



Soil acidity and aglime

SUMMARY

- Soil pH indicates the acidic level of a soil. A pH less than 7.0 indicates an acid soil.
- Soil acidification is a natural process that is increased by normal production practices, particularly the use of nitrogen fertilizer and manure.
- High levels of soil acidity (low soil pH) can reduce root growth, reduce nutrient availability, affect crop protectant activity.
- For most agronomic crops the soil pH should be between 6.0 and 7.0.
- A soil test determines the soil pH which indicates whether liming is required.
- The soil test also gives the exchangeable acidity of the soil. This along with optimal pH for crop growth, determines how much limestone is required to neutralize the acidity.
- Most aglime materials are calcium and/or magnesium carbonates. Burnt lime, hydrated lime, and some by-product materials are also used. Calcium sulfate (gypsum) and magnesium sulfate (Epsom salts) are not liming materials.
- Lime quality is based upon the neutralizing ability as determined by its calcium carbonate equivalent (CCE) and by the speed of reaction as determined by its fineness. Calcium and magnesium content and moisture level are also important.
- Lime quality information is required by Pennsylvania law to be on the label of all aglime materials.
- Soil test lime recommendations are usually given as an amount of CCE per acre. The actual amount of material required to meet the recommendation will vary depending on actual CCE, moisture content, and depth of incorporation.
- Actual cost of liming materials is compared on the basis of an equal amount of CCE.
- Liming materials should be mixed with the soil where possible.
- Even finely ground liming materials require several months to react. Apply aglime well in advance of acid-sensitive crops to allow time for it to neutralize soil acidity.

Soil acidity is among the important environmental factors which can influence plant growth, and can seriously limit crop production. Therefore, liming acid soils is basic to good soil and crop management. A sound liming program will increase soil productivity and, possibly more important under current conditions, increase efficiency of other crop production inputs such as fertilizers and crop protectants.

DEFINITION AND CAUSES OF SOIL ACIDITY

Acid soils are defined as any soil that has a pH of less than 7.0 (neutral). Acidity is due to hydrogen (H^+) ion concentrations in the soil. The higher the H^+ concentration, the lower the pH. It is also important to note that a one-unit change in pH equals a ten-fold change in acidity, therefore, small changes in pH can dramatically effect the lime requirement of that soil. Soil acidity is comprised of two components: active acidity and exchangeable (reserve) acidity. Active acidity is the concentration of H^+ ion in the solution phase of the soil and is measured by pH but is not a measure of the total soil acidity. The soil pH is a general indicator of whether aglime is needed to reduce the acidity. The exchangeable acidity refers to the amount of H^+ ions on cation exchange sites of negatively charged clay and organic matter fractions of the soil. Soil exchangeable acidity determines the amount of aglime necessary to increase the soil pH. Therefore, soil test reports show both soil pH and exchangeable acidity and a lime recommendation based on this total acidity, as well as other factors.

Initially, each type of soil has a certain level of acidity depending upon its composition, native vegetation, and rainfall amounts, however, various factors over time cause changes in soil pH. Leaching, erosion, and crop uptake of basic cations (calcium, Ca^{2+} ; magnesium, Mg^{2+} ; potassium, K^+), decay of plant residues, and plant root exudates are all means by which the soil acidity is increased. However, a common source of acidity comes from H^+ ions that are released when high levels of aluminum (Al^{3+}) in the soil react with water molecules. Acid residuals also occur from certain fertilizers.

Nitrogen sources that supply ammonium or react in the soil to produce ammonium nitrogen (e.g., ammonium nitrate, urea fertilizers, and animal manures) form acid and tend to increase soil acidity. With these reactions occurring, it is necessary to neutralize the acidity by adding lime to

the soil. The approximate pounds of calcium carbonate (CaCO₃) needed to *neutralize* the acidifying effects of one pound of nitrogen are as follows:

3 pounds for ammonium nitrate (NH₄NO₃), urea (NH₂-CO-NH₂), nitrogen solutions/UAN (urea+NH₄NO₃+water), and anhydrous ammonium (NH₃)

5.3 pounds for diammonium phosphate (DAP), [(NH₄)₂HPO₄]

7 pounds for ammonium sulfate [(NH₄)₂SO₄], monoammonium phosphate (MAP), [NH₄H₂PO₄], and ammonium polyphosphate (APP)

EFFECTS OF SOIL ACIDITY ON CROP PRODUCTION

For most agronomic crops, a soil pH of 6.0 to 7.0 is ideal for crop growth, however, the pH tolerance range for various crop species can vary (Figure 1). For example, legumes, as a group, and barley respond better to a pH range between 6.5 and 7.0, whereas oats can tolerate a pH of 5.5.

