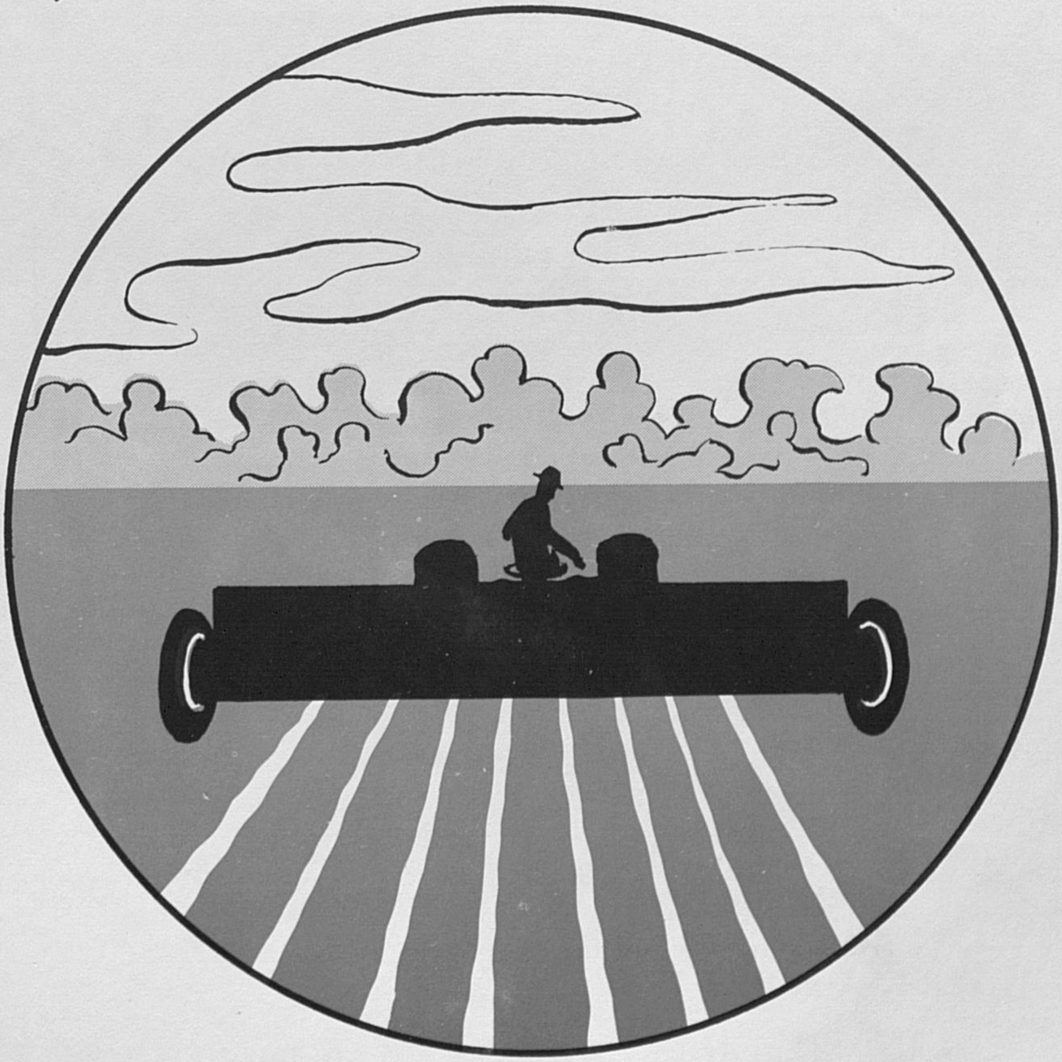
LIME AND FERTILIZER RECOMMENDATION GUIDE

CIRCULAR 619



UNIVERSITY OF KENTUCKY
COOPERATIVE EXTENSION SERVICE
AGRICULTURE AND HOME ECONOMICS

CONTENTS

Lime and Fertilizer Recommendation Guide

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The lime and fertilizer recommendations in this guide are based on the results of soil samples tested in laboratories under the supervision of the Kentucky Agricultural Experiment Station. These recommendations for Kentucky are arrived at by testing the soil, applying various rates of plant nutrients, and measuring crop response to each rate. The nutrient rate that gives the highest economic crop response over a period of years is the basis for the recommended amounts.

The lime and fertilizer recommendations listed in this guide should not be applied to soil test results from laboratories that use extracting chemicals, or other procedures that differ from those used in Kentucky Experiment Station controlled laboratories.

A number of different extractants and procedures are being used to appraise the chemical status of soils. Soil testing laboratories select their own extractants and establish their own methods and procedures. The differences among laboratories in the extractants used and the procedures followed often cause variations in the reports of chemical properties being tested.

Variations in methods and procedures may include the ratio of soil to extractant and/or the time of exposing the soil to the extractant. The variations in extractants used may include different extractants or the same extractant in different concentrations. Any one of these variations or a combination of them will result in different values being reported from one laboratory to another.

Farmers and others should not be alarmed when different laboratories report different chemical values on the same soil. However, if the recommended rate of lime and fertilizer applications is greatly different, this is cause for concern. The values of the chemical properties reported should be of little concern if there is sufficient information on the soil tests, soil treatments, and plant responses available to determine the best lime and fertilizer treatment from the results of a particular soil testing procedure. If correlations between soil tests and application rates have been made, then lime and fertilizer recommendations from different laboratories that use different soil testing procedures should be approximately the same, providing the same soil type and yield goals are involved. Therefore, lime and fertilizer recommendations developed from research on soils that differ greatly from Kentucky soil types should not be used for Kentucky soils.

The lime and fertilizer recommendations in this circular are based on the assumption that ammendments will be applied on deep, well-drained soils of high production potential. The amounts recommended should be adjusted downard as the production potential of the land drops to medium or lower for the crop being grown. Likewise the recommended amounts should be adjusted downard if the farmer's yield goals are less than the production potential of the land. How to determine when to make such adjustments is discussed more fully on pages 12 through 18 of this circular.

SOIL TESTING

Soil test results and a knowledge of past treatment and cropping history provide the best information available for determining quickly the lime and fertilizer needs of the land for a particular crop or cropping sequence. But to be reliable, soil test results must come from a competent laboratory and be made on a soil sample that adequately represents the chemical properties of the field or area in question.

