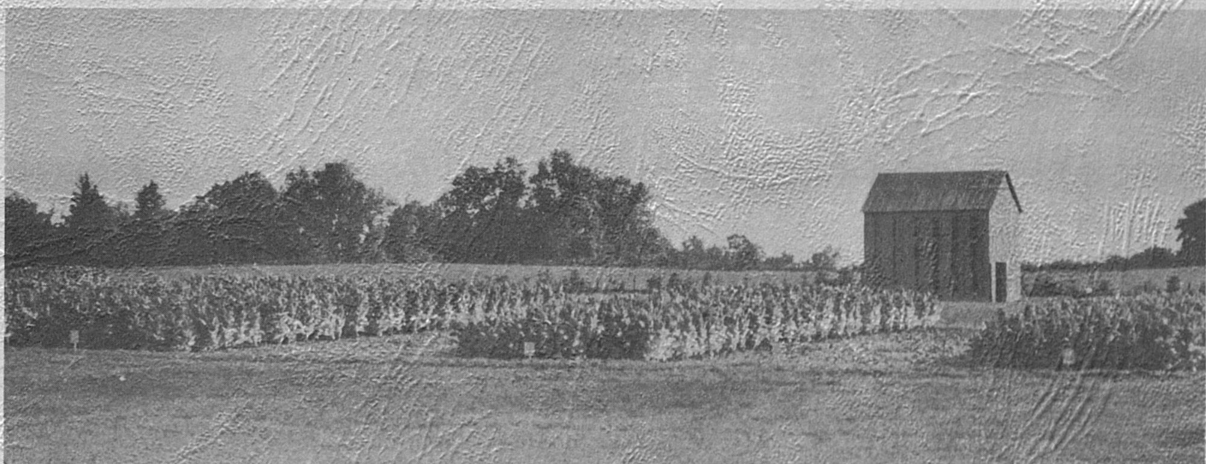
PROGRESS REPORT 59

SUMMARY OF FERTILITY EXPERIMENTS IN KENTUCKY, 1948-1956

By E.C. Doll, L.A. Link, and A.L. Hatfield



AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF KENTUCKY
LEXINGTON

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INTRODUCTION

Proper use of commercial fertilizers is essential for profitable crop production on most Kentucky soils. The Agronomy Department of the University of Kentucky Agricultural Experiment Station, carries on an extensive program to determine the best fertilizer and soil management practices for the production of most of the common field crops grown in Kentucky. Results obtained from 1948 through 1956 are presented in this summary. In most cases the data are self-explanatory, but a brief statement describing the results is generally given. Since this is only a summary, no discussions of the results or recommendation are included.

LOCATION OF FERTILITY EXPERIMENTS

Long-time fertility and soil management experiments are being conducted on the Campbellsville Soil Experiment Field in Taylor county, the Greenville Soil Experiment Field in Muhlenberg county, and at the Western Kentucky Substation in Caldwell county. Long-time experiments have recently been discontinued at Berea in Madison county and at Mayfield in Graves county. In addition to these permanent locations, numerous experiments are conducted on leased land throughout the state for shorter periods.

ROTATION EXPERIMENTS WITH GENERAL CROPS

A number of experiments have been conducted to determine the general fertilizer requirements of crops grown in a rotation, and some have been designed primarily to evaluate the effectiveness of various sources of phosphorus.

GENERAL FERTILITY EXPERIMENTS

Berea Soil Experiment Field: Work on the Berea Soil Experiment Field was conducted in cooperation with Berea College. All experiments were discontinued after yields were obtained in 1955. The soil type has been tentatively correlated as Monongahela silt loam, and is similar to a number of soils found at the base of the chain of Knobs surrounding the Bluegrass regions. These soils are light in color, quite acid, and low in both phosphorus and potash.

A four-year rotation of (1) corn, (2) wheat, and (3,4) two years of grass-legume hay was followed on four series of plots, so that each crop in the rotation was grown every year. Until 1948, manure was applied to all plots prior to planting corn in an amount equivalent to the crops removed from all series the previous year (except wheat grain). After 1948, the use of manure was discontinued on all but two plots in each series. On plots 4a, 5a, 7a, and 9a, phosphate applications were discontinued starting with corn in 1930. Rates and time of fertilizer applications per four-year rotation are given below:

L - Limestone - 4 tons per acre between 1913 and 1921
- 1 ton per acre between 1928 and 1930
- 2 tons per acre between 1948 and 1951

M - Manure - 10 tons per acre for corn

N - Nitrogen - Ammonium nitrate at the rate of 60 pounds of N per acre for corn, and 30 pounds for wheat (15 pounds in the fall and 15 pounds in the spring).

SP - Superphosphate - 20% superphosphate at the rate of 120 pounds of P_2O_5 per acre for wheat.

RP - Rock Phosphate - 240 pounds of P_2O_5 per acre applied for wheat

FRP - Rock Phosphate - 240 pounds of P_2O_5 per acre applied as finely ground rock phosphate for wheat.

K - Muriate of Potash - 60 pounds of K_2O per acre for corn and 30 pounds for wheat.

All of the phosphorus was applied in the fall for the wheat, and all of the manure in the spring for corn. Average yields from 1948 until the experiment was discontinued in 1954 are given below:

Plot	Treatment	Corn bu	Wheat bu	Hay 1st year lb	Hay 2nd year lb
1	0	2.3	1.0	170	410
1a	0	2.7	0.6	120	290
2	L N S P K	45.8	20.5	2590	3100
2a	L N F R P K	42.0	16.4	2580	3010
3	0	2.5	0.7	360	540
3a	M S P	23.7	5.4	1150	1320
4	N S P K	18.5	5.5	1170	890
4a	N (SP) K*	12.3	1.3	720	800
5	N R P K	39.0	9.2	1750	2010
5a	N (RP) K*	34.4	7.6	1340	1850
6	L N S P	22.1	17.8	1790	2300
6a	L N (SP)*	24.5	10.7	1500	1960
7	L N R P	21.1	15.8	2260	2230
7a	L N (RP)*	23.8	15.5	1750	1960
8	0	8.0	1.4	300	940
8a	M L S P	39.1	13.2	2730	3310
9	L N S P K	43.4	22.2	2960	3420
9a	L N (SP) K*	33.6	12.5	1610	2290
10	L N R P K	45.8	19.6	3150	3410
10a	L N (RP) K*	40.2	15.7	2700	2790

* Phosphate applications discontinued in 1930.

These results show the striking responses obtained at this location for limestone, phosphorus, and potash.

Campbellsville Soil Experiment Field: Experiments at this field were started in 1919, and fertility tests have been conducted continuously since that time. The major soil types on the field have been tentatively correlated as Bedford and Dickson silt loams. The soil is moderately acid (about pH 5.5), and responds well to applications of limestone and phosphate. After a period of intensive cropping, potash usually becomes limiting. The general fertility experiment is designed primarily to determine the effects of applications of limestone and phosphate on crop yields, although other comparisons are included. A three-year rotation of corn, wheat, and mixed grass legume hay is followed, with each crop in the rotation being grown on one of the three series each year. Recommended varieties of corn and wheat are seeded, and the hay crop consists of a mixture of Kenland red clover, Atlantic alfalfa, Korean lespedeza, orchardgrass, and red top. When this experiment was begun, manure was applied to all plots (except one in each series) in an amount equal to the crops removed (except wheat grain); starting in 1948, the use of manure on all plots except 8 and 15 was discontinued. The following table gives the rates of fertilization and the crops to which the fertilizer are applied:

L - Limestone	- 4 tons per acre applied between 1919 and 1934 - 1 ton per acre between 1948 and 1950 - 2 tons per acre between 1955 and 1957
M - Manure	- 8 tons per acre for corn
N - Nitrogen	- Ammonium nitrate at the rate of 90 pounds of N (270 pounds ammonium nitrate) per acre for corn, and 30 pounds per acre for wheat (15 in the fall, 15 in the spring)
P - Superphosphate	- 20% superphosphate at the rate of 90 pounds of P_2O_5 per acre rotation; all applied prior to seeding wheat
Bs - Basic slag	- Applied prior to seeding wheat at a rate to supply 90 pounds of P_2O_5 per acre rotation.
K - Muriate of Potash	- Applied at the rate of 90 pounds of K_2O per acre per rotation; 60 pounds of K_2O per acre for the corn and 30 pounds for the wheat

All of the phosphorus is applied in the fall just prior to seeding wheat, and all the manure (plots 8 and 15) is applied for the corn. The hay is not fertilized.

Every third plot in each series is a check plot, on which no fertilizers are applied. No fertilizer or manure have been applied to Plot 2 since the experiment was started in 1919, but all the check plots received applications of manure prior to the revision in 1948. The average annual yields obtained since the use of manure was discontinued in 1948 are given in the following table:

Plot	Fertilizer Treatment	Corn (bu) 9 crops	Wheat (bu) 8 crops	Hay (lb) 7 crops
1	0	17.7*	2.8	850
2	0	11.4	1.8	560
3	L	19.7	4.1	1050
4	0	16.7	2.5	860
5	P	53.6	17.5	3090
6	P K	58.3	18.4	3340
7	0	28.3	4.2	1520
8	M P	71.2	22.6	3990
9	N P K	67.9	26.7	3670
10	0	27.7	3.9	1650
11	N Bs K	60.2	30.4	4760
12	L P	45.4	19.2	4070
13	0	23.7*	4.3	1490
14	L P K	63.2	24.7	4990
15	L M P	70.5	23.8	4660
16	0	32.8	6.9	1790
17	L N P K	67.9	28.2	5490
18	L N Bs K	65.4	27.0	5730
19	0	38.1	6.5	1830

* Average of 8 crops.

The greatest response obtained in the experiment has been for the application of phosphate. While the addition of ground limestone has resulted in increased yields, a comparison of plots 3 and 5 shows that limestone alone is not nearly as effective in increasing the yields as is phosphate alone. When potash was applied (Plot 6), yields were increased somewhat (as compared with the yields of Plot 5). When the yields of Plots 6 and 9 are compared, a very definite response to nitrogen is obtained for corn and wheat; as would be expected, the nitrogen applications have very little effect upon the hay yields. This may be explained in two ways; first, nitrogen is fixed by the legumes in the hay, and second, because of their extreme solubility, nitrogen not used by the corn and wheat crops may be readily leached from the soil and thus usually has a very small residual effect. Other experiments conducted at Lexington indicate that losses of nitrogen through leaching occur mainly in January, February, and March.

A comparison of plots 5 and 12 shows that limestone and phosphate together are very little, if any, more effective, than phosphate alone in increasing the yields of corn and wheat. However, the hay yields are definitely better when both limestone and phosphate are applied. When the yields obtained on plots 12, 14, and 17 are compared, it is apparent that approximately the same responses to nitrogen and potash are obtained on the limed as on the unlimed plots.

Basic slag is applied as a source of phosphorus on plots 11 and 18. When the yields of these plots are compared with those of plots 9 and 17, it is evident that basic slag is equally as effective as superphosphate as a source of phosphorus. Furthermore, the neutralizing value of basic slag is approximately 80% of that of pure limestone. The much better hay yields on plot 11 as compared with plot 9 are mostly due to the neutralizing effect of basic slag.

Manure is applied to plots 8 and 15 at the rate of 8 tons per acre prior to plowing the series for corn. The treatments on plots 8 and 9 and plots 15 and 17 are designed to determine the relative effectiveness of manure as compared to commercial fertilizer. The yields of corn are approximately the same on all these plots, but the wheat yields are definitely poorer on the manured plots. This is mostly due to the lack of sufficient nitrogen on the plots which receive manure.

Greenville Soil Experiment Field: The Greenville Soil Experiment Field was established in 1913. The soil on this field, classified as Tilsit silt loam, is fairly representative of the upland soils of the Western Coal field and the sandstone area on its borders. Tilsit silt loam is described as a light yellowish brown, strongly acid silt loam, underlain by a mottled yellow, brown, and gray silty clay loam hardpan which is 10 to 20 inches thick and lies at depths of from 17 to 25 inches; this soil is moderately well drained. Under natural conditions, available phosphorus is very low, and potash usually becomes limiting after the soil is cropped for a short time. Because this soil is naturally strongly acid, applications of ground limestone are absolutely essential. These soils respond well to fertilization, and when properly managed, are capable of producing fairly good crop yields.

In the general fertility experiment, a four-year rotation of (1) corn, (2) wheat, and (3,4) two years of mixed legume-grass-hay is followed. The main objective is to determine the effects of lime and phosphate (supplied as either 20% superphosphate or raw rock phosphate) upon the yields of the various crops in the rotation. Four series of plots enable each crop of the rotation to be grown each year. The various symbols used to designate the plot treatments are given in the following table:

L - Ground Limestone	- Approximately 6 tons of limestone have been applied since 1913-1948 2 tons applied between 1955 and 1957
fL - Finely-ground Limestone	- 1 ton per acre
M - Manure	- 10 tons per acre plowed under for the corn crop
N - Ammonium Nitrate	- Applied at the rate of 90 lb of N (or 270 lb of ammonium nitrate) per acre per rotation; 60 lb of N for the corn, and 30 lb of N for the wheat. One-half of the N for the wheat is applied in the fall, and the other half as an early spring topdressing.
P - 20% Superphosphate	- Applied at the rate of 120 lb of P_2O_5 (600 lb of superphosphate) per acre per rotation, except on plots 1 and 9. Phosphate is applied to plot 1 at twice the regular rate, and to plot 9 at the rate of 80 lb of P_2O_5 (400 lb of superphosphate) per acre per rotation. All the phosphate is applied for the wheat crop.
RP - Rock Phosphate	- Applied at the rate of 240 lb of P_2O_5 per acre per rotation (approximately 720 lb of rock phosphate), except on plot 5a which receives 200 lb of P_2O_5 per acre, per rotation. All rock phosphate is applied for the wheat.