However, liming soil to maintain an optimal pH improves crop production in the long run. For example, perennial legumes will respond with higher yields and stand longevity. Other management factors also need to be considered, such as soil pH effects on herbicides. Soil pH below 6.0 causes reduced activity of triazine herbicides, whereas a pH greater than 7.0 can cause carryover problems with other types of herbicides. Although liming provides some plant-nutrient value (Ca²⁺ or Mg²⁺), its greatest benefit to plant growth is by counteracting the negative effects of soil acidity which can cause several of the following problems.

Soluble metal toxicity

As the pH decreases below 5.5, the availability of aluminum and manganese (Mn) increase and may reach a point of toxicity to the plant. Excess Al³⁺ in the soil solution interferes with root growth and function, as well as restricting plant uptake of certain nutrients, namely, Ca²⁺ and Mg²⁺. Liming acid soils reduces the activity of Al and Mn.

Figure 1. Favorable pH ranges for common crops.

Crop	Soil pH				
	5.0	5.5	6.0	6.5	7.0
Corn					
Alfalfa					
Soybeans					
Wheat					
Oats					
Barley					
Red clover					
Grasses					

Effect on phosphorus availability

Acid soils causes P to form insoluble compounds with aluminum and iron. Liming soils with low pH “dissolves” these insoluble compounds and allows P to be more available for plant uptake. However, liming soil to points beyond 7.0 causes P to form complexes with Ca or Mg, therefore, it’s best to maintain the soil pH between 5.5 and 6.8 to curb these problems (see Figure 2).

Micronutrient availability

The availability of micronutrients increases as soil pH decreases, except for molybdenum. Since micronutrients are needed by the plants in only minute quantities, plant toxicity in addition to other detrimental effects occur with excess amounts. Refer to Figure 2 for relationship between pH and nutrient availability.

Soil organisms

Microorganisms associated with nitrification (conversion of NH₄⁺ to NO₃⁻), require a certain soil pH range to function efficiently. Since these organisms require large amounts of Ca to perform the conversion, a pH of 5.5 to 6.5 is necessary for Ca to be available. Also, the activity of bacteria (*Rhizobia* species) which are responsible for nitrogen fixation in legume crops decreases when the pH drops below 6.0. In addition to less N being produced by organisms for crop utilization, microbes responsible for the breakdown of crop residues and soil organic matter are also affected by acid soils. Other microorganisms vary in their tolerance to soil pH.

Soil physical condition

Liming fine-textured soils improves the structure, and that has several positive attributes including reduced soil crusting, better emergence of small-seeded crops, and less power required for tillage operations.