The results of a soil test are a measure of the chemical properties of a soil at the time the test was made. Establishing lime and fertilizer treatments on the basis of these results includes consideration of the soil type and past treatment. For instance, some soils have the capability of releasing potassium and phosphorus throughout a growing season that may not be indicated by soil test results. (See pages 12 through 18.) Furthermore, lime applied during the previous three years probably has not reached its peak of effectiveness.

When soil test results are properly interpreted, the amounts of a nutrient or nutrients needed to provide a balance and an adequate supply, and the amount of lime needed to adjust soil acidity to the desired level, can be established for a particular crop or cropping sequence.

In the competitive business of farming the highest increment of economic crop production often determines the margin of profit. As farmers strive for such production, soil testing becomes more important. Failure to invest a very few dollars in lime or plant nutrients that are needed, or spending a very few dollars that are not needed, can turn potential profit into a break-even or a loss.

SOIL TESTING SERVICE IN KENTUCKY

The soil testing services now available in Kentucky consist of county laboratories and a central laboratory at the University of Kentucky in Lexington. The county laboratories conduct the following routine tests:

1. pH (water suspension).
2. Extractable phosphorus (0.15 *N* sulfuric acid).
3. Extractable potassium (0.15 *N* sulfuric acid).

The central laboratory conducts the following tests:

1. pH (water suspension).
2. Lime requirement (see pages 17-18 for interpretation).
3. Extractable phosphorus, Bray's No. 1 extractant.
4. Extractable potassium, 1 *N* Neutral ammonium acetate.
   The charge per sample is $1.00 for tests through 4.
5. Extractable magnesium, 1 N neutral ammonium acetate.
6. Extractable calcium, 1 *N* neutral ammonium acetate.
   The charge per sample is $1.50 for tests 1 through 6.
7. Spurway's test for greenhouse soils ($2.00/sample).
8. Organic matter content ($1.00/sample).

In addition to those nutrients now being tested for, there are other nutrient elements which are required for optimum plant growth. Some of these elements are known or suspected of being problems in Kentucky soils. Accordingly, research is being conducted on procedures and correlations to increase the number of elements for which soils can be tested. As plant response information becomes available to aid in interpreting new tests, they will be offered as additional services in the central laboratory.

Crop response to fertilizer and lime in studies conducted by the staff of the University of Kentucky Agricultural Experiment Station furnish the basis for interpreting the soil test results as given on pages 19 through 24. When using soil tests to make decisions on fertilizer practices, it is always important to regard the "lbs/A" shown by the soil test merely as an index and not as actual pounds per acre of readily available nutrients in the soil. The results of soil tests by most laboratories are reported as "lbs/A" of *extractable* nutrients which are related to, but not identical to, *available* nutrients. Therefore, it is important to use the test level of high, medium, or low to arrive at a "fertilizer decision."

COLLECTING SOIL SAMPLES

(For more detailed information see Kentucky Leaflet 139, "How To Take Good Soil Samples")

The results reported for a given soil test and the ensuing lime and fertilizer recommendation applies only to that portion of soil sample that was submitted for testing. If the soil sample does not adequately represent the soil of the entire field or area to be treated, the test results will not reflect the chemical properties of the field, and thus the recommendations when followed may not supply the nutrients needed for economic crop production. Poorly collected soil samples set the stage for inaccurate treatment recommendations that can lead to disappointment in crop response. Hence, the person who collects the soil sample plays a large part in determining whether or not the test results and treatment recommendations are applicable. If the person who collects the sample does not take the time and make the effort to get a representative sample, a soil test should not be made.

Procedure

1. It is best to collect samples when the land is dry enough to plow. Summer and fall are ideal.
2. Divide the field into areas in which all the soil looks alike and has had the same cropping, fertilizer and lime treatment. Collect a soil sample from the field or from each area as follows:
3. Use a sampling tube, augur, or spade.
4. Collect 10 or more equal-sized cores from the surface to plow-depth, a minimum of 6 inches.
5. Place all the cores in a clean box or pail and mix thoroughly. Remove one pint of the mixture from the box or pail and spread it on a clean paper to air dry. DO NOT HEAT!
6. Place the dried soil in a soil sample carton or clean paper sack.

7. Identify the sample by putting the farmer's name and address and field name or number on the container.
8. Take or send the sample to the local Extension office or laboratory and fill out the soil test report form. (See detailed instructions that follow.)

CAUTION: Avoid small and unusual spots in the field such as old lime and manure piles or hay stacks, small garden spots, and fertilizer bands, and stay at least 10 rods away from limestone gravel roads.

When To Collect Samples

Soil samples can be collected any time of the year except when the ground is frozen or saturated with water. However, it is easier to prepare the sample if the ground is dry. There are several advantages to collecting samples in the summer and fall: (1) the results are reliable for fall or spring treatment; (2) the ground is usually dry and farm work has usually slackened; (3) the work load in the soil testing laboratory is usually low; (4) the person making the recommendation has more time to consider each test result individually; (5) the farmer has more advance notice of his lime and fertilizer needs; and (6) lime, phosphate, and potash can be applied in the fall when the land is dry and firm whether the application is for fall-sown or spring-sown crops.

Dividing the Field

If the field or area in question has more than one soil type, a composite sample should be taken from each soil type, provided each area is large enough to be treated as a unit. Otherwise, the major soil type should determine the treatment. Likewise, if a part of the field has been limed and/or fertilized differently than other parts, a composite sample should be taken from each treatment area.

Fig. 1 illustrates a field that includes differing soil types and varying past treatment. It also illustrates a method of labeling composite soil samples from a field such as this. If the soil type and past treatment are uniform over an entire field or area, only one composite sample needs to be taken.