RP - Finely ground
Rock Phosphate - One ton of fine rock phosphate applied 1929-32, another ton between 1948 and 1951.

K - Muriate of Potash - Applied at the rate of 120 pounds of K_2O per acre per rotation. (200 pounds of 60% muriate of potash). 80 pounds of K_2O is applied for the corn and 40 pounds of K_2O for the wheat.

Phosphate applications have been omitted on plots 7a, 8a, and 13a since 1929. When this experiment was initiated in 1913, manure was applied to all plots, except plot 1, in an amount equal to the total weight of the crops (less wheat grain) removed during the entire rotation. In 1948 the use of manure was discontinued on all plots except 3a, 5a, and 9. The average annual yields obtained since the revision in 1948 are given in the following table:

Plot	Treatment	Corn bu/acre	Wheat bu/acre	Hay lb/acre 1st year	Hay lb/acre 2nd year
1	L 2(NPK)	46.4	37.6	4160	3380
1a	O	8.8	2.3	1190	1070
2	L N K	23.6	9.3	2320	1900
2a	L N fRP K	52.9	26.9	3880	4080
3	O	18.6	5.2	1820	1900
3a	M	40.6	11.3	2370	2590
4	P	39.9	17.2	2730	2900
4a	fL N P K	56.5	31.6	3640	3460
5	R P	38.5	18.4	3190	3100
5a	M RP	61.1	23.5	3900	3840
6	P K	52.8	18.8	3180	2910
6a	N P K	53.4	26.4	3000	3090
7	L N P K	58.1	34.4	4060	3510
7a	L N (P) K	42.4	16.7	2640	3130
8	L N RP K	63.8	29.8	4000	3800
8a	L N (RP) K	58.7	25.2	3340	3900
9	M L P	61.9	26.7	4040	3870
9a	L N P K	55.9	31.3	4020	4020
10	O	14.9	4.4	1380	2090
11	L P K	56.9	24.3	3990	3630
11a	L N P K	64.9	34.3	4180	3960
12	RP K	63.0	20.7	4030	3660
12a	N RP K	68.0	30.9	4150	4310
13	L N RP K	71.9	32.6	4330	4220
13a	L N (RP) K	72.2	31.3	4520	4440

The following table shows the average responses obtained from the different soil treatments:

Increase in yield due to:	Plots compared	Increase in Yield: Corn bu	Wheat bu	1st year Hay, lb	2nd year Hay, lb
Limestone	6a,7	4.7	8.0	1060	420
Superphosphate	3,4	21.3	12.0	910	1000
Rock Phosphate	3,5	19.9	13.2	1370	1200
Potash	4,5,6,12	18.7	2.0	650	290
Nitrogen	12a,12,11,11a	6.5	10.1	160	490
Manure alone	3,3a	22.0	6.1	550	690
Manure as compared with Nitrogen and Potash	9,9a	6.0	-4.6	20	-150

When this experiment was started in 1913, rock phosphate was applied to the proper plots at a rate to supply four times as much P_2O_5 as was applied to those plots receiving superphosphate. The rate of application of rock phosphate has since been reduced, and at the present time approximately 2 1/2 times as much P_2O_5 has been applied as rock phosphate as has been applied as superphosphate. When phosphate was applied at the above rates, no appreciable yield differences were obtained between plots to which superphosphate or rock phosphate has been applied. Up until 1948, however, manure was applied to all plots (except plot 1), and undoubtedly had some effect upon the yield comparisons.

The results of this experiment, as shown by the yield data, clearly show the value of rock phosphate used in a long-time soil building program. Data obtained from other experiments, however, indicate that when used without applications of manure or crop residues, superphosphate is much more effective than rock phosphate for the first few years. Nearly all the phosphorus in rock phosphate is unavailable to most crop plants in its original form, however, a chemical reaction between the rock phosphate and the soil slowly takes place and results in the release of phosphorus in an available form. This reaction is retarded by applications of limestone, and several years may be required under some conditions before enough phosphorus is released in available form to supply the needs of crop plants. When it is desired to use rock phosphate, supplemental phosphorus added as superphosphate would usually be advisable until sufficient available phosphorus has been accumulated from the reaction of rock phosphate with the soil.

Mayfield Soil Experiment Field: The Mayfield Soil Experiment Field, in Graves county, was established in 1913. Most of the soil on the field has been classified as Grenada silt loam, which is the most extensive upland soil type in the Purchase region of Kentucky. This experiment was discontinued in 1954 after the plot yields had been obtained. A four-year rotation of (1) corn, (2) wheat, and (3,4) two years of mixed legume-grass-hay was followed. The main objective was to determine the effects of lime and phosphate (supplied as either 20% superphosphate or raw rock phosphate) upon the yields of the various crops in the rotation. Four series of plots enabled each crop of the rotation to be grown each year. The various symbols used to designate the plot treatments follow:

L - Ground Limestone	-	Approximately 6 tons of limestone per acre applied during 1913-1919, and 2 tons per acre during 1948-1951 (except plots 14 and 16).
M - Manure	-	10 tons per acre for corn
N - Ammonium Nitrate	-	Applied at the rate of 90 lb of nitrogen (or 270 lb of ammonium nitrate) per acre per rotation; 60 lb of nitrogen (180 lb of ammonium nitrate) for the corn, and 30 lb of nitrogen (90 lb of ammonium nitrate) for the wheat. One-half of the nitrogen for the wheat is applied in the fall, and the other half as an early spring topdressing.
P - 20% Superphosphate	-	Applied at the rate of 120 lb of P_2O_5 (600 lb of superphosphate) per acre per rotation, except on plots 4 and 6, and to plots 4 and 6 at the rate of 80 lb of P_2O_5 (400 lb of superphosphate) per acre per rotation. All the phosphate is applied for the wheat crop.
RP - Rock Phosphate	-	Applied at the rate of 240 lb of P_2O_5 per acre per rotation (approximately 720 lb of rock phosphate), except on plot 5 which received 200 lb of P_2O_5 per acre, per rotation. All the rock phosphate was applied for the wheat crop.
RP - Finely ground Rock Phosphate	-	240 lb P_2O_5 per acre per rotation as on other RP plots.
K - Muriate of Potash	-	Applied at the rate of 120 pounds of K_2O per acre per rotation. (200 pounds of 60% muriate of potash) 80 pounds of K_2O is applied for the corn crop and 40 pounds of K_2O for the wheat crop.

Phosphate applications have been omitted on plots 6a, 8a, and 9a since 1929. When this experiment was initiated in 1913, manure was applied to all plots except plot 1, in an amount equal to the total weight of the crops (less wheat grain) removed during the entire rotation. In 1948 the use of manure was discontinued on all plots except 4, 5 and 6. Approximately 2 1/2 times as much phosphorus was applied as rock phosphate as was applied as superphosphate. The average yields of 7 corn, 6 wheat, 4 first-year hay and 2 second-year hay crops since 1948 are given in the following table:

Plot	Treatment	Corn bu/acre	Wheat bu/acre	Hay lb/acre 1st year	Hay lb/acre 2nd year
1	O	19.3	2.5	1270	1720
2	L	34.6	9.5	2520	2530
3	O	25.7	4.8	1340	1780
4	M P	49.1	17.3	2390	2530
4a	P	37.7	14.5	2010	2940
5	M RP	55.3	20.0	3110	3810
5a	RP	47.0	17.2	2840	3940
6	M L P	60.2	24.4	4110	3800
6a	M L (P)	58.2	22.2	3400	3670
7	O	32.3	9.2	1630	2460
8	L N RP K	58.1	29.7	3970	3280
8a	L N (RP) K	58.1	29.7	3970	3280
9	L N P K	56.8	29.6	3870	3050
9a	L N (P) K	48.8	23.9	3190	2820
10	L N P	39.8	26.8	3550	2580
10a	L N P K	52.2	27.7	3930	3000
11	O	32.1	11.8	1700	2810
12	L N P K	53.1	28.8	4050	3050
12a	L N RP K	55.0	23.4	4040	3800
13	L N K	47.1	21.0	2380	2990
14	(L) P K*	57.9	28.5	3930	3670
14a	L P K	----	21.3	3550	3520
15	O	33.7	12.1	1420	2620
16	(L) RP K*	59.3	21.1	3490	3960
16a	L RP K	----	22.0	4240	3900
17	L N P K	64.4	30.2	4390	4010

* Not Relimed 1948-51.

The following table gives the average responses obtained for the different soil treatments:

Yield decrease due to:	Plots Compared	Increase in Yield: Corn bu	Wheat bu	1st year Hay lb	2nd year Hay lb
Limestone	2,3	8.9	4.7	1180	750
Superphosphate	3,4a	12.0	9.7	670	1160
Rock Phosphate	3,5a	21.3	12.4	1500	2160
Potash	10,10a	12.4	0.9	380	420
Nitrogen	14a,17	6.5*	8.9	840	490

* Plot 14 used in comparison

Prior to 1948, when manure was applied to all plots, greater yield increases were obtained for limestone applied alone than for phosphorus applied alone. Since that time, however, greater yield responses have been obtained for phosphate applications. Responses have been obtained at this location for all of the fertilizer elements, showing the need for a complete fertilization program on the major upland soils of the Purchase.

Western Kentucky Substation: Experiments at the Western Kentucky Substation, in Caldwell county, have been conducted on two different soil types, one derived from limestone and the other from sandstone. Two major limestone soils, Pembroke silt loam and Crider silt loam, have been identified; the only difference between them is that the thickness of the loess (windblown material) cap is thicker on the Crider soil. Both are deep, well-drained, highly productive soils and are characteristic of the well-drained upland soil of the limestone section of the Western Pennyroyal. The other soil type, Tilsit silt loam, is located on the sandstone area and is similar to that which occures on the Greenville Soil Experiment Field.

Limestone Soil: From 1927 to 1944 an experiment was conducted comparing the effects of ground limestone on crops with respect to different times of application and different particle sizes. A 3-year rotation of (1) corn, (2) wheat, and (3) legume and grass hay was followed. There was very little difference in crop yields, whether the limestone (2 tons) was all applied at the beginning of the 18-year period, 1 ton each 9 years, or 1/3 ton in each 3-year rotation. For the 1/3 ton applications, there was no advantage in having the limestone finer than 10-20 mesh. In those tests, the amount of manure applied was equal to the weight of crops removed, (except wheat grain).

This project has been revised. Beginning with the 1949 corn crop, manure has been omitted from all but one treatment. Fertilizer treatments are given below:

L -	Ground Limestone
M -	8 tons manure per acre applied for corn
N -	65 pounds per acre of N applied as ammonium nitrate. 50 pounds applied for corn, 15 pounds as spring topdressing on wheat.
SP -	90 pounds of P_2O_5 per acre applied as 20% superphosphate prior to seeding wheat.
CSP -	90 pounds of P_2O_5 per acre applied as 45% concentrated superphosphate
FP -	90 pounds of P_2O_5 per acre applied as 28% fused tricalcium phosphate
RP -	180 pounds of P_2O_5 per acre applied as raw rock phosphate
K -	60 pounds per acre of K_2O applied as 60% muriate of potash for the wheat crop.

The average yields from plots of certain treatments in the present project are shown in the following table:

Treatment Number	Treatment	Corn - bu 8 crops	Wheat - bu 6 crops	Hay - lb 4 crops
1	O	42.0	17.3	1489
2	L	50.9	22.4	2180
3	SP	53.0	29.1	2265
4	SP K	53.7	27.7	2390
5	L SP	56.3	32.5	3255
6	L SP K	59.9	35.1	3825
7	L N SP K	60.6	37.6	3465
8	L CSP K	56.8	34.7	3825
9	L FP K	55.0	34.5	3460
10	RP K	55.7	29.8	2910
11	L RP K	56.7	31.1	3525
12	M L SP	58.1	34.3	3635

The treatments in which 20% superphosphate, concentrated superphosphate, and fused tricalcium phosphate are applied show no important differences among the various sources of phosphorus. A comparison of the first three treatments indicate that a greater response is obtained for phosphate alone than for limestone alone, but that the application of both (treatment 5) results in even higher yields.

<u>Sandstone Soil:</u> In 1929, a lime and fertilizer test was begun on the Substation's sandstone soil, using a 3-year rotation of (1) corn, (2) wheat, and (3) grass and legume hay. All plots received an application of farm manure for the corn crop through 1948. Beginning with the 1949 corn crop, manure was omitted from all but one of the plots.

The soil was very unproductive when experimentation started. However, it has responded remarkably well to liming, fertilization and good management. Limestone and phosphate applied together have given large increases in crop yields. The potassium and nitrogen applications probably would have increased crop yields also, had not rather liberal amounts of manure been used on the plots previous to 1949.

There is also a comparison between applying all the phosphate and potash for the rotation for the corn or applying it for the wheat. In some individual comparisons, corn yields were slightly greater when the fertilizer was applied for this crop, but wheat and hay yields were not so good. Considering all the crops, it has been appreciably better to apply phosphate and potash for the wheat crop. The average adjusted yields of the crops in the rotation from 1949 to 1953 are shown in the following table:

The various symbols used to designate treatments are given below:

M - Manure at the rate of 8 tons per acre applied ahead of corn.

P - Superphosphate, 20 percent, at the rate of 90 pounds P_2O_5 per acre for wheat on all plots except where specified for corn.

K - Muriate of potash, 60 percent, at rate of 90 pounds K_2O per acre for wheat on all plots except where specified for corn.

N - Ammonium nitrate at rate of 15 pounds N as a topdressing on wheat and 50 pounds of N per acre broadcast for corn.

L - Limestone, a total of 4 tons per acre applied since 1929.