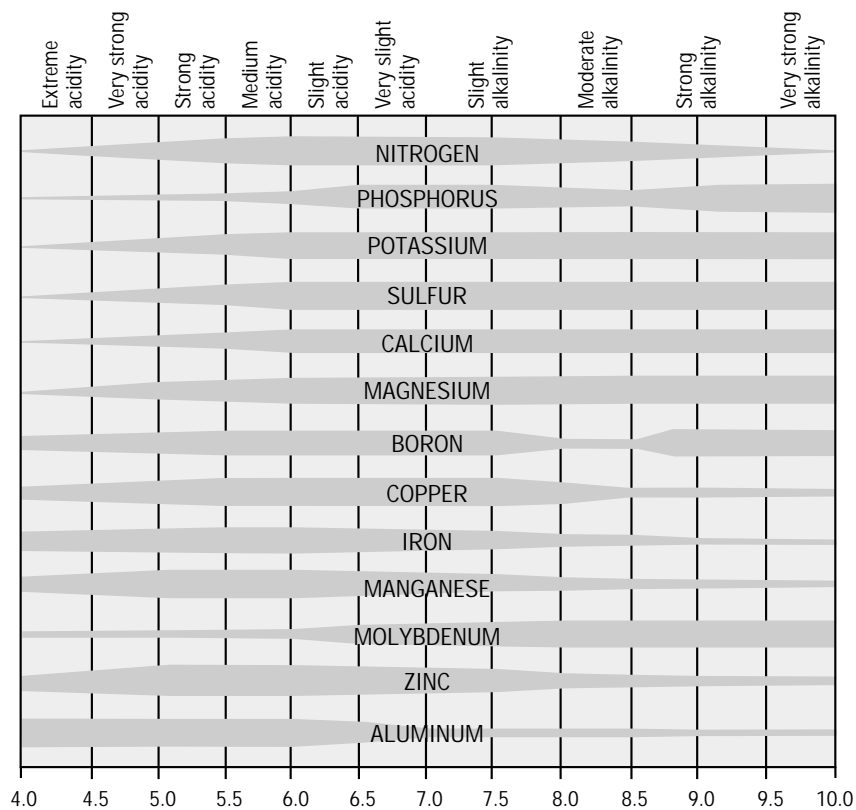
Disease

Soil acidity can have an influence on certain plant pathogens (disease-causing organisms). However, pathogens vary in their tolerance to soil acidity, so no soil pH range can be recommended. Therefore, proper identification of the problem is necessary before any management tactic is utilized.

SOIL SAMPLING

A soil test performed by a reliable laboratory provides a good estimate of the fertility status of a field. Proper soil sampling is an important first step in the testing process and should be done according to the directions with the sampling kit. Sampling techniques differ, however, for no-till situations. If the area has been in no-till corn management for two years or more, it is advisable to measure the pH of the soil surface. Since surface applications of nitrogen fertilizers and manure may acidify the upper soil layer, decreasing herbicide effectiveness and other chemical reactions, an analysis of acidity within the upper two inches of soil is necessary. Collect several representative cores less than two inches deep from the no-till area and

Figure 2. How soil pH affects availability of plant nutrients and aluminum.



mix thoroughly in a clean bucket. Remove a sample and measure the acidity with a simple accurate colorimetric field pH kit. If the pH of the surface soil is less than 6.2, take a standard soil sample for laboratory analysis. If the standard sample does not indicate a need for limestone and the surface pH is below 6.2, apply 2,000 pounds of calcium carbonate equivalent material. This amount of aglime should be adequate to neutralize the surface acidity.

AGLIME

A good liming program is based on a soil test that determines the degree of soil acidity and the correct amount of a liming material needed to neutralize that acidity. Once this amount is determined, a liming material must be selected that will economically satisfy the soil test recommendation and result in maximum, efficient production. However, before considering the necessary lime application amounts, an understanding of aglime materials, quality, and associated laws is helpful.

Aglime materials

Aglime is an agricultural liming material capable of neutralizing soil acidity, i.e., increasing soil pH. Common aglime materials and some of their important chemical properties are given in Table 1. By far the most common aglimes used in Pennsylvania (approximately 99 percent) are ground calcitic and dolomitic limestone. While they do supply essential calcium and magnesium in the process of

Table 1. Common aglime materials.

Material	Chemical formula	% CCE
Pure calcitic limestone	CaCO ₃	100
Dolomitic limestone	(Ca, Mg)CO ₃	109
Calcium oxide; lime, burnt, lump, or unslaked lime, quicklime	CaO	179
Calcium hydroxide; hydrated, slaked, or builders' lime	Ca(OH) ₂	136
Marl and shells	CaCO ₃	70-90
Slag (various)	CaSiO ₃	60-90
Industrial by-products	varies	varies

liming, it is the carbonate, oxide, or hydroxide part of these compounds that neutralizes soil acidity. Materials such as calcium sulfate (gypsum) or magnesium sulfate (Epsom salts) are not liming materials, even though they contain calcium and magnesium, because they are not capable of neutralizing soil acidity.

Aglime quality

Not all limestone is the same. The quality of aglime varies significantly and should be an important consideration in aglime management. Four factors are most important in assessing aglime quality; chemical purity, speed of reaction, magnesium content, and moisture.

1. Chemical purity

The chemical purity of aglime determines the amount of soil acidity the material can neutralize. Chemical purity is indicated by the material's calcium carbonate equivalent (CCE): the amount of soil acidity the material can neutralize compared to pure calcium carbonate (calcitic limestone, CaCO_3). The CCE is given as a percentage: a 100-percent-CCE limestone would be just as effective as pure calcitic limestone in neutralizing value; 90-percent-CCE limestone would be only 90 percent as effective; and a 109-percent-CCE limestone such as a dolomitic limestone would be 109 percent as effective. The calcium carbonate equivalent is given for each of the materials listed in Table 1. Calcium carbonate equivalent indicates only the equivalent neutralizing value of an aglime material; it says nothing about the actual calcium carbonate content of the material. For example, note that pure calcium hydroxide (hydrated or slaked lime) has a CCE of 136 percent but contains no calcium carbonate.