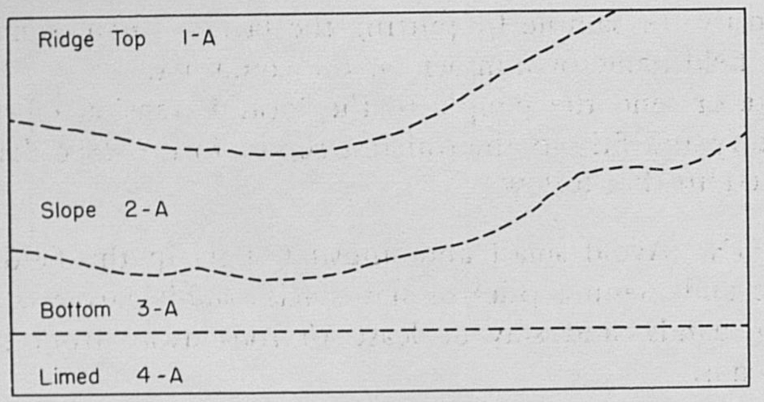

Fig. 1.—Field diagram for collecting soil samples

Sampling Tools

A soil sampling tool, a clean pail or box, and soil sample bags or boxes are needed when collecting samples. The tool used can be either a soil tube (core sampling tube), a ¾ to 1 inch soil or wood augur, or a spade. Of all the tools listed, the soil tube is most convenient and accurate.

Fig. 2 illustrates how to use the various tools when collecting soil samples. Each soil core should extend from the soil surface to plow sole depth, or a minimum of 6 inches.

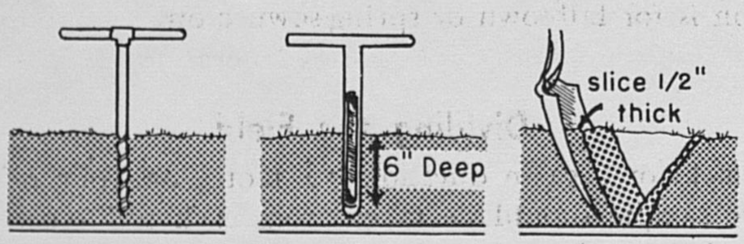

Fig. 2.—Tools for collecting soil samples

Collecting Soil Cores

A soil sample should be a composite of 10 to 20 individual cores taken from the field or area to be treated. Fig. 3 illustrates the zigzagging fashion that should be walked when collecting the soil cores that will make up the composite sample. The reason for zigzagging is to avoid following a line where previous applications of lime or fertilizer may have been unusually heavy.

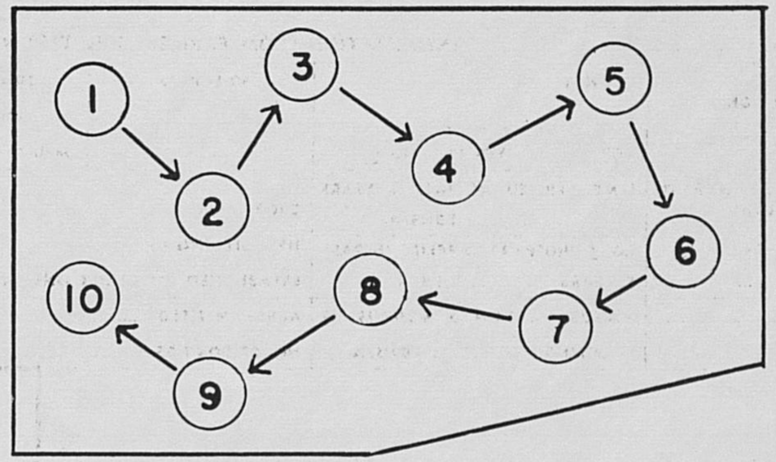

Fig. 3.—Field diagram for collecting soil cores

Handling the Sample

As the cores are collected, they should be dropped in a clean box or pail. When the selected number of cores have been taken, the lumps should be crushed, the rocks removed, and the composite sample should be mixed thoroughly. Then about a pint of the soil should be put in a sample bag or box. This is the sample that will be delivered to the local Extension office or the testing laboratory after it is labeled with the farmer's name and address and the field or area name or number. It should be air-dried before delivery to the testing laboratory. Soil sample boxes can be obtained from the local Extension office or the central laboratory.

THE SOIL TEST REPORT FORM

On the following page is the portion of the soil test report form that should be filled in by the farmer or gardener. This form is available at the local Extension office and the central laboratory.

The information requested on the above form is useful in adjusting lime and fertilizer treatments to compensate for past cropping and lime and fertilizer treatment, to the kind of soil being cropped and the crop to be grown. Lime applied within the past three years has not reached the peak of its effectiveness. Likewise, manure applied within the past six months will still yield some benefits. Thus, farmers should get credit for certain recent past practices when making fertilizer and lime applications.

DATE.. INFORMATION FROM FARMER: SOIL TEST REPORT

SAMPLE IDENTIFICATION	COUNTY .... ACP YES ☐ NO ☐	SOIL TYPE	DRAINAGE GOOD ☐ MED ☐ POOR ☐
FERTILIZER APPLIED IN PAST 12 MO. (LB/A) N.................. P_2O_5.................. K_2O..................	LIME APPLIED IN PAST 3 YEARS .... TONS/A	CROP .... NEW SEEDING ☐ ESTABLISHED ☐ CHECK ONE (✓)	
	ROCK PHOSPHATE APPLIED IN PAST 5 YEARS .... LB/A		
PREVIOUS CROP .... YIELD/A	MANURE WITHIN 6 MONTHS OF PLANTING .... TONS/A	ACRES IN FIELD .... NO. OF BORINGS	

TESTS TO BE MADE (✓) 1 ☐ 2 ☐ 3 ☐ SEE BACK	NAME .... MAIL ADDRESS .... CITY STATE ZIP CODE

LIMING AND FERTILIZING WHEN NO SOIL TESTS ARE MADE

When no soil tests are made, lime and fertilizer treatments must be based on a knowledge of past treatment and recent crop growth. However, such knowledge, usually known only by the farmer, does not tell if soil acidity or a single plant nutrient is determining the level of crop production. Neither will it tell if one or more of the plant nutrients is in abundant supply or if soil acidity is at the desired level.

When no soil test is made it is safest to assume that both lime and fertilizer are needed, then apply fertilizer and lime assuming that the fertility of the soil is low and it is moderately acid.

USING THE LIME AND FERTILIZER RECOMMENDATION GUIDE

The lime and fertilizer recommendations listed on pages —— through —— are given as ranges in tons of lime and pounds of N, P_2O_5 and K_2O per acre, to be applied alone or in combination for any particular soil test level and/or cropping history for the various field crops. The purpose of these ranges is to permit one to draw upon his knowledge of the production potential of the soil and other farm conditions to determine the most realistic lime and fertilizer treatment.