Treatment	Corn - Bu 4 crops	Wheat - Bu 3 crops	Hay - lb 3 crops
None (Av. 7 checks)	16.2	1.7	1010
L P	47.4	19.5	3470
L P K	49.8	21.3	4050
M L P	55.2	21.4	4230
L P K N	51.6	21.8	4050
P K	41.1	12.9	2490
L P*	50.3	14.7	3170
L P K*	55.4	15.4	3410
L P N*	54.9	19.7	3180
L P K N*	57.2	21.3	3150

* Phosphate and potash broadcast before corn was planted on these plots.

Two-Year Rotations of Corn and Wheat:

Two experiments are being conducted in which corn and wheat are grown in a 2-year rotation, with a legume seeded in the wheat to serve as a cover and green manure crop.

Greenville Soil Experiment Field: This experiment was started in its present form in 1952. The soil type is the same as that described in the General Fertility Experiment at the Greenville Soil Experiment Field. Corn and wheat are grown in a 2-year rotation on two series of plots, so that each crop is grown each year. An application of 320 pounds of P_2O_5 per acre per rotation is broadcast on all plots, one-half for the corn, and one-half for the wheat. Sweet clover and lespedeza are seeded in the wheat in the spring to serve as a green manure and cover crop. None of the sweet clover-lespedeza cover crop is removed. Each of four rates of nitrogen (0, 40, 80, and 120 pounds of N per acre per rotation) is combined with each of five rates of potash (0, 40, 80, 160, and 320 pounds of K_2O per acre per rotation) to give a total of 20 treatments. One-half of the potash is applied for each crop, and 5/8 of the nitrogen is applied for the corn and the remaining 3/8 for the wheat.

The average yields of five corn and four wheat crops are given in the following tables:

Average Yield of Corn (Bushels per Acre)

Rates of Nitrogen (Lb N per acre)	Rate of Potash (Lb K_2O per acre) 0 (0)*	40 (20)	80 (40)	160 (80)	320 (160)	Average
0 (0)*	30.6	34.6	42.7	52.6	52.3	42.6
40 (25)	20.9	31.1	46.2	56.1	55.4	41.9
80 (50)	18.0	36.7	44.7	55.8	56.4	42.3
120 (75)	12.4	34.6	45.3	54.4	54.5	41.9

* Figures in parenthesis refer to amount applied for corn crop.

Average Yield of Wheat (Bushels per Acre)

0 (0)*	16.7	22.3	24.1	19.3	18.5	20.2
40 (15)	26.1	31.7	31.2	30.3	26.5	29.2
80 (30)	26.0	34.3	36.4	32.5	28.0	31.4
120 (45)	19.9	35.4	36.5	33.6	31.9	31.5
Average	22.2	30.9	32.1	28.9	26.2	28.1

* Figures in parenthesis refer to applications for wheat crop.

The corn yields show that an increase in yield owing to the application of potash was obtained up to the rate of 160 pounds of K_2O per acre per year. For wheat, an increase in yield was obtained only for the rate of 20 pounds of K_2O, after which there was no increase. The decrease in yield of wheat for the higher rates of K_2O is probably due mostly to soil variation. Insofar as nitrogen is concerned, no increases in the corn yields have been obtained. However, a good response for the first 15 pounds of nitrogen has been obtained with wheat, and a smaller response for the next 15 pounds.

The cover crop showed as marked a response to potash as the corn and wheat. On the plots receiving the heavier rates of potash, more nitrogen was fixed by the legumes because of the heavier growth. Furthermore, the growth of wheat is very heavy on the high-nitrogen plots, and a poorer stand of lespedeza and sweet clover is obtained. Consequently, the average corn yields show no response for nitrogen.

The corn yields reported above are much lower than would be expected. These low yields are the result of dry weather during the growing season the first three years of these experiments.

In 1956, the better plots yielded approximately 85 bushels of ear corn per acre, and a good response was obtained for the first 25 pounds of nitrogen. The annual yields for the 5-year period that this experiment has been conducted indicate that the legume cover crop will fix enough nitrogen for yields of approximately 70 bushels, and that supplemental nitrogen must be applied for higher yields.

Western Kentucky Substation: Different rates of nitrogen are applied in a 2-year rotation of corn and wheat. A mixture of lespedeza and clover is sown in the wheat in early spring, but no hay is harvested. Nitrogen is used at rates of 0, 30, 60 and 120 pounds per acre for each corn crop and at half these rates as a spring top-dressing for each wheat crop. Phosphate at the rate of 200 pounds of P_2O_5 per acre and potash at the rate of 150 pounds of K_2O per acre are applied to each crop. The wheat has given much better response for additional nitrogen than the corn. This lack of response for the higher levels of nitrogen on corn is probably due in part to lack of moisture and in part to the nitrogen supplied by the legume cover crop.

Wheat has given a significant increase in yield for each additional amount of nitrogen; how ever, wheat lodged badly at the highest nitrogen level, and no stand of legumes was obtained at this rate.

The average yields for 1955 and 1956 are given in the following table:

Rate of Nitrogen (Lb per Acre)			Bushels per Acre	
Corn	Wheat	Total	Corn	Wheat
0	0	0	61.0	18.1
30	15	45	72.1	30.1
60	30	90	75.4	39.9
120	60	180	77.0	47.3

Legumes in Rotation

Western Kentucky Substation: A rotation experiment was conducted from 1927 to 1954 to evaluate the effects of various legumes on the yields of succeeding corn and wheat crops grown in a 3-year rotation with the various legumes. This experiment was located on the Western Kentucky Substation on a soil of limestone origin tentatively correlated as Crider silt loam. A description of this soil was previously given under the discussion of the general fertility experiment at this location. Ground limestone (L) was applied to the appropriate plots at the rate of 4 tons per acre during the course of the experiment, phosphate (P) at the average rate of 110 pounds of P_2O_5 per acre per rotation, and potash (K) after 1936 at the average rate of 85 pounds of K_2O per acre per rotation. The fertilizer treatments, the various legumes grown, the method of handling the legumes, and the average yields for the period of the experiment are given in the following table:

Treatment			Average Yield per Acre		
Fertilizer	Legume	Method of Handling	Corn, bu	Wheat, bu	Hay, lb
None	Lespedeza and clover	Hay	34.8	8.3	1380
PK	Lespedeza	Plowed down for corn	48.4	17.2	----
PK	Lespedeza	Hay	42.3	15.0	1840
LPK	Lespedeza	Hay	54.9	19.4	2950
PK	Cowpeas	Hay, rye cover crop	36.0	11.7	2280
PK	Soybeans	Hay, rye cover crop	37.5	12.4	2920
PK	Soybeans	Grain harvested, straw returned rye cover crop	44.1	14.5	----
LPK	Sweet Clover	One hay cutting only	58.9	20.9	2580
LPK	Alfalfa	Last cutting plowed down for corn	56.9	20.8	1860
LPK	Alfalfa	Hay	54.0	20.3	2210
LPK	Clover*	Hay	54.1	22.0	2790
LPK	Clover*	Plowed down for corn	56.2	23.5	----
MLPK	Clover*	Hay, manure returned equivalent to hay removed	55.8	23.2	2790
LPK	Timothy	Hay	45.9	15.6	2770
LPK	Clover and Timothy	Hay	51.9	18.7	2940
LNPK	Timothy	Hay	51.1	20.3	3130

* Mixture of red and alsike clover until 1935, after which only red clover was seeded.

The most striking result of this experiment has been the response obtained for applications of limestone, and the low yields of corn following soybeans and cowpeas. On the plots seeded to Timothy, considerable volunteer lespedeza was generally present, so these treatments cannot be considered representative of results obtained when no legumes are grown. All the legumes except cowpeas and soybeans were seeded in the wheat in the spring, and the stands of alfalfa obtained in this manner were not generally satisfactory. The best legumes for use in a short rotation, from the standpoint of both the yields of the grain crops and the yield and quality of the hay appears to be red clover and lespedeza.

Greenville Soil Experiment Field: An experiment to determine the effects of various methods of handling lespedeza grown in a 3-year rotation with corn and wheat was conducted from 1936 until 1956. Ground limestone (L) was applied at the rate of 2 tons per acre when the experiment was started, and phosphate (P) and potash (K) were applied at rates to insure that neither was limiting plant growth. The various systems of crop management and the yields are given in the following table:

Fertilizer Treatment	Crop Removed			Average Yields per Acre, Year of Rotation				
	1st year	2nd year	3rd year	First Corn, bu	Second Wheat, bu	Second Hay, lb	Third Wheat, bu	Third Hay, lb
None	Corn	Wheat	Hay	15.0	3.2			1680
LPK	Corn	Wheat	Hay	36.4	17.1			3420
LPK	Corn	Wheat	Hay, followed by rye cover	37.7	17.1			3510
LPK	Corn	Wheat	Wheat, hay followed by rye cover	35.2	15.9		6.8	3370
LPK	Corn	Wheat	Hay, followed by rye cover	32.2	14.3	2460		2660
LPK	Corn	Wheat*	Timothy Hay Lespedeza Hay	35.4	13.3			4050**

* Both Lespedeza and timothy seeded in wheat.
** Includes both timothy and lespedeza cuttings.

The yields of both corn and wheat were much lower than those obtained on adjoining experiments. Possibly heavier rates of application of the soil amendments might have resulted in increased yields. The most striking results obtained were the response of all crops to soil treatment. The use of a rye cover crop to prevent leaching after the lespedeza was removed had very little effect upon the succeeding corn yields and no effect on the wheat yield; yield increases were not sufficient to justify the use of a cover crop in this experiment. It would appear that, in this experiment, the lespedeza could not fix sufficient nitrogen for satisfactory yields of the succeeding corn crop.

EXPERIMENTS COMPARING VARIOUS SOURCES OF PHOSPHORUS

Although different sources of phosphorus, particularly superphosphate and rock phosphate, have been included in the general fertility experiments, a number of experiments have been conducted primarily to compare various sources and rates of phosphorus. Most of these experiments in recent years have been conducted in cooperation with the Tennessee Valley Authority to evaluate the effectiveness of various phosphate fertilizers developed by the TVA.

Rotation Experiments

Campbellsville Soil Experiment Field: This experiment is a comparison of various rates of superphosphate and rock phosphate. As in the general fertility experiment, this experiment was also revised in 1948. Nitrogen and potash are applied to all plots, including the check plots. The rate and source of phosphorus, 20% superphosphate (P) or 30% rock phosphate (RP), is given in the following table under "Phosphate Treatment". A three-year rotation of (1) corn, (2) wheat and (3) grass-legume hay is followed, and each crop is grown every year on one of the three series. The average yields since 1948 are given in the following table:

Plot	Phosphate Treatment	Corn (bu) 9 crops	Wheat (bu) 8 crops	Hay (lbs) 7 crops
1	None	18.1	1.8	1510
2	P 300	59.3	16.3	2330
3	RP 750	70.8	18.9	3250
4	None	22.0	2.6	1470
5	(P) **	47.0	7.9	2060
6	(RP) **	68.8	15.9	3020
7	None	24.2	4.8	1580
8	L P 300	55.5	26.7	3930
9	L RP 750	69.4	26.3	5240
10	None	24.4	5.4	1720
11	L (P) **	49.8	17.8	3280
12	L (RP) **	66.2	24.1	4490
13	None	32.7	6.6	1920
14	RP 750	69.3	23.2	4160
15	L RP 750	70.7	26.2	5010
16	None	37.0	9.1	1570

* Uniform rates of nitrogen and potash are applied to all plots (90 lb per acre of N and 90 lb per acre of K_2O per rotation).

** Phosphate applications omitted since 1931.

At present, the yields from the plots to which rock phosphate is applied are as good or better than those from the plots which received superphosphate. However, phosphate from these two sources have been applied to the respective plots once during each complete rotation since 1919, and approximately 2-1/2 times as much P_2O_5 has been applied as rock phosphate as superphosphate. When this experiment was first started, however, the yield from the unlimed plots to which rock phosphate was applied approached and equalled those from the plots to which superphosphate was applied. Four times as much phosphorus was applied as rock phosphate as was applied as superphosphate. The relative effectiveness of rock phosphate as a source of phosphorus was initially suppressed by the application of limestone. However, the yields of wheat and hay from the limed plots to which rock phosphate was applied eventually became higher than those from the plots which also received rock phosphate but were not limed.

The results of this experiment, as given in the preceding table, clearly show the value of rock phosphate used in a long-time soil-building program. The early results of this and other similar experiments, however, show that for the first few years much greater responses are usually obtained when superphosphate is used to supply all or part of the phosphorus. In its original form, nearly all the phosphorus in rock phosphate is unavailable to plants. However, a chemical reaction between the rock phosphate and certain components of the soil slowly takes place, and results in the release of phosphorus to an available form. Several years may be required before enough phosphorus is released in available form to supply the needs of the crop plants. When it is desired to use rock phosphate, supplemental phosphorus added as superphosphate would probably be advisable until sufficient available phosphorus has accumulated from the reaction of rock phosphate with the soil.

Western Kentucky Substation:

Limestone Soil: This experiment, begun in 1940, is a comparison of concentrated superphosphate and raw rock phosphate, each being used at various rates in a 3-year rotation of (1) corn, (2) wheat, and (3) grass and legume hay. The experiment is located on the limestone soil which was described in the general fertility experiment at this same location.

Results of the experiment are given in the following table (All yields are an average of duplicate plots):

Applied Rate of P_2O_5 per Rotation		Corn, Bu 16 crops	Wheat, Bu 14 crops	Hay, lb 14 crops
Rock Phosphate	100	49.8	19.0	2299
Concentrated Superphosphate	50	49.1	28.2	2844
Rock Phosphate	150	52.3	21.1	2817
Rock Phosphate	200	54.4	22.5	3155
Concentrated Superphosphate	100	57.7	31.0	3748
Rock Phosphate*	300-100	52.2	20.6	2710

* 300 lb per acre first application and 100 lb each rotation thereafter.

