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AN ESTIMATE OF THE SOIL FERTILITY STATUS OF GRAVES AND TODD COUNTIES IN KENTUCKY

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BACKGROUND

Some concern has developed during recent years that fertilizer is being used by farmers on fields with residual levels of P and K high enough that such use is not justified as a means of increasing crop yields. This has been due to increased "average" soil test values for samples routinely submitted to college soil test laboratories.

For this reason, studies were conducted in Graves and Todd Counties in Kentucky during the period September, 1978 to September, 1980, to determine if soil samples routinely submitted to college test laboratories do or do not accurately reflect the average soil fertility status of a county.

Graves County is located in the Purchase physiographic region of Kentucky and is characterized by soils developed in thick loess on a slightly rolling to undulating topography. Dominant soil series are Grenada, Calloway, Henry, and Falaya. Although major stream channels have cut through the loess into the underlying coastal plains sediments, soils developed in those sediments are minor. As shown by data in Table 1, the county is used intensively for crop production.

Todd County lies in the Western Pennyroyal and Western Coalfield physiographic regions of Kentucky. The two regions are abruptly separated along an east-west direction, generally following U.S. highway 68. About half the county lies in the Western Coalfields region, north of highway 68, and is characterized by soils developed in a thin loess mantle overlying interbedded sandstone, shale, and limestone on a hilly to steeply sloping topography. Row crop production is not as intensive as in the southern half of the county and is concentrated on the broader ridges where the Zanesville soils are the most important.

The southern half of the county lying south of highway 68 is characterized by deep red soils developed from limestone and having a thin loessial influence at the surface. Topography is undulating to gently rolling and the area is very intensively used for row-crop production. Major soil series are the Crider and Pembroke. Todd County is also an important crop producing county in Kentucky as shown in Table 1.

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Table 1. POTENTIAL AND 1979 PRODUCTION OF ROW-CROPS.

County	Total[1/] Land Acres	Acres[2/] Potential Row-Crop Base	Open Acres[1/] in Cropland Use	1979 Row-Crop[3/] Acres Harvested (000)			1979 Row-Crop Acreage as % of Potential Cultivation Base	1979[3/] Cash Receipts From Crops (Millions $)
				Corn	Soybeans	Tobacco		
Graves	358,400	171,712	220,600	36.0	127.9	2.73	97	35.6
Todd	240,640	90,179	145,555	31.0	66.0	2.69	110	28.2

1/ Data from Kentucky Soil and Water Conservation Needs Inventory. USDA-SCS. 1970. Open acres in cropland use includes all crops, both row, meadow, and pasture.

2/ Data from Agricultural Production Potentials for Kentucky Counties. U.K. College of Agric. 1973.

3/ Data from County Estimates for 1979. Ky Crop and Livestock Reporting Service.

METHODS AND PROCEDURES

The two counties were selected because (a) both had been sending farmer samples to the UK Central lab for at least 5 years, thereby providing a standard reference data base, (b) both counties are row-crop intensive (c) Graves County lies completely within a major physiographic region, having similar soils throughout the county, and (d) Todd County is abruptly split between two major physiographic areas, making it possible to compare between them within the county.

It was determined to sample enough randomly selected fields in each county so that the total number of such samples would approximate the number of samples submitted by farmers to the UK Soils Testing Laboratory from the two counties each year. For Graves County, 513 fields were sampled, while 424 fields were sampled in Todd County. Farmers submitted an average of 622 samples per year from Graves County during the 1977-79 period. An average of 464 farmer samples were submitted per year for the period from Todd County.

Aerial photographs of a 1:20,000 scale were purchased through the Kentucky A.S.C.S. office for each county. Sites for sampling were determined by superimposing a grid over a base county aerial photo of smaller scale, randomly selecting coordinates for each grid, and then locating the sampling site in each grid from these coordinates. Any coordinates not resulting in a site located in an open field were rejected, and new coordinates randomly selected until they fell in an open field. By this process, we sampled only from the population of open fields in each county, making the assumption that such sites selected represented a random sampling of the "open field" population. It was also predetermined to exclude any site which was an abandoned field, so that we were sampling only open fields which were in agricultural use either for row crops, meadow, or pasture production.

Each site so selected was then located on the larger scale (1:20,000) maps so that it could accurately be located and identified for sampling. A composite soil sample from each site was taken by randomly taking 20 cores (0-6 inch depth) within an area no larger than 15-20 acres. The composite sample was thoroughly mixed in a clean plastic bucket and a pint of soil then taken for routine soil analysis. Samples were tested at the U.K. Central Soil Testing Laboratory in Lexington, under supervision of the U.K. Division of Regulatory Services. Samples were processed and tested in the same manner as those routinely submitted by farmers. Each sample was tested for water (1:1) pH, buffer pH (SMP) if water pH was less than 6.0, Bray P-1 extractable Phosphorus and neutral normal ammonium acetate extractable potassium. This is the identical set of soil test procedures routinely performed on farmer samples. Random sites in Graves County were sampled during the period, September, 1978 to May, 1979. Random sites in Todd County were sampled during the period September 1979-September 1980. Results of all farmer samples submitted from each county during the 3-year period 1977-79 were averaged for comparison with results from the randomly-taken samples. Differences between source of sample means were tested for significance by use of the "t-test". The UK categorization of soil test values is shown in Table 2.