In determining lime and fertilizer treatments the following factors should be considered:

(a) Where the test value lies within the soil test category of high, medium, or low, that is, whether a sample tests in the upper or lower portion of the low or the medium or the high range.
(b) Yield potential of the soil.
(c) Productivity goal of the farmer.
(d) Chemical characteristics of the soil.
(e) Recent past treatment.

The higher rates of treatment listed in each test category are to be used when the soil is capable of producing (with proper fertilizer and management) at least 125 bushels of corn, or 3 tons of legume-grass hay, or 3,000 pounds of burley tobacco per acre. The soil treatment for a specific condition should be adjusted upward or downward on the basis of the five factors listed above.

Of these factors, (b) will be discussed on page 12 and (c) is self-explanatory. Factor (a) justifies a downward adjustment of the fertilizer rate in proportion to the closeness of the test value to the next highest test category. Factor (d) is primarily concerned with the ability of the soil to supply potassium and phosphorus (see page 13). In factor (e) a downward adjustment should be made for recent applications of lime or manure.

The factors to be considered in determining soil treatment are interrelated, and all of them should be considered. *Case A*—Let's assume that: (1) A soil test value is at or near the lower limits of a particular category, (2) the farmer's yield goals and management abilities are high, (3) the productive potential of the land is high, and (4) the land is derived from sandstone. In such situations the treatment should be at or near the upper limits of the suggested range. *Case B*—At the other extreme let's assume that: (1) A soil test value is near the upper limit of a particular category, (2) the farmer's yield goal (or the productive potential of the soil) is low, and (3) the soil has a high rating for release of nutrients not necessarily shown in the soil test (see pages 17 and 18). The rates of fertilizer recommended for *Case B* would be considerably less than for *Case A*.

ADJUSTING LIME AND FERTILIZER RECOMMENDATIONS

Manure

For each ton of manure applied, reduce N recommended from fertilizers 6 pounds, P_2O_5 5 pounds, and K_2O 10 pounds. See Circular 593, "Farm Manures."

Tobacco stalks

For each ton of stalks applied, reduce N recommended from fertilizers 30 pounds, P_2O_5 10 pounds, and K_2O 70 pounds. See Leaflet 269, "Tobacco Stalks and Stems."

Tobacco stems

For each ton of tobacco stems applied, reduce N recommended from fertilizers 27 pounds, P_2O_5 10 pounds, and K_2O 140 pounds. See Leaflet 269, "Tobacco Stalks and Stems."

Liming when heavy nitrogen applications are made

The lime recommendations in this circular are made on the assumption that the recommended nitrogen rates will be followed. However, some farmers apply more nitrogen than is recommended in this circular, especially on corn and tobacco. If this practice is continued over a few years, lime applications should be adjusted upward from the recommended amounts, or should be more frequent. The amount or adjustment depends on how much more nitrogen is applied than is recommended. Usually the amount of lime applied should be increased by half when the recommended amount of nitrogen is doubled. If you grow corn or tobacco continuously on the same land and apply nitrogen equal to or above the recommended amounts, you should check the acidity level frequently, to determine how often to apply lime.

Production potential of the land

Depth of rooting zone and poor physical structure can easily be, and often are, limiting factors to high crop yields on some Kentucky soils. These soils are apt to have a hard pan, fragipan, or clay pan somewhere in the soil profile that prevents proper drainage and restricts root penetration to shallow depths. In other soils bedrock may limit the depth of the rooting zone.

High water tables, compact pans, or bedrock also limit air penetration to the shallow depths. Plant roots will grow no deeper in the soil than air can go. Usually the depth to which a dark color—red, brown, or black—extends into the soil profile is a good indicaton of the depth of air penetration and thus the depth of the rooting zone.

A soil capability map shows the depth of the rooting zone. If you don't have a capability map, a soil core sampler or post hole digger can be used to estimate the depth of the rooting zone.

Soils that break up in clods that are difficult to pulverize when dry have poor physical structure. In such soils there is a tendency to crust when dry, water penetration is slow, and water availability is low. These soil characteristics limit crop yields to a level below those of soils with good structure even though the fertility and management practices are the same on the two soils.

Fertilization programs should be adjusted to the production potential of the land as estimated by the effective rooting depth and physical structure. A shallow rooting zone, from 12 to 15 inches, will in most years, limit corn yields to about 70 bushels per acre and tobacco yields to about 1,500 pounds, even though the fertility levels are high. Soils that have limited yield levels such as these should not be fertilized for high yields, such as for 125 bushels of corn or 3,000 pounds of tobacco, because of the economics involved.

Phosphorus and potassium releasing potential

Routine soil tests in Kentucky indicate the amounts of phosphorus and potassium available at the time the analysis is made. Such soil tests do not reflect the total amount of phosphorus and potassium a specific soil is capable of releasing throughout a growing season, but the soil tests are useful in giving a general soil test level. Therefore, the fertilizer should be applied according to the general soil type as indicated in Figures 4 and 5.

Figures 4 and 5 show the areas of Kentucky that have soils with different potentials for supplying phosphorus and potassium. The lines separating the soil areas (Fig. 4 and 5) indicate rough approximations of where the transitions between soil types with different potentials occur. Hence, close observations would show instances where the soil type in one category extends a few hundred feet or even a few miles across the line into another category. The