Rock phosphate was relatively more effective for corn and hay than for wheat. Concentrated superphosphate was very effective on all crops. Yields of wheat have been considerably higher on plots receiving concentrated superphosphate than on those receiving rock phosphate to which four times as much P_2O_5 was applied. It should be noted that when concentrated superphosphate was used the yields of all crops were increased materially by increasing the rate of application from 50 pounds to 100 pounds of P_2O_5 per acre.

All plots received the same amount of potash and nitrogen fertilizer. Limestone was applied at the rate of 1 ton per acre in the beginning and 1/3 ton in each rotation thereafter. The pH of the soil of these plots is approximately 6.4. All limestone, phosphate, and potash treatments were applied when the wheat was seeded. Limestone was used only in moderate amounts, but probably too much was used for the best performance of rock phosphate. However, rock phosphate neutralizes soil acidity only very slightly, and its application does not take the place of liming. When rock phosphate is used, only enough limestone should be applied to grow the legumes in the cropping system.

It is known that the phosphorus in raw rock phosphate is less readily available to most crops than that in concentrated superphosphate. For this reason, rock phosphate is used at a higher rate per acre; however, over a period of years a much larger amount of residual phosphate is left in the soil from the use of rock phosphate. All crop residues, including the corn stover and wheat straw, are removed from the plots and no manure is used. It has been demonstrated in other tests that rock phosphate is more readily available to crops when used with manure and crop residues.

<u>Sandstone Soil:</u> This experiment, initiated in 1930 and concluded in 1954 is a comparison of superphosphate, basic slag, and raw rock phosphate as sources of phosphorus, and is located on sandstone soil similar to that occurring on the Greenville Soil Experiment Field.

At the rates used (twice as much phosphorus in the rock phosphate as in the other two phosphates), the three phosphates were about equally effective in this experiment. It will be noted that the corn and wheat yields were not increased by the use of ground limestone in this experiment. The treatments are given in the following table:

P -	20% superphosphate at rate of 60 pounds P_2O_5 per acre ahead of wheat
Bs -	Basic slag at rate of 60 pounds P_2O_5 per acre ahead of wheat
RP -	Rock phosphate, ordinary grinding, at rate of 120 pounds P_2O_5 per acre ahead of wheat
fRP -	Rock phosphate very finely ground (300 mesh) at rate of 120 pounds of P_2O_5 per acre ahead of wheat
K -	Muriate of potash 60 percent at rate of 90 pounds K_2O per acre ahead of wheat

N - Ammonium nitrate at 15 pounds N as a spring topdressing on wheat and 50 pounds N broadcast ahead of corn (increased from 15 pounds N on corn prior to 1949)

L - Limestone, a total of 2 tons per acre applied since 1930

The average yields are given in the following table:

Treatment	Average of 22 crops Corn, Bu	Wheat, Bu	Hay, lb
None	26.0	6.0	1481
P K N	36.4	17.6	2397
fRP K N	42.1	17.7	3174
Bs K N	40.2	16.7	3029
L P K N	42.9	19.8	3412
L fRP K N	45.0	16.3	3722
L RP K N	43.3	14.6	3365

Note - Manure was previously applied to all plots until 1949, at a uniform rate based on the average yields of the check plots the preceding year.

Greenville Soil Experiment Field: This experiment is located on the sandstone soil described under the general fertility experiment at the same location.

A 3-year rotation of (1) corn, (2) wheat, and (3) red clover hay is followed. Rates of 20, 40, 60, 80, 100, 160, 240 and 320 pounds of P_2O_5 per acre per rotation are included; one-half of the phosphorus is applied for the corn and one-half for the wheat. The eastern half of each plot is limed to approximately pH 6.8, and the west half to approximately 5.8. The use of three series (100, 200, and 300) enables each crop in the rotation to be grown each year. Nitrogen is applied at the rate of 60 pounds per acre for corn and 30 pounds for wheat. Potash is applied at the rate of 80 pounds of K_2O per acre for corn, and 80 pounds of K_2O for wheat. No fertilizers are applied for the red clover hay. The average annual yields are given in the following table:

Pounds of P_2O_5 per acre per rotation	Corn, bu pH 5.8 (10 Crops)	Corn, bu pH 6.8	Wheat, bu pH 5.8 (11 Crops)	Wheat, bu pH 6.8	Hay, lb pH 5.8 (7 Crops)	Hay, lb pH 6.8
20	35.0	41.0	17.0	20.3	2870	3080
40	41.2	44.6	20.0	22.9	3020	3090
60	46.4	49.6	25.0	27.5	3420	3660
80	50.4	53.3	27.5	30.6	3810	3910
100	54.4	57.5	29.8	31.2	4160	4170
160	58.2	61.7	32.6	33.7	4970	5080
240	64.0	63.7	33.7	34.2	5000	5320
320	59.1	63.2	33.7	34.7	5330	5350

For corn and wheat, an increase in yield was obtained for each additional increment of phosphorus up to and including the rate of 240 pounds of P_2O_5 per acre per rotation; for hay an increase in yield was also obtained for the rate of 320 pounds of P_2O_5. When comparing the plots which were limed to pH 5.8 with those limed to pH 6.8, in almost every case the yields from the plots which received the heavier limestone applications (pH 6.8) were higher than those from the plots which were only limed to pH 5.8. Furthermore, these increases in yield due to additional limestone applications were greater for the plots which received the lower rates of phosphorus.

Residual Effects of Phosphorus from Various Sources: This experiment was started in 1949 near the Greenville Soil Experiment Field, and is located on the same type of soil. A three year rotation of (1) corn, (2) wheat, and (3) grass-legume hay is followed on one series of plots, so that only one crop in the rotation is grown each year. All plots received ground limestone at the rate of 2 tons per acre prior to starting the experiment. All of the phosphorus was applied in 1949, one-half in the spring for the corn crop, and the remaining half in the fall for wheat; none has been applied since. Ammonium nitrate is applied at a rate to supply 60 pounds per acre of N for corn and 30 pounds for wheat. Muriate of potash is applied at a rate to supply 60 pounds per acre of K_2O for corn and 30 pounds for wheat. No fertilizers are applied for the hay. The various sources of phosphorus and the yields obtained are given in the following table:

Source of Phosphorus	Rate of P_2O_5 lb per Acre	Yields per Acre							
		1949 Corn bu	1950 Wheat bu	1951 Hay lb	1952 Corn bu	1953 Wheat bu	1954 Hay lb	1955 Corn bu	1956 Wheat bu
None	---	22.4	1.9	1230	9.0	8.0	2290	14.9	4.1
Fused Tricalcium Phosphate	120	53.5	27.3	3470	23.6	15.6	2690	26.9	10.5
Concentrated Superphosphate	120	59.1	28.3	3250	22.9	14.6	2610	27.7	7.3
Rock Phosphate	120	25.1	4.0	1360	14.5	15.9	2750	34.5	10.0
Rock Phosphate	240	28.9	4.7	1760	19.4	19.6	2830	42.3	14.7
Fused Tricalcium Phosphate	60	37.7	21.7	2050	14.6	10.5	2210	20.5	4.5
Concentrated Superphosphate	60	46.7	22.3	2050	12.2	10.5	1890	17.1	4.1
Dicalcium Nitric Phosphate	60	47.6	21.3	2160	16.4	10.9	2290	17.9	5.5
Rock Phosphate 200, plus Concentrated Superphosphate 40	240	41.5	18.5	2130	21.5	20.0	2990	41.5	15.0
Difference required for Significance (0.05)		8.2	3.7	720	4.4	3.2	N.S.	5.9	4.5

Except for the first two crops (corn in 1949 and wheat in 1950) the yields obtained in this experiment could have been increased by additional phosphate applications. However, trends in yields obtained using the available forms of phosphorus, (such as concentrated superphosphate) and the more unavailable rock phosphate are distinct.

Relatively higher yields were obtained in the first two crops when concentrated superphosphate was used, and the residual effectiveness was much less than the initial effectiveness. Conversely, the initial response to rock phosphate was very low, but the yields increased as the experiment progressed. The treatment in which a mixture of concentrated superphosphate and rock phosphate was applied shows the advantage of applying available phosphorus for the first few years if rock phosphate is to be used.

Annual Experiments

Several annual experiments have been conducted throughout the state in which various phosphate fertilizers were compared as sources of phosphorus for various crops. There experiments were conducted in cooperation with the Tennessee Valley Authority. Only those tests conducted for the last four years (1953-56, inclusive), are included in this summary. In all cases an effort was made to locate the experiments on a soil very low in available phosphorus. In all of these tests, supplemental nitrogen and potash were applied to all plots in equal amounts, so that the only element varied was phosphorus. All experiments were replicated at least four times, and the results were subjected to statistical analysis. The various sources of phosphorus, rates and methods of application, and the yields are given in the following tables, (unless otherwise stated, all of the phosphorus for corn was applied in the row):

Sources of Phosphorus for Corn:

1953, Taylor County (Gilmore Farm)

Source of Phosphorus	Method of Application	Rate of P_2O_5 lb per Acre	Yield of Ear Corn bu per Acre
Concentrated Superphosphate	Row	30	50.8
" "	Broadcast	30	43.7
Fused Tricalcium Phosphate	Row	30	47.2
" "	Broadcast	30	44.8
Calcium Metaphosphate	Row	30	48.3
" "	Broadcast	30	50.2
High Alumina Nitric Phosphate			
High Water Solubility	Row	30	45.3
Low Water Solubility	Row	30	42.6
Commercial Type Mixture			
High Water Solubility	Row	30	50.7
Low Water Solubility	Row	30	50.8
No Phosphate Check	--	--	42.3
Difference required for significance (0.05)			5.4

1953, Taylor County (Cox Farm)

Source of Phosphorus	Rate of P_2O_5* lb per Acre	Yield of Ear Corn bu per Acre
Concentrated Superphosphate	30	50.6
" "	60	51.5
" "	90	58.3
Nitric Phosphate, Low Water-solubility	30	51.9
" "	60	53.9
" "	90	55.2
Nitric Phosphate, High Water-solubility	30	52.2
" "	60	53.1
" "	90	51.0
No Phosphate (Check)	--	41.7
Difference required for significance (0.05)		

*All phosphate applied broadcast

1954, Grayson County (Clemons Farm)

Source of Phosphorus	Rate of P_2O_5 lb per Acre	Yield of Ear Corn bu per Acre
Concentrated Superphosphate	30	32.2
Nitric Phosphate, TVA Process III	30	33.2
" " TVA Process IV	30	33.3
High Alumina Nitric Phosphate:		
Low Water-solubility	30	34.1
High Water-solubility	30	32.0
Commercial-Type Mixture:		
Low Water-solubility	30	30.9
No Phosphorus (Check)	--	7.3
Difference required for significance (0.05)		4.5

1954, Hopkins County (Hunt Farm) and 1955, Edmonson County (McCombs Farm)

Fertilizer Treatment		Hopkins Co.		Edmonson Co.	
Water Solubility of Phosphorus (% of avail. P)	Particle Size of fertilizer (mesh)	Rate of P_2O_5 (Lb/A)	Yield of Ear Corn (bu)	Rate of P_2O_5 (Lb/A)	Yield of Ear Corn (bu)
7	-6, +14	30	22.7	20	19.7
6	-14, +35	30	22.8	20	31.2
7	-35	30	25.7	20	32.5
25	-6, +14	30	24.4	20	23.7
26	-14, +35	30	23.9	20	28.7
26	-35	30	24.7	20	27.5
60	-6, +14	30	27.5	20	30.6
60	-14, +35	30	25.3	20	28.1
60	-35	30	25.5	20	31.4
100	-6, +14	30	25.2	20	33.6
99	-14, +35	30	25.6	20	30.3
100	-35	30	25.8	20	30.1
No Phosphorus (check)	(0.05)		13.3		15.6
Difference Required for Significance (0.05)			3.3		8.1

1955, Edmonson County (McCombs Farm) and Ohio County (Tichenor Farm)

Source of Phosphorus	Rate of P_2O_5 lb/A	Yield of Ear Corn (Bu per Acre) Edmonson Co.	Ohio Co.
Nitric Phosphate, TVA Process III	20	28.9	26.3
Nitric Phosphate, TVA Process II	20	23.1	34.0
High Alumina Nitric Phosphate			
Low Water-Solubility	20	22.9	35.5
High Water-Solubility	20	25.4	40.9
Diammonium Phosphate Mixture	20	28.7	49.2
Commercial Type Mixture	20	23.1	40.5
Concentrated Superphosphate	20	27.8	43.9
"	10	29.0	38.7
"	40	35.8	54.0
"	80	37.2	61.7
" (40 row, 120 broadcast)	160	39.9	----
No Phosphate (check)	-	13.3	23.7
Difference required for Significance (0.05)		9.7	11.0

1956, Nelson County (Keene Farm)

Source of Phosphorus	Rate of P_2O_5 (lb/A)	Yield of Ear Corn (Bu per Acre)
High Alumina Nitric Phosphate:		
Low Water-Solubility	30	60.4
High Water-Solubility	30	63.1
Diammonium Phosphate Mixture	30	70.7
Ammonium Metaphosphate	30	68.0
Hydrolyzed Calcium Metaphosphate	30	64.4
Commercial Type Mixture	30	65.8
Concentrated Superphosphate	30	65.4
" "	60	80.2
" "	90	83.2
No Phosphorus (check)	--	38.6
Difference required for significance (0.05)		12.4

1956, Nelson County (Keene Farm)

This experiment was designed to determine the effects of various associated salts upon the utilization of phosphorus. Concentrated superphosphate (CSP) and diammonium phosphate (DAP) were used as sources of phosphorus. Phosphate was applied in a band, 3 inches to one side and 2 inches below the seed. Associated salts were mixed with the phosphorus in the same band, or applied separately in a similarly located band on the opposite side of the seed. Fertilizer salts associated with the phosphorus were muriate of potash (KCl), sulfate of potash (K_2SO_4), and ammonium nitrate (N), and were applied at rates to supply 30 pounds of K_2O per acre and 30 pounds of N per acre. The treatments and yields are given in the following table:

With Phosphate	Separate from Phosphate	Source of Phosphorus	Rate of P_2O_5 (Lb/A)	Yield of Ear Corn (Bu per A)
N, K Cl	---	CSP	30	72.3
N, K_2SO_4	---	CSP	30	76.5
---	N, K Cl	CSP	30	73.7
---	N, K_2SO_4	CSP	30	71.8
N	K Cl	CSP	30	89.1
K CL	N	CSP	30	65.3
---	N, K Cl	CSP	30	74.6
N, K Cl	---	DAP	30	73.4
---	N, K Cl	DAP	30	78.8
---	N, K Cl	CSP	15	74.5
---	N, K Cl	CSP	60	78.4
---	N, K Cl	None	--	53.8
Difference required for significance (0.05)				15.3

From a complete analysis of the data, the following conclusions may be drawn from this experiment:

1. No differences were evident between CSP and DAP as sources of phosphorus for corn.

2. Ammonium nitrate, when associated with the phosphate in the same band, resulted in increased yields of corn.

3. Chloride, when associated with the phosphate in the same band, resulted in decreased yields of corn.

These results were obtained at one location and for only one year, and no general conclusions should be drawn from these data.

