			7.7	
		3	do.	do.	12			8.2	
		4	do.					5.5	
		5	None	Burnt	2			6.0	
		6	None	Ground limestone	4			4.7	
		7	None	do.	12			7.2	
		8	None					4.0	
		9	600 lbs. acid phosphate + 100 lbs. muriate of potash	Burnt	2			6.7	
		10	do.	Ground limestone	4			7.5	
		11	do.	do.	12			10.7	
		12	do.					8.2	
		13	600 lbs. slag meal + 100 lbs. muriate of potash	Burnt	2			7.0	
		14	do.	Ground limestone	4			8.1	
		15	do.	do.	12			8.3	
		16	do.					8.1	