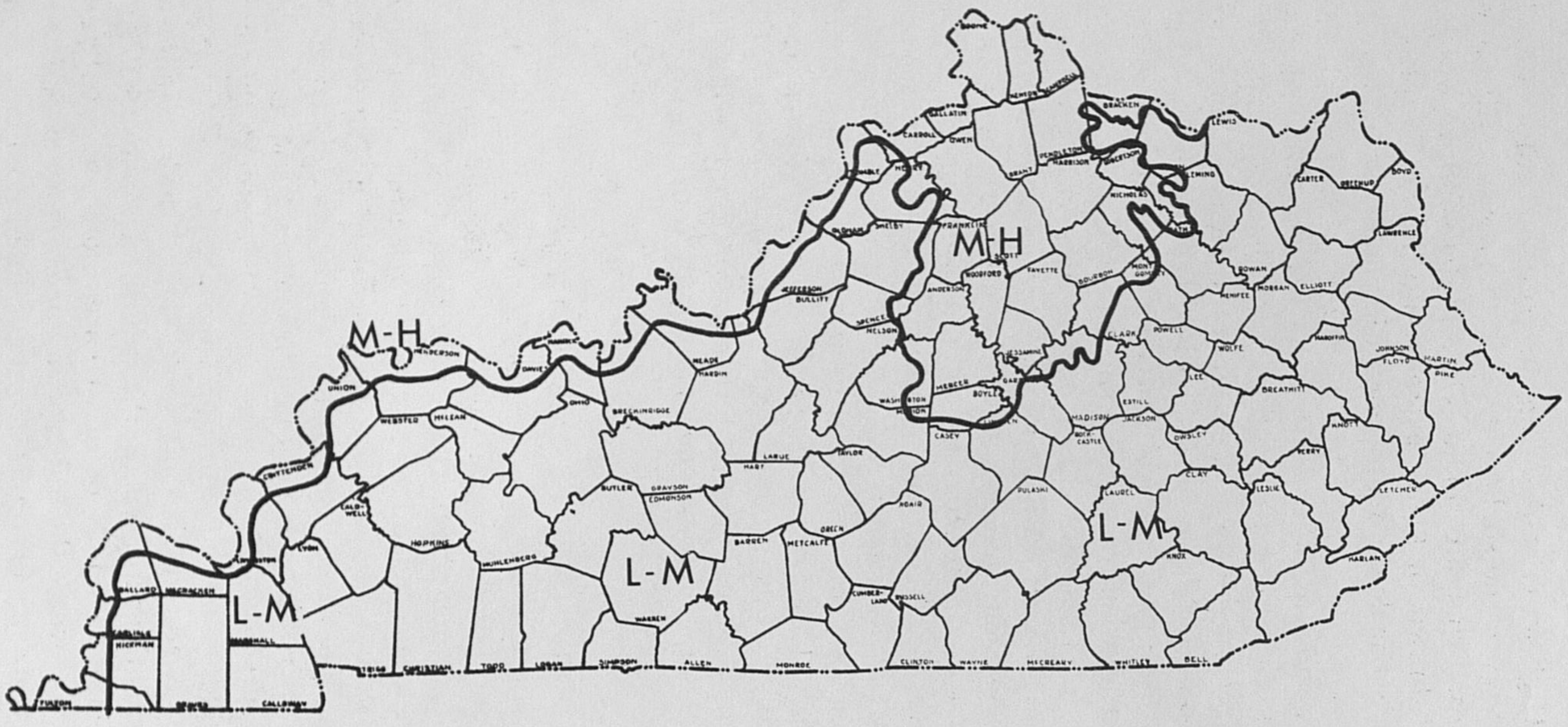

Fig. 4.—Relative phosphorus supplying potential of soil areas in Kentucky

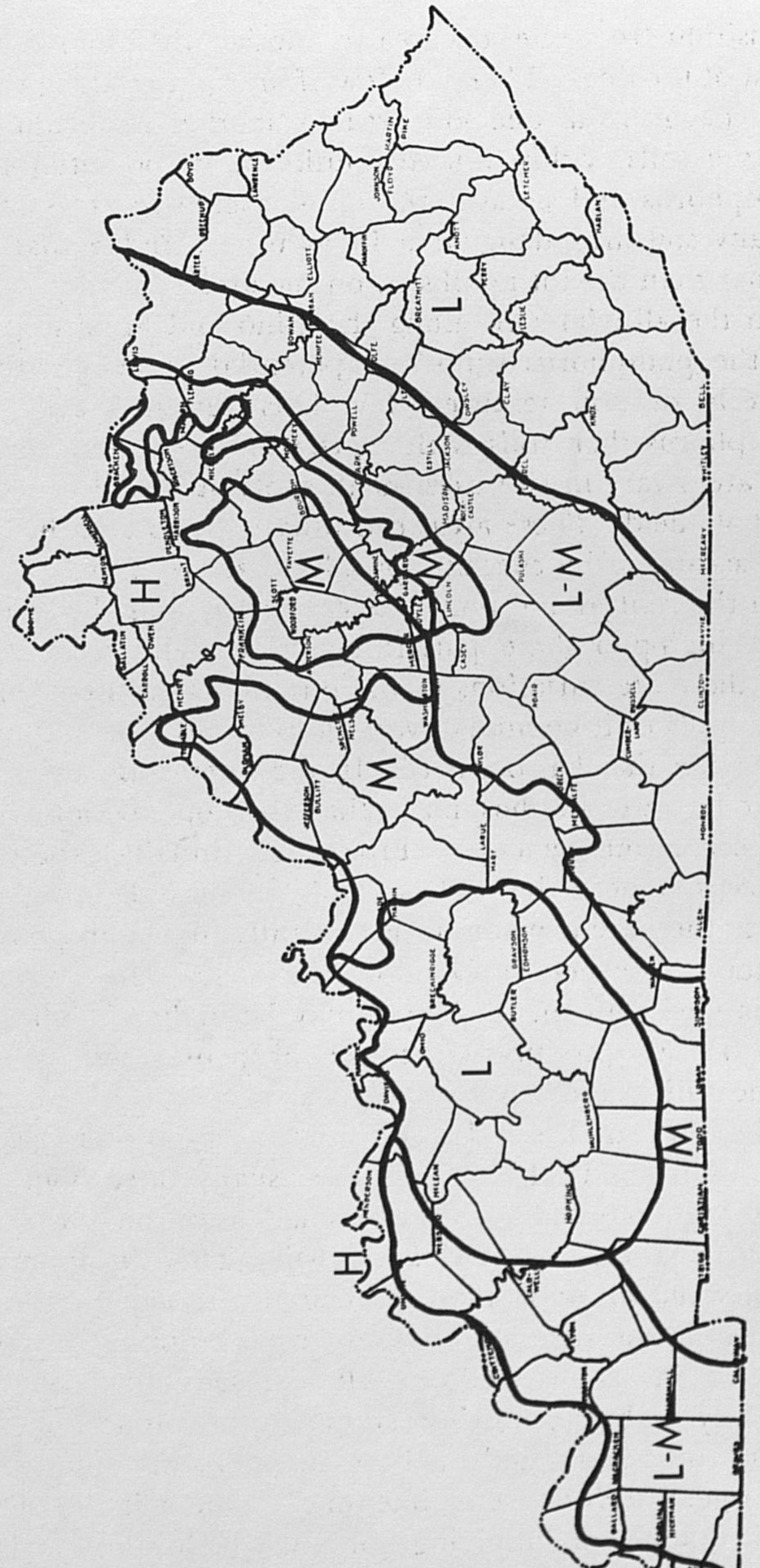

Fig. 5.—Relative potassium supplying potentials of soil areas in Kentucky

transition from one soil area to another therefore is gradual along most of the lines. There are few, if any, places along the lines where the change from one soil area to another is abrupt. Neither are all the soils within an area uniform in potential for supplying phosphorus and potassium. Thus, there are areas of varying size in any soil area designated in Figures 4 and 5 that are lower or higher than the rating placed on the area generally.