Sources of Phosphorus for Wheat:

1954, Grayson County (Fraim Farm)

Sources of Phosphorus	Rate of P_2O_5 (Lb/A)	Yield of wheat per Acre. Pasture Clippings (Lb.) April 21	May 24	Total	Grain Bu
High Alumina Nitric Phosphate	30	1104	1826	2930	39.3
Fused Tricalcium Phosphate	30	1167	1783	2950	41.1
Concentrated Superphosphate	30	1329	1739	3068	41.1
No Phosphate*	--	743	2211	2953	39.1
No Fertilizer	--	313	1184	1496	27.4
Difference required for significance (0.05)		170	180	240	5.2

*Received nitrogen and potash

1954, Taylor County (Gilmore Farm)

(Wheat was grown in 1954 following corn grown on the same plots in 1953.)

Source of Phosphorus	Rate of P_2O_5 Corn	Rate of P_2O_5 Wheat	Yield of Wheat (Bu per Acre)
Concentrated Superphosphate	30	30	30.1
" "	30	60	39.2
Calcium Metaphosphate	30	30	32.7
" "	30	60	36.1
Fused Tricalcium Phosphate	30	30	32.0
" " "	30	60	36.4
High Alumina Nitric Phosphate			
High Water-Solubility	30	30	24.5
Low Water-Solubility	30	30	24.3
Commercial Type Mixtures:			
High Water-Solubility	30	30	31.1
Low Water-Solubility	30	30	27.3
No Phosphorus	--	--	13.6
Difference required for significance (0.05)			5.6

1954, Taylor County (Gilmore Farm)

Residual effectiveness of phosphates applied for sudan grass in 1953, no additional application for wheat in 1954.

Source of Phosphorus	Rate of P_2O_5*	Yield per Acre (bu)
Concentrated Superphosphate	30	26.8
High Alumina Nitric Phosphates:		
High Water-Solubility	30	24.7
Low Water-Solubility	30	25.2
No Phosphorus	--	18.3

Difference required for significance (0.05)

*Applied for sudan grass in 1953

1955, Butler County (Clark Farm) and Muhlenberg Co. (Lovell Farm)

Source of Phosphorus	Yield of Wheat (Bu per Acre)			
	Butler County ($Lb\ P_2O_5$ per Acre)		Muhlenberg County ($Lb\ P_2O_5$ per Acre)	
	20	40	20	40
Nitric Phosphates:				
Process III	25.2	25.9	21.3	17.7
Process IV (K_2SO_4)	21.0	21.7	12.9	17.8
" " (H_2SO_4)	25.6	25.6	17.0	19.4
High Alumina Nitric Phosphates:				
Low Water-Solubility	24.2	25.1	11.9	15.2
High Water-Solubility	24.3	25.9	11.2	19.7
Diammonium Phosphate	24.3	25.0	15.2	18.8
Diammonium Phosphate Mixture	23.2	28.7	17.4	20.1
Commercial Type Mixture	25.4	26.4	12.7	18.3
Concentrated Superphosphate	26.4	26.9	13.9	17.0
No Phosphorus	19.4		14.2	
Difference required for significance (0.05)	4.6		n.s.	

Sources of Phosphorus for Sudan Grass:

1953, Taylor County (Gilmore Farm)

Sources of Phosphorus	Rate of P_2O_5 Lb per Acre	Yield per Acre (lb)
High Alumina Nitric Phosphate:		
Low Water-Solubility	30	2363
High Water-Solubility	30	2584
Concentrated Superphosphate	30	2773
No Phosphate	0	2129
Difference required for significance (0.05)		n.s.

1956, McLean County (Troutman Farm)

Source of Phosphorus	Rate of P_2O_5* Lb per Acre	Yield per Acre (lb)
High Alumina Nitric Phosphate:		
Low Water-Solubility	30	2562
High Water-Solubility	30	3072
Diammonium Phosphate Mixture	30	3262
Ammonium Metaphosphate	30	2576
Hydrolyzed Calcium Metaphosphate	30	2996
Commercial-Type Mixture	30	2552
Concentrated Superphosphate	30	3807
" "	60	3979
" "	90	4871
No Phosphate	--	1398
Difference required for significance(0.05)		1256

* Phosphate applied in band

1955-56 Muhlenberg County (Lovell Farm)

Sudan grass was seeded in spring 1955, followed by wheat in the fall, and sudan grass again in summer 1956, after the wheat had been removed. No phosphates were applied for the last sudan grass crop. Limed plots received applications of ground limestone at the rate of 3 tons per acre.

Source of Phosphorus	Rate of P_2O_5*	Yield per Acre 1955 Sudan Grass Cuttings First (Cwt.)	1955 Sudan Grass Cuttings Second** (Cwt.)	1956 Wheat-Sudan Grass Cuttings Wheat Bu	1956 Sudan Grass First (Cwt.)	1956 Sudan Grass Second** (Cwt.)
Limed Treatments:						
High Alumina Nitric Phosphates:						
Low Water-Solubility	20-0-0	18.3	12.3	32.7	23.3	8.7
" " "	20-20-0	16.3	13.4	35.0	23.5	7.9
" " "	40-0-0	16.9	13.1	31.0	24.6	7.6
High Water-Solubility	20-0-0	18.1	12.9	32.9	24.0	9.2
" " "	20-20-0	18.4	12.6	32.6	26.1	7.6
" " "	40-0-0	18.2	13.0	32.2	23.8	7.4
Conc. Superphosphate	20-0-0	18.9	11.3	31.8	22.6	8.8
" "	20-20-0	21.4	11.3	35.6	25.3	8.0
" "	40-0-0	22.7	11.1	34.6	23.1	8.4
" "	80-0-0	29.9	10.8	34.4	26.5	7.9
" "	120-0-0	31.3	10.8	36.5	26.1	7.4
" "	160-0-0	30.1	10.3	36.1	28.4	6.7
Unlimed Treatments:						
High Alumina Nitric Phosphates:						
Low Water-Solubility	40-0-0	21.0	12.9	28.0	21.2	7.9
High Water-Solubility	40-0-0	19.1	11.6	32.0	21.3	7.2
Conc. Superphosphate	40-0-0	20.7	12.7	32.5	21.2	8.0
No Phosphorus (Check)	------	14.7	12.2	27.6	20.2	8.6
Diff. required for significance 0.05		5.5	n.s.	n.s.	n.s.	n.s.

* Rate of P_2O_5 given is for sudan grass-wheat-sudan grass sequence

**Moisture-limiting factor

Source of Phosphorus for Pasture:

1952-1954, Laurel County (Tucker Farm)

Mixture of orchardgrass, tall fescue and Ladino clover seeded in spring, 1952. Fertilizer applied in 1953 and 1954 as early spring topdressing.

Source of Phosphorus	Rate Fertilizer* ($N-P_2O_5-K_2O$)	Yield Per Acre (lb) 1952	1953	1954**
Calcium Metaphosphate	50-125-50	1563	5236	4574
" "	50-250-50	1640	5348	4694
Fused Tricalcium Phosphate	50-50-50	1884	5172	4969
" " "	50-125-50	1511	4596	3906
" " "	50-250-50	1697	5470	5257
Concentrated Superphosphate	50-50-50	1575	4591	4397
" "	50-125-50	1584	5078	4580
" "	50-250-50	1730	5085	4354
" "	50-250-50	1620	4995	4016
" "	0-250-50	1083	5140	4433
No Phosphate (Check)	50-0-50	1192	3638	3274
Difference required for significance		325	544	850

* 125 and 250 lb rates of P_2O_5 are initial applications only, all others annual.
**Only 25 lb of N per acre applied in 1954.

Sources of Phosphorus for Alfalfa:

1956, Simpson County (Holloway Farm)

Mixture of Atlantic Alfalfa and orchardgrass seeded in September, 1955. All fertilizers applied at time of seeding.

Source of Phosphorus	Rate of P_2O_5 (Lb per Acre)	Yield Per Acre (Lb) Cutting First	Second	Total
Ammonium Metaphosphate	50	2721	1296	4016
" "	150	2842	1483	4325
Calcium Metaphosphate	50	3049	1663	4712
" "	50	3106	1290	4396
" "	50T*	3187	1187	4374
" "	150	3205	1427	4632
Calcined Leached Zone Ore	50	2632	1154	3786
"	150	2655	1027	3682
Concentrated Superphosphate	50	2517	1282	3799
" "	50	2726	1466	4183
" "	50T*	2771	1343	4114
" "	100	2970	1674	4643
" "	100	2683	1474	4157
" "	150	2928	1466	4394
" "	200	2790	1586	4376
No Phosphorus (check)	---	2332	1156	3488

* Phosphate topdressed immediately after seeding

Effectiveness of Various Sources of Phosphorus:

In most of the preceding experiments, phosphorus from the various sources was applied at low rates to soils extremely low in available phosphorus. By this method, differences in yield resulting from the use of the various materials would be magnified, and the different sources of phosphorus more accurately evaluated. If these materials were used at heavier rates or applied to soils with a higher level of available phosphorus, many of these differences would not be apparent. On this basis, the following conclusions may be drawn:

1. Calcium metaphosphate and fused tricalcium phosphate appear to be equal to concentrated superphosphate as sources of phosphorus.

2. The initial availability of phosphorus applied as rock phosphate is very low, but the availability increases with time. If rock phosphate is to be used, it should be supplemented with an available form of phosphorus for the first few years.

3. Most of the nitric phosphates are equal to concentrated superphosphate and equal, or superior, to commercial-type mixed fertilizers as sources of phosphorus.

4. The high-alumina nitric phosphates are satisfactory sources of phosphorus for the production of grain crops, but have not been equal to concentrated superphosphate when rapid, early growth is desired.

5. Diammonium phosphate has in every instance, been equal or superior to concentrated superphosphate as a source of phosphorus.

6. The water solubility of the phosphorus has not been a factor in the production of grain crops, but fertilizers in which at least one-third to one-half of the phosphorus is in water-soluble form apparently result in more rapid early growth.

7. The particle size of mixed fertilizers with the range of 6 to -35 mesh apparently has little effect upon the availability of the phosphorus in the fertilizer.

PASTURE EXPERIMENTS

Greenville Soil Experiment Field: An experiment to determine the effects of nitrogen and potash on the yield of a pasture mixture composed of orchardgrass, tall fescue, and Ladino clover was started at the Greenville Soil Experiment Field in 1954, and yields have been obtained in 1955 and 1956. The soil is similar to that described under the General Fertility Experiment at the Greenville Soil Experiment Field. All the phosphorus and potash are applied as an early March topdressing, and nitrogen is applied to the appropriate treatments in early March and in June. The treatments and yields are given in the following table:

Annual Treatment ($N-P_2O_5-K_2O$) Lb per Acre	Total Yield per Acre (lb) 1955	1956
0-100-0	2717	2860
0-100-50	3953	4262
0-100-100	5000	5316
0-100-(200)*	4530	4587
0-100-(400)*	5137	4830
0-100-200	4997	5486
50M-100-200	5160	6025
50J-100-200	5650	6174
50M + 50J-100-200	5380	6268
100M-100-200	5087	6876
100J-100-200	5093	6275

* All of potash applied at time of seeding, none applied since.

The application of potash at the rate of 100 pounds of K_2O per acre has given increases in yield, but additional applications beyond this rate have not resulted in yield increases. No significant increases in yield have been obtained for the application of nitrogen. Chemical analyses have shown that nitrogen fertilization has not increased the nitrogen content of the herbage.

Simpson County Pasture Experiment: This experiment was started in August, 1955, to determine the effects of fertilizers on the yield and quality of pasture herbage. The soil type (Pembroke silt loam) is similar to that described in the General Fertility Experiment located on limestone land at the Western Kentucky Substation.

Two separate experiments which receive the same fertilizer treatments are included in this test: one (I) in which the pasture mixture is composed of orchardgrass, tall fescue, Kentucky bluegrass, white clover and Korean lespedeza, and the other (II) composed of orchardgrass, tall fescue, Ladino clover and Korean lespedeza. Prior to seeding, an initial fertilizer application of 20-20-0 pounds per acre ($N-P_2O_5-K_2O$) was broadcast and disked in on all except three treatments of each experiment. Of these three treatments, one received no fertilizer, and fertilizers were applied to the other two treatments at the present recommended rate based upon the results of the soil test; in this case, an application of 20-120-60 per acre was applied. One of these two treatments will receive no further fertilization, and the other will receive the present recommended maintenanceapplication of 0-30-60 per acre annually. The grass-legume mixtures (except the Korean lespedeza) were seeded September 1, 1955, using a cultipacker seeder. Korean lespedeza was seeded in the early spring of 1956, as well as an additional seeding of the other grasses and legumes to insure a uniform stand on all plots.