Table 2. CATEGORIZATION OF SOIL TEST VALUES IN KENTUCKY

Active Acidity		Extractable Phosphorus		Extractable Potassium	
Soil-Water pH	Category	Bray P-1 level ----lbs/A-----	Category	Amm. Ac. level --lbs/A--	Category
Above 6.8	near neutral	less than 10	very low	less than 75	very low
6.8-6.4	slightly acid	10-30	low	75-165	low
6.4-5.8	acid	30-60	medium	165-250	medium
5.8-5.2	strongly acid	60-80	high	250-375	high
below 5.2	very acid	above 80	very high	above 375	very high

RESULTS OF THE STUDY

Soil test results were summarized from the randomly sampled fields and compared with the average soil test results from farmer samples submitted from each county during the 3-year period, 1977-79.

A. GRAVES COUNTY: A comparison of the county average soil test results is shown in Table 3. As indicated by these data, there was little difference in the average for farmer-submitted and randomly taken samples. Residual level of extractable soil phosphorus was in the low-medium range, while potassium was in the high-medium category.

Of the 513 random sites, 245 were identified as occurring on uplands and 78 as occurring on bottomlands. The remaining 190 sites were undesignated. This made it possible to test for differences in soil test values between upland and bottomland soils. Table 4 shows this comparison. There were significant differences between the average soil test values for upland and bottomland sites. While bottomland soils were slightly more acid and had higher levels of extractable phosphorus, they were lower in extractable potassium. Of greater interest though, is the comparison between the randomly sampled sites and the farmer-submitted samples which show little difference except for lower potassium value from the farmer samples as compared to random upland samples. Soils were more acid and extractable phosphorus was greater on the bottomland sites than farmer samples while there was no difference in extractable potassium.

B. TODD COUNTY: A comparison of the county average soil test results is shown in Table 4. As shown in this comparison, soils were slightly more acid on the random sites while extractable phosphorus and potassium was higher. Residual level of extractable phosphorus and potassium was in the high-medium and high category, respectively, for the randomly sampled sites.

Of the 424 random sites in Todd County, 228 occurred south of highway 68 in the Western Pennyroyal area while the remaining 196 were located north of highway 68 in the Western Coalfields area. Since there are major differences between the soils which occur in these two areas, we compared the average soil test values from each area. As would be expected, due largely to differences in intensity of row crop production in the two areas, random sites from fields in the Western Coalfields area are more acid and lower in residual extractable phosphorus and potassium than those

from the Western Pennyroyal area. When the average soil test values from each of these areas is compared with the county average of all farmer-submitted samples, those from the Western Pennyroyal averaged higher for residual soil content of extractable phosphorus than the county average of all farmer samples. Randomly sampled sites from the Western Coalfields were also more acid and had a lower level of residual potassium than the county average of all farmer samples.

C. DISTRIBUTION OF RESULTS BY FERTILITY CATEGORY: A more realistic appraisal of lime and fertilizer needs can be made by summarizing soil test results according to the categories shown in Table 2. Results of such comparisons are shown in Table 5-6. These comparisons indicate that:

(1) In Graves County, with the average soil test level from all randomly sampled sites testing a pH of 6.1, P of 36, and K of 224, we would conclude that about the only need for lime would be for legumes, that there was a moderate need for phosphorus, and that little potash is needed. However, if we look at the distributions of the randomly sampled sites shown in Tables 10-12, we see that about half the fields would need lime (the sum of all <5.3, 5.3-6.0, plus some unknown amount of the 6.1-6.7); over 80 percent would need phosphate (the sum of all <10, 10-30, and 31-60); and about 70 percent would need potash.

(2) In Todd County, with an average soil test level from all randomly sampled sites testing a pH of 6.37, P of 58, and K of 322, there would be virtually no need for lime, P, or K for any crop. But on the basis of the array of randomly sampled site results shown for Todd County in Table 6, we would conclude that something over 1/3 of the fields would need lime; about 2/3 of the fields would need phosphate; and just over 1/3 of the fields would need potash. On the basis of average for samples from the Western Pennyroyal vs. those from the Western Coalfields (as shown in Tables 4-6), we get yet another picture. In the Western Pennyroyal (southern half of the county), something over 1/4 the fields would need lime as compared to about 1/2 the fields in the Western Coalfields (northern half of the county). Just over 1/2 the fields in the Pennyroyal would need phosphate as compared to nearly 4/5 of those in the Coalfields. Only 1/6 of the fields in the Pennyroyal would need potash while 2/3 of those in the Coalfields would require its use. This is largely due (in addition to the different origin of soils) to the effect of much greater row-crop intensity (with its attendant greater fertilizer and lime use) in the Pennyroyal than in the Coalfields.