In the alluvial soils along the Ohio and Mississippi River (Fig. 4), the phosphorus supplying potential varies greatly, depending largerly on soil texture. The finer textured soils release more phosphorus than soils with coarser textures. The coarser textured soil areas vary in size from small spots in a field to several acres or a whole field. These areas can usually be located by observing the soil texture or by checking past fertilizer response.

In the central and northern Kentucky areas the soils are derived from high-phosphate parent materials. However, in these areas also there are variations in the phosphorus content and the potential supply of it because of variations in soil type and in the amount of erosion that has occurred. In the Eden soils, the ridge tops are apt to be lower in phosphorus than the slopes because of the erosion that occurs on the slopes. Erosion continually exposes the subsoil or keeps it near the surface, and the subsoil, being younger and nearer the parent material, is generally higher in phosphorus than the top soils generally found on the ridges. However, even though the eroded soils on the slopes may be higher in phosphorus, they may be less productive because of poorer soil structure, lower permeability, and less available water.

The soils in the Eden Hills area of northern Kentucky and surrounding central Kentucky are usually rated high in potassium supplying potential. However, small areas on the ridge tops are low to medium in this characteristic. This variation is caused by a different soil type than is generally found on the slopes as a result of less erosion and more intensive cropping on the ridge tops. Soils on the slopes and the alluvial soils along the streams are normally high in potassium supplying potential.

The soil areas rated medium in potassium supplying potential are largely derived from limestone. Some soils in these areas are low in potassium supplying potential, because of variation in soil type and shallower rooting zones.

In the Purchase area and in some counties immediately to the northeast of it, a loessal mantle covers the surface. Variations in potassium supplying potential are caused mainly by the depth of loess material and of rooting zone, as well as past treatment.

The soils that are rated low in potassium supplying potential are derived mainly from sandstone. Variations in potassium supplying potential are due largely to variations in soil type, the amount of erosion that has occurred, and the depth of the rooting zone.

In south central Kentucky and in the counties immediately to the northeast, the soils are primarily a mixture derived from sandstone, limestone, and shale. Variations in potassium supplying potential depend on the kind of parent material that contributed most to composing the soil. Soils derived chiefly from limestone are higher in potassium supplying potential than those derived chiefly from sandstone.

Liming to correct exchangeable acidity

The soil acidity (pH) categories (strongly acid, moderately acid, slightly acid, and near neutral) referred to on pages —— through —— in this circular are based on a soil-water suspension test. This test indicates the "active" acidity (H-ion activity) at the time the test was made. It odes not directly indicate the "exchangeable" acidity, aluminum and hydrogen, that occupies the exchange sites on the clay and humus fractions of the soil.

Exchangeable as well as active soil acidity can be measured by using buffer solutions to displace the exchangeable aluminum and hydrogen from the soil clay and humus. This procedure is referred to as the "lime requirement" test. The amount of lime required to cause a given pH change in the soil is determined by measuring the pH of a soil-plus-buffer suspension. The buffer solution has an initial pH of 7.5 and the extent to which the soil counteracts the neutralizing ("liming") chemicals in the buffer reflects the lime needs of the soil.

The lime requirement test provides more reliable information, especially on buffered soils, than the soil-water suspension test does.

The lime requirement test (Buffer based on the Shoemaker-McLean-Pratt method, Ohio State University) is made in the central Soil Testing Laboratory, Agricultural Experiment Station, Lexington, Ky. 40506.

The amount of lime required to bring Kentucky soils to the indicated pH according to the soil buffer pH is shown in Table 1.

In table 1, pH levels of 6.0, 6.4, and 6.8 were designated because

Table 1.—Lime Required on Kentucky Soils to Adjust Soil Acidity to Designated pH Levels When the Soil Buffer pH (Lime Requirement Reading) Is Known

Soil-Buffer pH (Lime Requirement)	Agricultural limestone (tons/acre) required to adjust soil to:**		
	pH 6.0	*pH 6.4*	*pH 6.8*
6.7*	1.0	1.5	2.0
6.6	1.5	2.25	3.0
6.5	2.0	2.5	3.5
6.4	2.25	3.0	4.0
6.3	2.5	3.5	4.5
6.2	3.0	4.0	5.0
6.1	3.5	4.5	5.5
6.0	4.0	5.0	6.0
5.9	4.25	5.25	7.0
5.8	4.5	5.5	
5.7	5.0	6.0	
5.6	5.75	6.75	
5.5	6.0	7.0	

* In some sandy soils, even though the soil-water pH is 5.9 or below, the soil-buffer pH may be 6.8 or above. For such cases, use a nominal application of about 1 ton per acre for most crops.

** Limestone needs are listed assuming: (1) The limestone will be thoroughly mixed with the soil (2) It will have two years to react with the soil to give the indicated pH and (3) A good quality limestone is used and at least 45 percent of it will pass through a 50-mesh screen.

these are the approximate pH levels desirable for tobacco; for grain crops, clover-grass mixtures, and straight grass; and for alfalfa and alfalfa-grass respectively.

If hydrated lime is to be applied, use ⅔ of the rate given in Table 1.

When soil tests are made using the lime-requirement test, usually two pH values are reported: (A) on the new soil test report form, the left column (pH) will be the pH of the soil in a 1:1 suspension with water, and (B) in the right column of "Test Levels" will be the pH of the soil in a buffer solution (lime requirement reading).

If the soil-water pH is 6.0 or above, no measurement is made with the soil in a buffer (lime requirement). For such soils where a pH greater than 6.0 is desired, limestone may be applied on the basis of the soil-water pH (1:1 soil-water suspension).