The various rates of fertilizer, as given in Table I, were applied as a top-dressing on March 28 and 29, 1956. In addition, borax was applied to all plots at the rate of 15 pounds per acre. All of the phosphorus was applied in the early spring, but, in order to avoid salt injury, no more than 120 pounds per acre nitrogen (N) and 120 pounds per acre of potash (K_2O) were applied. Additional nitrogen and potash on treatments receiving heavier rates of nitrogen and potash were applied after the pasture was harvested.

The soil tests showed pH 6.2, available phosphorus very low, and available potassium low.

The growth of the grass-legume mixture in the fall of 1955 showed a very definite response to the initial rates of fertilization. The best stand and the heaviest growth occurred on the plots which received the heavy initial rate of fertilization (20-120-60). A poor stand and weak growth resulted when no fertilizer was applied. The stand on the plots which received the initial applications of 20-20-0 was nearly as good as that on plots which received the heavier application (20-120-60), but the growth was much less.

The yields obtained in the first and second cuttings are given in the following tables. The average total yields obtained for the two cuttings are summarized in the following table:

Yield per Acre (Cwt.)

Pounds per acre P_2O_5		Pounds K_2O per Acre 60	120	240	480
Pasture Mixture I:					
30		23.0	25.5	22.8	
60		29.3	29.2	28.0	
120		29.6	34.4	28.9	
240				29.6	35.3
Check (0-0-0)	11.1				
Initial App. (20-120-60)	41.4				
" " plus 0-30-60	40.5				
Pasture Mixture II:					
30		31.7	32.1	32.0	
60		30.3	34.4	38.0	
120		32.7	42.2	36.4	
240				36.8	35.5
Check (0-0-0)	11.7				
Initial App. (20-120-60)	50.5				
" " plus 0-30-60	50.5				

In all but one instance, the yields obtained from plots to which 240 pounds per acre of K_2O has been applied are less than those from the corresponding plots to which 120 pounds of K_2O have been applied. Evidently, the application of 120 pounds of K_2O after the first cutting had been removed resulted in some salt injury. This effect was not visually apparent. An excellent response was obtained for phosphate fertilization, and the response is relatively greater when 120 pounds of K_2O were applied per acre than when 60 pounds were applied. For both pasture mixtures, the highest yield was obtained from the treatments to which the recommended initial fertilizer application was applied. This is another striking illustration of the necessity of adequate fertilization in establishing a stand of grasses and legumes.

The effects of the various rates of nitrogen are given in the following table:

Yield per Acre (Cwt.)

Pounds per Acre		Pounds Nitrogen (N) per Acre				
P_2O_5	K_2O	0	30	60	120	240
Pasture Mixture I:						
30	60	23.0	33.1	34.7	39.3	46.5
60	120	29.3	37.2	36.6	46.5	55.3
120	240	28.3	35.2	44.0	44.3	51.8
Pasture Mixture II:						
30	60	31.7	37.0	37.8	44.0	53.6
60	120	34.4	39.0	41.5	53.0	50.8
120	240	36.4	43.3	42.9	51.8	55.3

At every rate of phosphorus and potash, the applications of nitrogen resulted in increased yields. Although no botanical separation of the herbage have as yet been made, visual observations indicated that the legume component of the mixture is almost entirely gone at rates of 120 and 240 pounds of nitrogen per acre. A rank coarse growth of grass also results at these higher rates of nitrogen.

At this stage of a pasture experiment, any results must be considered preliminary and subject to change on the basis of subsequent data. The striking effect of the heavier initial fertilizer application, however, again illustrates the absolute necessity of proper fertilization when stands of grasses and legumes are to be established. The responses to the various rates of phosphorus and potash are consistent with those obtained in other experiments on this soil type. Other experiments in Kentucky involving the nitrogen fertilization of grass-legume mixtures have not given results consistent with those obtained in this experiment: in general, nitrogen has not resulted in either increased yields or increased nitrogen content of the herbage. The reason for these apparently conflicting responses to nitrogen in the different experiments is not apparent at this time.

ALFALFA EXPERIMENTS

Greenville Soil Experiment Field: An experiment was started in August 1949, on a soil similar to that described under the General Fertility Experiment at this location. Alfalfa was reseeded again in 1951, and the initial fertilizer treatments again applied. Fertilizer treatments were revised in 1955, and the alfalfa was reseeded in 1956, The initial fertilizer treatments were again applied. Boron was applied in all except one treatment at a rate approximately equal to 15 pounds borax per acre.

Treatments and yields are given in the following table:

1950-1954		1955-1956	
Fertilizer Treatments (P_2O_5-K_2O) (Lb/A)	Average Annual Yield (Tons/Acre)	Annual Fertilizer Treatment (P_2O_5-K_2O) (Lb/A)	Average Annual Yield (Tons/Acre)
200-0	2.54	60-0	1.78
200-33*	3.36	60-33	2.74
200-100	3.23	60-(100)***	2.42
200-66*	3.73	60-66	3.52
200-200	3.76	60-(200)	2.97
200-300	4.22	60-(300)	3.78
300-300	4.15	60-133	4.12
0-300	2.55	0-133	1.84
300-300**	4.09	60-133**	3.83

* Potash applied annually
** No boron applied
*** Initial applications only

An excellent response has been obtained for both phosphorus and potash. Boron apparently resulted in a slight yield increase during the later portion of the experiment, and differences due to boron are generally greater on the second and third cuttings than on the first.

Western Kentucky Substation: An experiment was initiated in September 1954, to determine the optimum rate and time of potash applications for alfalfa. The soil is derived from limestone and has previously been described under the general fertility experiment at this location. Phosphate and potash both tested medium at the time the experiment was started. Treatments and yields are given in the following tables:

Rates of Potash:

Potash (Lb/K_2O per Acre)	Yield per Acre (Tons) 1955	1956
0	1.98	3.85
60	1.93	3.74
120	1.87	3.76
(240)	2.09	4.06
(360)	1.72	3.75
(360)*	1.83	4.34

() Initial application only
* No boron applied

Time of Application: 120 pounds of K_2O per acre applied annually in all treatments.

Time of Potash Application		Yield per Acre (Tons) 1955	1956
II	Early Spring	2.24	3.74
III	Following 1st cutting	2.25	3.74
IV	Following 2nd cutting	1.90	3.53
I	Following 3rd cutting	2.27	3.84

In the two years that yields have been obtained in this experiment, no significant differences have been obtained between any of the treatments. This particular soil has a comparatively higher supplying power for potassium, and the level of potassium had been maintained by periodic potash applications for a number of years prior to starting this experiment.

Trace Elements for Alfalfa on Limestone Soil: A top-dressing of the trace elements magnesium, manganese, iron, copper, zinc, and boron on limestone soil was applied May 20, 1954 following the first cutting of an established stand of alfalfa. One treatment consisted of all the trace elements. A check treatment with no trace elements was used and also a treatment in which only boron was applied. A fourth treatment consisted of all the elements except boron. A fertilizer top-dressing of 0-100-120 (N-P_2O_5-K_2O per acre) was applied on all plots.

Three cuttings following treatment were made in 1954, and four cuttings were made in 1955. All treatments were repeated in 1955 following the first cutting. Differences between yields were not significant at the 5% level. This field had previously been treated with boron at time of seeding. The yields obtained are given in the following table:

Treatments	Acre Yield (Lb)	
	1954	1955
0-100-120 (check)	5137	5279
0-100-120 with boron	5120	5128
0-100-120 with all trace elements	5517	5264
0-100-120 with trace elements except boron	5174	5331

Simpson County: This experiment was seeded in September 1955, and is located on a limestone soil similar to that on which the preceding experiment is located. All fertilizers were applied at the time of seeding, except for top-dressings of nitrogen which were applied after the first cutting had been removed. The treatments and yields are given in the following table:

Fertilizer Treatment ($N-P_2O_5-K_2O$) (Lb per Acre)	Yield per Acre (Tons)	
	1st Cutting	2nd Cutting
0-120-0	1.33	0.59
0-120-60	1.29	0.63
0-120-120	1.22	0.69
0-120-180	1.30	0.67
0-120-240	1.30	0.69
0-120-(240)	1.42	0.65
0-120-(480)	1.32	0.60
30-120-120	1.33	0.69
60-120-120	1.38	0.66
120-120-120	1.28	0.71
Difference required for significance	n.s.	n.s.

No significant differences were obtained between any of the treatments during the first year of the experiment. However, plot observations made before the second cutting was harvested indicated that potassium was becoming limiting on those plots which did not receive potash.

TOBACCO EXPERIMENTS

Burley Tobacco

Campbellsville Soil Experiment Field: These tests were revised in 1950, and the results given are the averages for the past 5 years. Manure is applied to the appropriate plots at the rate of 15 tons per acre and is applied just prior to plowing the plots. Sufficient lime is applied to the plots labeled "L" to prevent the soil from becoming too strongly acid for tobacco and to help establish and maintain legumes in the rotation. Nitrogen (N) is applied as ammonium nitrate, phosphate (P_2O_5) as 20% superphosphate, and potash (K_2O) as sulfate of potash. On two plots, tobacco is grown in continuous culture, with a barley-vetch cover crop. On four plots, a two-year rotation of (1) tobacco, followed by a rye cover crop, and (2) a clover-grass mixture clipped, but none of the herbage removed. On the remaining plots a three year rotation of (1) tobacco followed by a rye cover crop seeded to (2) red clover and grass clipped and not removed, and (3) red clover and grass with the first cutting only removed for hay. The variety of tobacco grown has been Kentucky 16. The average yields for the past five years are given in the following table:

Fertilizer Treatment Pounds per Acre ($N-P_2O_5-K_2O$)		Yield Pounds per Acre	Value Acre	Value (Cwt.)
	0-0-0	690	$260	$37.50
Nitrogen Comparisons:	L 0-180-240	1400	770	55.00
	L 40-180-240	1430	780	54.50
	L 80-180-240	1530	860	56.00
	L 120-180-240	1540	820	53.00
Phosphorus Comparisons:	L 80-60-240	1490	795	53.50
	L 80-120-240	1540	845	55.00
	L 80-180-240	1530	860	56.00
Potassium Comparisons:	L 80-180-0	1230	505	41.00
	L 80-180-60	1430	705	49.50
	L 80-180-120	1340	665	49.50
	L 80-180-180	1530	820	53.50
	L 80-180-240	1550	860	55.50
Manure Comparisons:	L 0-180-0	1160	555	48.00
	LM 0-180-0	1410	740	52.50
	L 80-180-60	1430	705	49.00
	LM 80-180-60	1510	790	52.50
	120-180-240	1590	855	53.50
	120-360-720	1650	925	56.00
	80-120-120	1570	800	51.00
	LM (30)0-360-0	1680	975	58.00
	Fertilizer application: 120-180-240 per acre.			
Comparison of Rotations:	Continuous culture	1400	745	53.00
	2 year rotation	1810	1000	55.00
	3 year rotation	1545	840	54.50
	Fertilizer application: 15 T manure and 0-180-0 per acre.			
	Continuous culture	1500	840	56.00
	2 year rotation	1610	910	56.50
	3 year rotation	1520	825	54.50

In 1949 an experiment was started to determine the effectiveness of rock phosphate as a source of phosphorus for tobacco grown in continuous culture and to determine the effects of manure on the availability of phosphorus supplied as rock phosphate. A cover crop of barley and vetch is seeded each fall immediately after the tobacco is harvested. The fertilizer treatments and the average yield and value of the tobacco are shown in the following table:

Fertilizer Treatment ($N - P_2O_5 - K_2O$)	Source of Phosphorus	Yield Lb/Acre	Value Cwt.	Value Acre
120-60-200	Superphosphate	1520	$52.50	$800
120-120-200	Rock Phosphate**	1400	53.00	740
120-0-200	None	690	44.50	310
M*20-120-100	Rock Phosphate**	1190	52.00	620
M*20-0-100	None	1050	50.00	520

* Manure at the rate of 10 tons per acre.
**Rock Phosphate has been applied at a rate to supply twice as much P_2O_5 as is added as superphosphate.