SUMMARY

Soil test averages from randomly sampled fields being used for agricultural purposes were no different than those of all farmer-submitted samples in Graves County, a county located completely within a single physiographic region. Stratification of the random sites into either upland or bottomland sites showed some differences within the county, however. Bottomland sites were slightly more acid and considerably higher in available phosphorus than the average of all farmer-submitted samples. The upland site averages were nearly the same as those for the farmer-submitted samples with the exception of being slightly higher in extractable potassium.

In Todd County, a county abruptly divided between two distinctly different physiographic regions, soil test averages for all randomly sampled sites differed from those of all farmer-submitted samples. In this case, average values of farmer-submitted samples were slightly lower in pH, and considerably lower in residual content of extractable phosphorus and potassium.

Stratification of the random sites into either Western Pennyroyal or Western Coalfields location showed average soil test values from the Western Coalfield sites to be considerably more acid and considerably lower in residual content of extractable phosphorus and potassium. In the case of Todd County, average value of all farmer-submitted samples underestimated the average value from all randomly samples sites. These differences were greatest when comparing average values from the Western Pennyroyal locations to those of all farmer-submitted samples.

We conclude from this study that the average soil test values of all farmer-submitted samples from a county of somewhat uniform physiography may well-approximate the "average" pH, P, and K soil test values of all open land in agricultural use in that county. However, our study would indicate that in counties with distinct differences in physiography, the average soil test values of farmer-submitted samples may vary considerably from average values determined from a random sampling of fields in agricultural use in such a county.

Table 3. AVERAGE SOIL TEST VALUES FOR GRAVES COUNTY.

		Av. Soil Test			
Source of Samples	No. Samples	Water pH	Buffer pH	P	K
Upland, random	245	6.16	6.54	32	235
Bottomland, random	78	6.01	6.61	50	219
Farmer Submitted	1868[1/]	6.15	6.55	36	217
Difference between Av. for:					
Upland vs Bottomland		0.15*	0.07*	18*	16*
Upland vs Farmers		.01	.01	4	18*
Bottomland vs Farmers		.14*	.06*	14*	2

[1/] Samples submitted 1977-79

* Differences significant at 95% probability level

Table 4. AVERAGE SOIL TEST VALUES FROM TODD COUNTY.

Source of Samples	No. Samples	Av. Soil Test Water pH	Buffer pH	P	K
All random samples	424	6.37	6.60	58	322
Farmer submitted samples	1391[1]	6.46	6.58	42	278
Random samples from Pennyroyal	228	6.48	6.66	72	389
Random samples from Coalfields	196	6.25	6.55	41	244
Difference between Av. for:					
Random vs Farmers		0.09*	0.02	16*	44*
Random, Pennyroyal vs Coalfields		.23*	.11*	31*	145*
Pennyroyal vs Farmers		.02	.08	30*	111*
Coalfields vs Farmers		.21*	.03	1	34*

1/ Samples submitted 1977-79

* Differences significant at 95% probability level

Table 5. DISTRIBUTION (%) OF SOIL TEST LEVELS

Water pH	Graves Co. Farmer	Graves Co. Random	Todd Co. Farmer	Todd Co. Random
<5.3	11	15	5	7
5.3-6.0	32	30	20	26
6.1-6.7	34	35	35	33
>6.7	23	20	40	34
Phosphorus Test Level				
<10	24	12	27	12
10-30	43	46	35	28
31-60	20	25	21	27
61-80	5	10	7	8
>80	8	7	10	25
Potassium Test Level				
<75	1	0	0	0
75-165	38	23	21	13
166-250	39	46	30	24
250-375	16	26	32	32
>375	6	5	17	31

Table 6. DISTRIBUTION (%) OF SOIL TEST LEVELS IN TODD COUNTY BY SAMPLE SOURCE

		Random Samples	
Water pH Reading	Farmer	Western Pennyroyal	Western Coalfields
<5.3	5	2	12
5.3-6.0	20	23	30
6.1-6.7	35	38	27
>6.7	40	37	31
Phosphorus Test Level			
≤10	27	8	16
10-30	35	20	37
31-60	21	29	26
61-80	7	10	6
>80	10	33	15
Potassium Test Level			
<75	0	0	0
75-165	21	4	24
166-250	30	11	38
251-375	32	36	27
>375	17	49	11

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