LIME AND FERTILIZER RECOMMENDATION RATES

Table 2.—For Grain Crops

Soil Test Results	Recommendations		
	Corn[1]	Small Grain[2]	Soybeans[3]
Acidity (pH)	Limestone, tons/A		
Strongly acid—below 5.3	3-4	3-4	3-4
Moderately acid—5.3-6.0	2-3	2-3	2-3
Slightly acid—6.1-6.7	0-2	0-2	0-2
Near neutral—Above 6.7	none	none	none
Nitrogen Level—from Cropping History, Following:	Nitrogen (N)[4], lb/A		
Corn or sorghum— (low)	100-150	30-60	none
Grass legume or legume sod— (med.)	60-100	0-30	none
Continuous tobacco 4 or more years— (high)	30-60	none	none
Phosphorus—lb of Elemental P/A	Phosphate (P_2O_5), lb/A		
Low—30 lb or less	60-120	80-120	40-80
Medium—31-60 lb	0-60	40-80	0-40
High—above 60 lb	none	none	none
Potassium—lb of Elemental K/A	Potash (K_2O), lb/A		
Low—125 lb or less	60-120	40-80	40-80
Medium—126-200 lb	0-60	0-40	0-40
High—above 200 lb	none	none	none

[1] The high fertilizer rates for corn in each category are for corn planted before May 15, with a population of at least 15,000 stalks per acre. Increase the nitrogen applications 30 lb/A and K_2O 60 lb/A when corn follows a corn crop that was harvested for silage. If more than 40 lb nitrogen plus potash is used at the row, the fertilizer should be placed 2 inches to the side and 2 inches below the seed.

[2] For small grain apply half of the nitrogen at planting time and half in late February or before March 10. If all the nitrogen is applied in the fall, increase the rate by 15 to 20 pounds per acre. Total nitrogen applications may be increased 30 lb/A when the stiffer straw introduction varieties of wheat are grown, because those varieties will stand higher rates without lodging.

[3] Nitrogen applications are not recommended when soybeans are properly inoculated.

[4] Because of possible leaching losses in Kentucky, nitrogen should not be applied in the fall on fallow land for crops to be planted the following spring.

Table 3.—For Tobacco

(Because of the chlorine in manure, applications of manure should not be greater than 10 tons per acre.)

Soil Test Results	Recommendations Burley	Dark
Acidity (pH)	Limestone, tons/A[1]	
Strongly acid—below 5.3	2-3	2-3
Moderately acid—5.3-6.0	1-2	1-2
Slightly acid—6.1-6.7	none	none
Near neutral—Above 6.7	none	none
Nitrogen Level	Nitrogen (N), lb/A[2]	
from Cropping History, Following		
Grass sod— (low)	125-150	150-200
Grass-legume or legume sod— (med.)	75-100	100-150
Continuous tobacco 4 or more years— (high)	50-75	50-100
Phosphorus—lb of Elemental P/A	Phosphate (P_2O_5), lb/A	
Low—30 lb or less	200-300	150-200
Medium—31-60 lb	100-200	100-150
High—Above 60 lb	0-100	50-100
Potassium—lb of Elemental K/A	Potash (K_2O), lb/A[3]	
Low—125 lb or less	225-300 S	75-150 S
Medium—126-200 lb	175-225 S	0-75 S
High—Above 200 lb	125-175 S	0

[1] Limestone should be applied in the fall just after tobacco is harvested. If ground limestone is applied on strongly acid soils in the spring, half of it should be plowed in; the other half disked in after plowing.

[2] Excessive rates of N should be avoided.

[3] Potash should be in the sulfate form. Apply an additional 100 pounds of potash per acre on dark tobacco for "cutting."

Because of the chlorine in manure, applications of manure should not exceed 10 tons per acre.

Table 4.—For Hay and Pasture Seedings

	Alfalfa-Grass[1]	Clover-Grass[1]	Grass
Acidity (pH)	Limestone, tons/A		
Strongly acid—below 5.3	4-5	3-4	3-4
Moderately acid—5.3-6.0	3-4	2-3	2-3
Slightly acid—6.1-6.7	2-3	0-2	0-2
Near neutral—above 6.7	none	none	none
Nitrogen Level from Cropping History, Following:	Nitrogen (N), lb/A		
Corn and sorghum— (low)	25-40	25-40	25-40
Grass-legume or legume sod— (med.)	0-25	0-25	0-25
Continuous tobacco 4 or more years (high)	none	none	none
Phosphorus lb of Elemental P/A	Phosphate (P_2O_5), lb/A		
Low—30 lb or less	100-160	80-120	80-120
Medium—31-60 lb	60-100	40-80	40-80
High—above 60 lb	none	none	none
Potassium lb of Elemental K/A	Potash (K_2O), lb/A		
Low—125 lb or less	100-160	80-120	40-80
Medium—126-200 lb	60-100	40-80	20-40
High—above 200 lb	none	none	none

[1] Apply 1½ to 2 pounds of elemental boron per acre at seeding time either in a borated fertilizer or as a fertilizer borate on all alfalfa fields and on clover fields for seed production.

Table 5.—For Legume-Grass or Grass Annual Topdressing (P_2O_5)

Soil Test Results		Recommended P_2O_5 lb/A	
		Low P Supplying Soils	High P Supplying Soils[1]
		Legume-grass hay—3 tons/A yield goal	
Low—	30 lb or less[2]	30 to 60[3]	0 to 40[3]
Medium—	31 to 60 lb	0 to 30[3]	0 [3]
High—	61 to 90 lb	0 [3]	0
		Legume-grass pastures—2 tons/A yield goal	
Low—	30 lb or less[2]	20 to 40[3]	0 to 20[3]
Medium—	31 to 60 lb	0 to 20[3]	0 [3]
High—	61 to 90 lb	0 [3]	0
		Grass pasture—2 tons/A yield goal	
Low—	30 lb or less[2]	20 to 40	0
Medium—	31 to 60 lb	0 to 20	0
High—	61 to 90 lb	0	0

[1] See page 13 for discussion of phosphorus supplying capabilities of soils.

[2] Low test levels not generally encountered in high phosphorus supplying soils.

[3] For each additional ton in yield goal for hay or pasture, increase the P_2O_5 application 30 lb/A on low phosphorus supplying soils and 20/A on high phosphorus supplying soils. Yield goals above 3 tons per acre usually will involve alfalfa.