Greenville Soil Experiment Field:

Rotation Experiments: These experiments were revised in 1950, and the yields given are the averages for the past six years. Manure is applied to the appropriate plots at the rate of 15 tons per acre, unless otherwise noted. Sufficient ground limestone is to be applied to plots labelled "L" to prevent the soil from becoming too strongly acid and to help establish and maintain legumes in the rotations. Nitrogen (N) is applied as ammonium nitrate, phosphorus (P_2O_5) as 20% superphosphate, and potash (K_2O) as sulfate of potash. On two plots (801 and 801a) tobacco is grown as a continuous culture with a barley-vetch cover crop. On four plots (601, 601a, 701 and 701a), a two year rotation of (1) tobacco, followed by rye cover crop and (2) a clover-grass mixture; nothing is removed from these plots except the tobacco crop, the rye and grass legume mixture is kept clipped. On the remaining plots a three-year rotation of (1) tobacco followed by a rye cover crop seeded to (2) red clover and grass clipped and not removed, and (3) red clover and grass with the first cutting only removed for hay. The variety of tobacco grown is Ky. 35. The average annual yields for the past five years are given in the following table:

Fertilizer Treatment Pounds per Acre $(N - P_2O_5 - K_2O)$	Yield Pounds per Acre	Value Acre	Value Cwt.
Phosphorus Comparisons:			
L 80-120-240	1430	$785	$55.00
L 80-180-240	1420	800	56.50
Manure Comparisons:			
LM 0-180-0	1300	710	55.00
M 0-180-0	1230	650	52.50
LM 0-180-0	1140	600	53.00
LM 0-180-0	1350	740	54.50
LM 0-180-0	1280	690	54.00
L2M 0-360-0	1510	855	56.50
LM(10T)50-100-200*	1520	870	57.00
Potash Comparisons:			
L 80-180-0	890	305	34.50
L 80-180-60	1250	620	49.50
L 80-180-120	1310	670	51.50
L 80-180-180	1210	645	53.50
L 80-180-240	1420	795	56.50
Nitrogen Comparisons:			
L 0-180-240	1000	485	48.50
L 80-180-240	1420	795	56.50
L 120-180-240	1520	835	55.00
Comparison of Rotations:			
Fertilizer Treatment: 120-180-240 per Acre:			
Continuous	1750	885	50.50
2-year rotation	1800	1000	55.50
3-year rotation	1520	835	55.00
Fertilizer Treatment: 15T Manure and 0-180-0 per Acre:			
Continuous	1750	935	53.50
2-year rotation	1590	875	55.00
3-year rotation	1300	710	55.00

* 4-year average

Effect of Soil Conditioners on Yield and Quality: Two experiments were conducted at the Greenville Soil Experiment Field for a period of three years to determine if two synthetic soil conditioners would effect the yield or quality of burley tobacco. The soil on which these experiments were conducted was in extremely poor physical condition. Sufficient phosphorus, and potassium were applied to all plots for optimum yields, and no manure was applied. The yields and value of the tobacco are given in the following tables:

Year of Experiments	With Soil Conditioner	Without Soil Conditioner
Experiment with Soil Conditioner No. 1:		
1952:		
Yield per Acre (Lb)	2160	2310
Value per Cwt ($)	45.50	42.50
Value per Acre ($)	985	985
1953:		
Yield per Acre (Lb)	1740	1760
Value per Cwt ($)	50.50	49.50
Value per Acre ($)	875	870
1954:		
Yield per Acre (Lb)	1570	1570
Value per Cwt ($)	48.50	47.50
Value per Acre ($)	760	745
Experiment with Soil Conditioner No. 2:		
1953:		
Yield per Acre (Lb)	1160	1210
Value per Cwt ($)	46.50	44.00
Value per Acre ($)	540	530
1954:		
Yield per Acre (Lb)	1660	1670
Value per Cwt ($)	49.00	44.50
Value per Acre ($)	810	745

No significant differences in yield were obtained between the treatments in which the soil conditioners were applied and those in which none were applied. However, there was a trend for the tobacco grown on the plots which received applications of the soil conditioners to be slightly higher in quality; however this difference was neither statistically significant nor great enough to pay for the cost of the treatment. Results of these and other tobacco experiments indicate that higher yields and better quality tobacco could have been produced by the use of manure rather than by the use of synthetic soil conditioners.

Effect of source of phosphorus on yield and quality: An experiment to determine the relative effectiveness of concentrated superphosphate (CSP), a nitric phosphate (NP), and raw rock phosphate (RP) was started at Greenville in 1951. The soil type is similar to that described under general fertility experiment at this location. All plots received uniform applications of nitrogen and potash (as sulfate) at a rate sufficient for optimum production. This experiment was conducted in cooperation with the Tennessee Valley Authority. Tobacco was grown continuously on the same plots and was followed by a barley-vetch cover crop. Fertilizer treatments were reapplied annually on the same plots for the duration of the experiment. Annual treatments and yields are given in the following table:

Fertilizer Treatment $N - P_2O_5 - K_2O$ (Lb per Acre)	Source of Phosphorus	Yield per Acre (Lb)	Value Cwt	Value Acre
1951:				
60-120-120	NP	1080	45.50	490
60-120-120	CSP	980	43.50	425
60-600-120	RP	1230	43.50	535
60-0-120	--	1070	37.00	395
1952:				
80-120-120	NP	1620	37.50	605
80-120-120	CSP	1510	38.50	580
80-0-120	RP	1560	38.00	595
80-0-120	--	1290	27.50	355
1953:				
120-60-120	NP	750	36.50	275
120-60-120	CSP	790	38.00	300
120-0-120	RP	850	37.00	315
120-0-120	--	630	30.00	190
1954:				
120-120-240	NP	1730	47.50	820
120-120-240	CSP	1580	45.50	715
120-240-240	RP	1660	47.00	780
120-0-240	--	1400	39.00	545

The seasons in 1952 and 1953 were extremely unfavorable for tobacco production. None of the differences between the sources of phosphorus were statistically significant, but significant increases in both yield and quality were obtained for the application of phosphorus.

Western Kentucky Substation: An experiment to determine the effects of various combinations and rates of fertilizer on the yield and quality of burley tobacco was initiated in 1947 and concluded in 1952 on limestone soil similar to that described under the General Fertility Experiment at this location. Tobacco was grown every year, and a barley cover crop sown each fall after the tobacco had been cut. Where nitrogen, phosphorus, and potash (as the sulfate) were to be applied, 30 pounds of N per acre, 40 pounds of P_2O_5, and 30 pounds of K_2O were applied as a row application, divided into two bands, one on each side of the row. Any additional fertilizer was applied broadcast prior to plowing. The various fertilizer treatments and the average annual yields and value of the tobacco are given in the following table:

Plot	Fertilizer Treatment ($N-P_2O_5-K_2O$)	Average Yield (Lb per Acre)	Value	
			Cwt	Acre
1	0 - 0 - 0	1000	$38.50	$385
2	0 -120-120	1000	39.00	390
3	40-120-120	1340	45.00	600
4	0 - 0 - 0	900	36.50	330
5	80-120-120	1520	46.50	710
6	120-120-120	1630	47.50	770
7	0 - 0 - 0	990	35.00	345
8	120- 0 -120	1650	44.00	720
9	120- 40-120	1640	44.50	730
10	0 - 0 - 0	1000	35.50	355
11	120- 80-120	1670	43.00	715
12	120-120- 0	1650	39.00	645
13	0 - 0 - 0	990	36.50	365
14	120-120-40	1640	42.50	690
15	120-120-80	1610	44.00	705
16	0 - 0 - 0	800	34.50	275
17	120-120-120	1590	47.50	755
18	160-160-160	1760	46.50	815
19	0 - 0 - 0	960	41.00	395

Since no legumes were seeded in the cover crop, a greater response was obtained for nitrogen than can be expected when a legume cover crop is grown. This experiment provides an excellent illustration of the effect of potassium on the quality of burley tobacco. Although potash did not appreciably affect the yield (plots 6, 12, 14, 15 and 17), the quality of tobacco was increased and a corresponding increase in the value per acre was obtained.

Another experiment at the same location was conducted from 1948 to 1952 to determine the effect of fertilizer placement on the yield and quality of burley tobacco. Potassium was applied as sulfate of potash. Tobacco was grown every year, and a barley cover crop was seeded each fall after the tobacco was cut. Average annual yields and the quality of the tobacco are given in the following table:

Plot	Fertilizer Treatment Pounds per Acre ($N - P_2O_5 - K_2O$) Broadcast	Row	Manure Tons per Acre	Yield per Acre (Pounds)	Value Cwt	Value Acre
1	--	--	--	1220	$41.50	$505
2	80-80-80	--	--	1550	43.50	675
3	60-60-60	20-20-20	--	1570	44.00	690
4	--	--	--	1230	41.00	505
5	80-80-80*	--	--	1630	43.50	710
6	60-60-60**	20-20-20	--	1590	41.50	655
7	--	--	--	1170	39.00	455
8	--	80-80-80	--	1630	43.00	705
9	--	40-40-40	--	1460	44.50	655
10	--	--	--	1220	40.50	495
11	40-40-40	--	--	1450	44.50	645
12	--	--	10	1510	47.50	710
13	--	--	--	1280	42.50	550
14	0-80-0	--	10	1520	45.50	695
15	0-80-0	--	10	1650	48.00	790
16	--	--	--	1210	41.00	495
17	0-80-0	--	20	1640	49.50	805
18	--	80-80-80***	--	1730	45.50	780
19	--	--	--	1090	40.00	435

* Broadcast after plowing, all others broadcast before plowing.
** In plow furrow
*** Complete minor element mixture applied.

The placement of the fertilizer had very little effect upon either the yield or the quality of the tobacco in this experiment. Most of the differences between treatments are too small to be significant. The use of manure apparently resulted in tobacco of higher quality, although the yields were not affected.

In another experiment conducted from 1952 to 1954, burley tobacco was grown each year, and different cover crops were seeded after the tobacco was cut. In addition, potassium was applied as muriate of potash in certain treatments. All fertilizers were broadcast and plowed under. The treatments, average yield and value of the tobacco are given in the following table:

Fertilizer Treatment Pounds $N-P_2O_5-K_2O$ per acre	Source of K_2O Sulfate (lb)	Source of K_2O Muriate (lb)	Cover Crop	Yield per Acre (lb)	Value Cwt	Value Acre
60-120-180	180	---	Barley	1580	$55.00	$700
60-120-180	180	---	Barley and Vetch	1630	42.50	700
0-120-180	180	---	Barley and Vetch	1410	41.00	585
60-120-180	180	---	Oats and Vetch	1550	42.50	660
60-120-180	180*	---	Barley and Vetch	1650	44.00	730
60-120-180	130	50	Barley and Vetch	1630	40.50	665
60-120-180	80	100	Barley and Vetch	1650	41.50	685
60-120-180	--	180*	Barley and Vetch	1630	44.50	725
120-120-180	180	---	Barley	1740	42.50	740
60-120-240	240	---	Barley and Vetch	1640	43.50	715
60-120-300	300	---	Barley and Vetch	1630	44.00	715
60-120-180	180	---	Barley and Crimson Clover	1530	42.50	650
60-120-180	180	---	Rye and Vetch (Clipped)	1680	44.00	745
60-120-180	180	---	Rye and Vetch	1560	41.00	645

* Potash applied preceding fall.

The kind of cover crop had very little apparent effect upon the succeeding tobacco crop. A good vigorous cover crop to prevent leaching of soluble plant nutrients and to stop soil eorsion during the winter is the most important consideration, and selection of the particular crop to be used is apparently not too critical. The use of a legume in the cover crop is advisable. The results obtained using muriate of potash are not as conclusive as those obtained in experiments at other locations, where muriate of potash resulted in extremely poor quality tobacco.

An experiment to determine the response of burley tobacco to magnesium, manganese, iron, copper, zinc, and boron was conducted for three years. Each of the three seasons received below average rainfall; however, fair to good yields of tobacco were obtained. Sufficient nitrogen, phosphorus, and potassium were applied for maximum yields. The plot area had previously been limed to a pH of 6.5. No manure was applied. No deficiency symptoms of any of the six elements included in the test were apparent. Yields and acre values do not indicate any significant response for the addition of any of the six elements.

Federal grades were placed on representative samples of each of the farm grades made at stripping time. The season's average value for each grade was then used to calculate the acre values. The quality was very uniform between treatments with only slight variation in value per hundred-weight. On the basis of information available at the present time there is no apparent need for minor elements in the production of burley tobacco in Kentucky. The average annual yields and values for the three-year period are given in the following table:

Minor Elements for Burley Tobacco
Yields and Values - 3 year Average 1953-1955

	Treatment*	Yield per Acre Lbs.	Value Cwt	Value Acre
1	None	1838	$50.82	$934
2	Mg Mn Fe Cu Zn and B	1875	49.55	929
3	All except magnesium	1767	49.69	878
4	All except manganese	1783	49.24	878
5	All except iron	1825	49.92	911
6	All except copper	1807	49.81	900
7	All except zinc	1879	49.60	932
8	All except boron	1846	49.84	920

* Each plot received 120 pounds of nitrogen, 180 pounds of phosphate, and 360 pounds of potash per acre.

Dark Tobacco

Western Kentucky Substation: This study of the effect of various fertilizer treatments on yield and quality of dark tobacco was begun in 1945. The tobacco is grown on limestone soil in a 3-year rotation of (1) dark tobacco, air cured, (2) grass and legumes clipped to represent grazing, and (3) grass and legumes for hay. Comparisons are made between manure and chemical fertilizers at various rates of application and combinations.

The pH of the limed (L) plots is in the moderately acid range, and that of the unlimed plots is in the upper part of the strongly acid range. The plots are limed principally for better legume growth, but the tobacco following has benefited, probably because of a greater nitrogen supply from the legumes on the limed plots rather than as a direct result of the limestone application.

The fertilizer carriers used are ammonium nitrate, superphosphate, and sulfate of potash. Fertilizers and manure are broadcast on the sod before plowing except for applications at the hill of 10 pounds per acre of N, P_2O_5, or K_2O where applied. Manure is used at the rate of 10 tons per acre for one treatment.

The average yields and acre-values of the tobacco for the nine years 1947 — 1955 are given in the following table:

Fertilizer Treatment Pounds per Acre $N - P_2O_5 - K_2O$		Yield per Acre Lb	Value Cwt	Acre
LM	0 - 60 - 0	1444	$31.37	$453
	0 - 0 - 0	983	26.25	258
L	0 - 60 - 60	1327	30.59	406
L	30 - 60 - 0	1311	29.52	387
L	30 - 60 - 60	1401	30.83	432
L	60 - 60 - 60	1466	31.51	462
	60 - 60 - 60	1387	30.28	420
L	30 - 60 - 120	1431	32.35	463
L	100 -120 - 120	1619	32.06	519

FERTILIZER TESTS WITH CORN

<u>River Bottoms:</u> In 1945 and 1948, a total of 22 fertilizer experiments were conducted on over-flow bottom soils in western Kentucky. These experiments were designed to determine if corn would respond to fertilization and which element or combination of elements was responsible for any responses obtained. The fertilizers were applied in continuous bands on each side of the row when the corn was 3 to 6 inches high. The band of fertilizer was located 3 to 4 inches from the row and 2 to 4 inches below the surface of the soil. Sixty pounds each of N, P_2O_5 and K_2O was applied. Nitrogen was applied as ammonium nitrate, phosphate as 20% superphosphate, and potash as muriate of potash. Each treatment was replicated three times at each location.