Table 6.—For Legume-Grass or Grass Annual Topdressing (K_2O)

Soil Test Results		Recommended K_2O lb/A: Low K Supplying Soils	Recommended K_2O lb/A: High K Supplying Soils[1]
		Legume-grass hay—3 tons/A yield goal	
Low—	125 lb or less[2]	60 to 100[3]	0 to 60[3]
Medium—	126 to 200 lb	30 to 60[3]	0 [3]
High—	201 to 300 lb[4]	0 to 30[3]	0
		Legume-grass pastures—2 tons/A yield goal	
Low—	125 lb or less[2]	30 to 60[3]	0 to 30[3]
Medium—	126 to 200 lb	0 to 30[3]	0
High—	200 to 300 lb[4]	0 [3]	0
		Grass pasture—2 tons/A yield goal	
Low—	125 lb or less[2]	20 to 40[5]	0 to 30[5]
Medium—	126 to 200 lb	0 to 20[5]	0 [5]
High—	200 to 300 lb	0 [5]	0

[1] See page 13 for discussion of potassium supplying capability of soils.

[2] Low test level is not generally encountered in high potassium supplying soils.

[3] For each additional one ton yield goal, increase K_2O application 40 lb/A on low potassium supplying soils and 30 lb/A on high potassium supplying soils. Yield goals above 3 tons per acre usually involve alfalfa.

[4] Should be retested during the fall of the succeeding year.

[5] For each additional one ton yield goal, increase K_2O application 30 lb/A on low potassium supplying soils and 20 lb/A on high potassium supplying soils.

Nitrogen Topdressing—Legumes and Grass

Grass-Legume Mixture

Nitrogen is not recommended on established stands of grass-legume mixtures where the stand consists of 25 percent or more legumes. When the legume stand is less than 25 percent, the field should be renovated or nitrogen fertilizer should be applied at the rates recommended below.

Grass with Little or no Legume

Up to 200 pounds of actual nitrogen can be applied annually. The rate is dependent on the need, utilization, management, and yield potential of the soil. Rates greater than 60 pounds per acre annually should be applied in 2 or 3 applications. When the nitrogen is applied in one application, it should be put on in March. March and late July are the most desirable times if you make two applications. March, May, and late July or early August are preferred times of applications when forage production is the primary goal and three applications of nitrogen are needed.

BORON RECOMMENDATION

Apply 1½ to 2 pounds of elemental boron per acre annually either in a borated fertilizer or as a fertilizer borate on all alfalfa fields and on clover fields that are used for seed production.

GRASS SEED PRODUCTION ON ESTABLISHED SOD

(See Kentucky Leaflet 246A, *"Grass Seed Production,"* for further information on managing grass fields for seed production.)

Nitrogen

Bluegrass for seed

Two applications of nitrogen are recommended: 30 to 40 pounds of nitrogen per acre between November 15 and December 15 and an additional 30 to 40 pounds per acre between February 15 and March 15. If all the nitrogen is applied in one application, do not apply more than 65 pounds per acre during the November-December period or more than 45 pounds per acre in the February-March period. Excessive rates may causing lodging.

Fescue for seed

Depending on stand and previous recent nitrogen fertilization, apply 45 to 70 pounds of nitrogen per acre between November 15 and December 15.

Orchard grass for seed

Depending on stand and previous recent nitrogen fertilization, apply 45 to 70 pounds of nitrogen per acre during the period of February 15 to March 15. Late application will encourage vegetative growth and result in lower seed production.

Timothy for seed

Depending on stand and previous recent nitrogen fertilization, apply 40 to 60 pounds of nitrogen per acre during the period of February 15 to March 15.

Phosphate and Potash

Fields testing low or medium in phosphorus and potassium should be treated with these fertilizers at rates recommended in the soil test category for grass.

CONVERSION FACTORS

Soil tests made in laboratories under supervision of the Agricultural Experiment Station show available phosphorus and potassium as elemental forms. However, fertilizer recommendations are now and will continue to be made in terms of P_2O_5 (phosphoric acid equivalent) and K_2O (potash) as long as fertilizers are guaranteed in these terms.

Actual pounds of elemental P and K can be computed from the oxides (and *vice versa*) by multiplying by the following factors.

From	*To*	*Factor*
P_2O_5	P	0.44
P	P_2O_5	2.29
K_2O	K	0.83
K	K_2O	1.20

FERTILIZER AND LIME APPLICATIONS

Time of application

Lime, phosphate, and potash can be applied any time of the year without loss from leaching. However, there might be some loss if the materials are applied on steep, bare land where heavy rain can cause rapid runoff or soil erosion that will carry some of the materials with it.

Lime, phosphate, and potash can be topdressed on hay and pasture fields after any harvest during the year or before growth starts in the spring. These materials can be applied on row crop land immediately after harvest or on sod land in the fall or winter for any crop that is to be planted in the spring.

Nitrogen should be applied at or near planting time on row crops and hay and pasture crops. It should be applied on grass fields near the time growth response is expected. (See Leaflet 246, *Grass Seed Production,* for more information on fertilization for seed production.)

Placement

Crop growth response can be expected from topdressing lime, phosphate, potash, and nitrogen on sod crops. However, since the first three materials move slowly in the soil, it is better that they be applied before tillage and worked into the soil if the field is to be tilled. They should be applied before disking for renovation.

Lime, phosphate and potash should be plowed down or disked in ahead of planting row crops if conventional tillage is practiced. Research indicates that good response to lime, phosphate, and potash can be expected, however, when these materials are broadcast and left on the surface when row crops are planted in sod.

Nitrogen moves freely in the soil and in the direction of water movement. The placement of nitrogen fertilizer depends on the kind of material used, whether it is applied on bare or sod land, and the temperature at the time of application.

Anhydrous ammonia (see Cir. 519, *"Use of Anhydrous Ammonia as a Nitrogen Fertilizer"*) should be placed below the surface and sealed in the soil to prevent loss through the escape of gaseous ammonia. Pelleted urea should be worked into the soil to prevent loss due to volatilization if it is applied during warm, sunny weather.

On bare land there may be some loss of nitrogen due to volatilization from any kind of nitrogen fertilizer when it is left on the surface during warm, sunny weather. However, the loss is insignificant except from pelleted urea.

On sod land the volatilization losses from surface applications of nitrogen solutions with urea and pelleted urea are substantial if the application is made during warm, sunny weather. Losses from other sources of nitrogen applied on sod land are insignificant.

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