The results of the tests in the Ohio River bottoms in 1946 are given in Table 1 and those in 1948 in Table 2. Considering each test separately, only 3 locations out of 16 resulted in yield increases which were significant. An examination of the yields show, however, that slight increases (not statistically significant) were obtained for some of the fertilizer treatments at each location.

In 1946, the average yields for all 12 experiments showed a significant increase for each individual element, whether applied alone or in combination with another element. The greatest response, however, was obtained when nitrogen and potash were applied together, with or without phosphorus. The average yields of the experiments in 1948 showed a significant response for every treatment in which nitrogen was included, but none for phosphorus and potassium applications in which nitrogen was not included.

The results of four experiments conducted in the Cumberland River bottoms in 1946 are given in Table 3. Considering each test individually, significant responses were obtained for each treatment in which both nitrogen and potash were applied. The average yields for all four experiments show a significant response for every treatment in which nitrogen was applied, and the greatest response was again obtained when nitrogen and potash were applied together.

In 1946, two experiments were conducted on creek bottoms which are frequently overflowed by backwaters from the Ohio River. The results of these tests are given in Table 4. The greatest response was obtained when nitrogen was applied in combination with either phosphorus or potash.

Table 1. Effects of various fertilizer treatments upon the yield of corn in the overflow soils of the Ohio river in 1946.

Fertilizer Treat.[1/]	Location of Experiment (County)												
	Ballard		Crittenden		Daviess			Henderson			Livingston	Union	
	I	II	I	II	I	II	III	I	II	III	I	I	Ave.
O	35.6	30.4	76.3	78.7	55.8	71.8	64.3	72.3	85.4	60.0	59.0	57.0	62.2
P	37.4	28.9	83.8	82.8	60.2	72.2	73.1	69.8	91.5	56.0	62.5	66.7	65.4
N	40.9	33.5	85.9	72.7	59.2	74.8	80.1	75.1	90.9	63.0	64.5	60.0	66.7
NP	40.4	34.0	84.4	88.2	62.2	79.7	65.4	71.5	86.4	63.4	56.5	65.6	66.5
NK	41.9	34.1	86.0	88.5	65.5*	80.3	73.8	81.0	99.2	67.0	63.3	65.3	70.5
PK	40.0	34.8	82.8	85.3	62.4	69.7	71.3	73.5	93.1	60.3	58.9	66.7	66.6
NPK	44.5*[2/]	38.6*	83.3	84.5	66.7*	77.4	83.8	75.1	96.6	65.7	61.8	63.2	70.1
L.S.D.	6.6	5.3	N.S.	N.S.	7.1	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	2.9
C. V.	6.9	6.6	4.9	6.1	6.7	8.2	14.9	9.2	8.5	7.4	12.1	10.0	5.4
Soil Test[3/]													
pH	7.4	7.2	7.5	7.4	6.3	7.3	7.0	7.0	-	7.3	7.3	7.2	
P	V.H.	V.H.	V.H.	V.H.	M	V.H.	H.	V.H.	-	V.H.	V.H.	V.H.	
K	M.	M.	V.H.	V.H.	L	M.	L.	V.L.	-	V.L.	H.	V.H.	

1/ Applied in the row at rates to supply 60 lbs of N, 60 lbs of P_2O_5, and 60 lbs of K_2O per acre.

2/ Denotes significant increase over the check plot.

3/ L = low, M = medium, H = high, V.H. = very high, V.L. = very low.

* Denotes significant yield increase.

Table 2. Effects of various fertilizer treatments on the yield of corn on the overflow soils of the Ohio River in 1948.

Fertilizer Treatment 1/	Location of Experiment (County) Crittenden	Daviess	Henderson	Livingston	Average
O	61.8	43.0	57.1	74.3	59.0
K	60.7	46.1	64.1	69.6	60.1
N	68.3	50.8	67.4	80.3	66.7*2/
NP	66.9	53.6	69.2	79.1	67.2*
NK	66.1	55.6	67.6	89.8	69.8*
PK	59.2	47.6	69.6	76.8	63.3
NPK	72.6	48.2	67.2	79.2	66.8*
L.S.D.	n.s.	n.s.	n.s.	n.s.	5.0
C.V.	9.0	12.9	15.0	9.2	5.3
Soil Test 3/					
pH	6.7	5.4	7.3	7.5	
P	V.H.	M	V.H.	V.H.	
K	V.H.	V.H.	L	M.	

1/ Applied in the row at rates to supply 60 lb of N, 60 lb of P_2O_5, and 60 lb of K_2O per acre.
2/ Denotes significant increase over the check plot.
3/ L = low, M = medium, H = high, V.H. = very high.
* Denotes significant yield increase.

Table 3. Effects of various fertilizer treatments on the yield of corn on the overflow soils of the Cumberland River in 1946.

Fertilizer Treatment 1/	Location of Experiment Crittenden	Livingston	Trigg I	Trigg II	Average
O	46.4	51.9	70.3	61.3	57.5
P	47.2	56.2	73.4	60.4	59.3
N	54.1	63.0	78.9	66.3	65.6*
NP	58.7*2/	63.5	76.3	69.5	67.0*
NK	65.6*	71.8*	83.5*	75.1*	74.0*
PK	51.0	58.9	78.9	65.7	63.6*
NPK	68.6	70.3*	84.5*	77.0*	75.1*
L.S.D.	13.8	11.7	12.7	9.1	3.7
C.V.	10.4	7.9	6.8	5.6	3.9
Soil Tests 3/					
pH	-	5.4	7.2	6.0	
P	-	V.H.	V.H.	M.	
K	-	V.L.	V.L.	V.L.	

1/ Applied in the row at rates to supply 60 lb of N, 60 lb of P_2O_5, and 60 lb of K_2O per acre.
2/ Denotes significant increase over the check plot.
3/ L = low, M = medium, H = high, V.H. = very high.
* Denotes significant yield increase

Table 4. Effect of various fertilizer treatments on the yield of corn in creek bottoms along the Ohio river, 1946.

Fertilizer Treatment 1/	Locations of Experiment: Daviess	Locations of Experiment: Union	Average
O	40.2	87.1	63.7
P	41.1	87.6	64.4
N	44.4	88.3	66.4
NP	49.4	92.9	71.2*2/
NK	50.2	94.3	72.3*
PK	40.4	93.3	66.9
NPK	53.7	94.0	73.9*
L.S.D.	n.s.	n.s.	
C.V.	14.2	7.4	
Soil Tests 3/			
pH	5.7	-	6.1
P	M	-	3.8
K	V.H.	-	

1/ Applied in the row at rates to supply 60 lb of N, 60 lb of P_2O_5, and 60 lb of K_2O per acre.
2/ Denotes significant increase over the check plot.
3/ L = low, M = medium, H = High, V.H. = very high.
* Denotes significant yield increase.

Most of the soils on which these experiments were located had been cropped continuously in corn for a number of years and little or no fertilizer had been applied. The soil tests (given in the tables) indicated that most of these soils, particularly those on the lower Ohio bottom, were well supplied with lime. Available phosphorus was generally very high. The tests for potassium ranged from very low to very high. The soil tests, together with the results obtained in the fertilizer experiments, indicate that most of the bottomland soils along the Cumberland and Ohio rivers are high in phosphorus and fairly high in potassium. From the cropping history of the soils on which the experiments were located, a good response to nitrogen applications would ordinarily be expected. However, the increase in yield due to nitrogen applications was not so great as would commonly be expected under similar cropping and fertilization practices on upland soils.

From the results of these experiments, it is evident that large increases in corn yields cannot be attained on the overflow bottoms of the Ohio and Cumberland rivers by the use of commercial fertilizers alone, but that small increases are to be expected. Also, row applications at the time of planting (to serve as a starter fertilizer) would appear to be a desirable practice. It is extremely doubtful if additional fertilizer applications would be of any benefit.

Upland Soil: Fifteen annual experiments were conducted at various locations throughout the state in 1954, 1955, and 1956 to determine the effects of various rates of nitrogen and potash on the yield of corn. In general, these experiments have substantiated the results of the other experiments upon which the present fertilizer recommendations are based, in which both soil tests and past cropping history are considered.

In most of these experiments, all of the nitrogen and potash were broadcast and disked in prior to planting corn, although in some instances part of the fertilizer was applied in the row. The rates of nitrogen and potash and the yields obtained at the various locations are given in the following table: Heavy, uniform applications of phosphate were made on all plots.

Pounds of Nitrogen (N) per Acre	Yield of Ear Corn (Bus. per Acre)						
	1954			1955		1956	
	Fayette Co.	Grayson Co.	Hopkins Co.	Fayette Co.	Ohio Co.	Nelson Co.	Simpson Co.
0	72.9*	12.9	22.4	69.0*	60.6	59.2	74.8*
30	--	--	--	--	--	--	75.8*
40	68.3*	--	--	76.2	--	--	--
50	--	--	--	--	--	93.4	--
60	--	--	--	--	--	--	83.7*
80	76.0*	--	--	76.9*	--	--	--
90	--	--	--	--	--	--	79.7*
100	--	53.9	37.1	--	82.0	104.5	--
120	74.0*	--	--	80.1*	--	--	78.9*
160	69.9*	--	--	80.8*	--	--	--
200	72.9*	63.1	37.0	--	82.7	99.8	--
Pounds of Potash (K_2O) Per Acre							
0	64.7	63.1	38.8	75.2	89.2	100.3	74.7
40	74.3	--	--	75.3	--	--	76.8
50	--	67.7	37.0	--	83.6	--	--
60	77.0	--	--	--	--	101.6	--
80	--	--	--	71.5	--	--	68.1
100	--	69.2	39.6	--	84.4	--	--
120	72.5	--	--	75.9	--	99.8	78.9
160	73.1	--	--	82.2	--	--	--
Difference Required for Significance (0.05)	n.s.	7.3	5.2	n.s.	9.4	23.1	n.s.

* Corn grown following sod crop.

An examination of these data indicate that when corn is grown following a sod crop, little or no response to nitrogen can be anticipated. Responses to potash were not marked, but results of other experiments indicate that when nitrogen and phosphate, with no potash are applied for a time, potash difficiencies will soon develop.

Experiments on creek bottom soils: Eight experiments were conducted in Western Kentucky in 1955 and 1956 on creek bottom soils that are not subject fo frequent overflow. Heavy, uniform applications of phosphate were made on all plots. The various rates of nitrogen and potash and the yields of ear corn are given in the following table:

Yield of Ear Corn (Bu per Acre)

Pounds of Nitrogen (N) per Acre	1955 Graves Co.	1955 Lyon Co.	1955 Marshall Co.	1956 Livingston Co.	1956 Lyon Co.	1956 Marshall Co.	1956 McCracken Co.	1956 Trigg Co.
0	36.8	52.6	68.1	87.0	71.3	45.9	71.0	102.0
50	64.0	65.5	72.2	--	--	--	--	--
60	--	--	--	86.1	102.2	79.6	71.0	112.1
100	75.6	64.3	67.6	--	--	--	--	--
120	--	--	--	100.2	110.8	78.1	69.5	107.9
180	--	--	--	101.9	100.2	102.7	73.2	--
200	84.6	73.8	76.4	--	--	--	--	--
240	--	--	--	--	--	--	--	111.2
Pounds of Potash (K_2O) Per Acre								
0	--	--	--	90.3	91.6	84.1	64.4	107.9
100	--	--	--	101.9	100.2	102.7	73.2	107.9
D.R.F.S.(0.05)	23.2	n.s.	n.s.	n.s.	n.s.	11.2	n.s.	n.s.

Although statistical analyses of the individual experiments do not, in many instances, show significance, a combined analysis would undoubtedly indicate that highly significant responses were obtained for the first 50 or 100 pounds of nitrogen. Any heavier applications would not be profitable. In some instances, particularly Marshall Co. in 1955 and McCracken and Trigg Counties in 1956, very little response was obtained for applications of nitrogen. Responses to potash were obtained at every location in 1956 except Trigg County.

GRAIN SORGHUM EXPERIMENTS

Two experiments were conducted in 1955 and two in 1956 to determine the effects of nitrogen and potash on the yield of grain sorghum. All of these experiments were located in Calloway County on Grenada silt loam, which is the most extensive upland soil in the Purchase region. Uniform heavy applications of phosphate were applied to all plots. The rates of nitrogen and potash and the yields obtained are given in the following table. Grain sorghum was seeded following the removal of a small grain in every case except the second experiment in 1956, in which the grain sorghum followed a lespedeza sod.

Pounds of Nitrogen (N) Per Acre	Yield per Acre (Bu) 1955		1956	
	1	2	1	2
0	36.2	26.9	24.5	21.6*
25	40.4	28.3	--	--
30	--	--	31.1	21.4*
50	41.9	35.0	--	--
60	--	--	34.3	18.7*
100	40.5	37.0	--	--
120	--	--	43.6	20.5*
200	43.2	40.1	--	--
Pounds of Potash (K_2O) Per Acre				
0	42.2	37.5	37.4	18.3
50	--	39.6	--	--
100	40.5	37.0	43.6	20.5
D.R.F.S. (0.05)	n.s.	6.9	7.9	n.s.

* Following lespedeza sod.

The results of these experiments indicate nitrogen should probably be applied at approximately one-half the rate as for corn under the same conditions. No response to nitrogen was obtained following a legume crop.