The CCE value of a limestone is obtained directly by dissolving a sample of the material in an acid. However, aglime analysis is often reported in different ways, such as calcium oxide (CaO) and magnesium oxide (MgO) or as calcium carbonate (CaCO_3) and magnesium carbonate (MgCO_3). You can easily calculate the CCE value of an aglime material reported in these ways by using the conversion factors listed in Table 2. Convert the analyses to calcium carbonate and then add them up.

Table 2. Conversion factors for liming materials.

$\text{Ca} \times 2.50 = \text{CaCO}_3$
$\text{Mg} \times 4.17 = \text{CaCO}_3$
$\text{CaO} \times 1.79 = \text{CaCO}_3$
$\text{MgO} \times 2.50 = \text{CaCO}_3$
$\text{MgCO}_3 \times 1.19 = \text{CaCO}_3$
$\text{Ca(OH)}_2 \times 1.36 = \text{CaCO}_3$

Example:

$\text{Ca } 35\% \times 2.50 = 87.50\%$
$\text{Mg } 2\% \times 4.17 = 8.34\%$
CCE = 95.84%

Liming materials containing less than 50 percent CCE are mostly of components that do not contribute to the neutralizing capabilities of the material. As compared to an aglime with a higher percentage CCE value, larger amounts would be necessary to reduce soil acidity. The chemical purity of a limestone depends on the geologic formation where the material is quarried or mined and can vary considerably from quarry to quarry or even within a single quarry. This variation is a problem that producers must face in guaranteeing aglime quality.

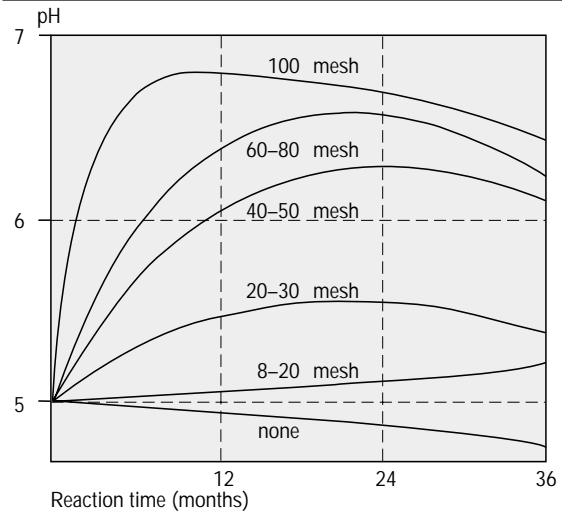
2. Speed of reaction

The speed with which an aglime material reacts with the soil to neutralize acidity and thus increases soil pH is determined by the fineness of the material. The finer the material, the faster it will react because limestone's solubility increases as it is ground finer. Also, limestone affects only a very small volume of soil around each particle, so the finer the material, the greater the total surface area that is available to come into contact with the soil and neutralize it (assuming adequate soil mixing). Aglime should react with the soil as quickly as possible. Generally, aglime should react completely within three years. Quicker reaction may be desirable on rented ground or for shorter-season annual crops.

Aglime fineness is given as the percentage of the material that passes through sieves of specified mesh. Sieve mesh is the number of wires per inch on the sieve. The higher the number, the finer the material that will pass through.

Aglime larger than 20 mesh (about the fineness of table salt/sugar) reacts extremely slowly; little will react within two to three years. The speed of reaction increases to a practical maximum with 100-mesh material. The effect of aglime fineness on speed of reaction is shown clearly in Figure 3.

Figure 3. Effect of aglime fineness on speed of reaction.



In each case illustrated in Figure 3, sufficient aglime was applied to neutralize the soil acidity to raise the soil pH to 7.0. However, only the 100-mesh material came close to achieving that goal. Therefore, it would seem desirable to use only 100-mesh or smaller aglime. However, this decision must be balanced against the high cost of grinding limestone to finer than 100 mesh. A compromise must be reached so that the material is fine enough to be effective agronomically but still economical. A material with at least 95 percent passing through a 20-mesh sieve, 60 percent passing through a 60-mesh sieve, and 50 percent passing through a 100-mesh sieve is generally adequate. Spending extra for a finer-sized liming material would only be

recommended in emergency situations where very rapid reaction is required.

3. Calcium and magnesium content

In addition to acid neutralization capabilities, lime also serves as a source of calcium and magnesium. The magnesium content of aglime is important when a soil test indicates a need for magnesium. Magnesium requirements are met most economically by applying an aglime material that contains magnesium.

The magnesium content of aglime varies considerably. Unfortunately, there is no official trade classification of limestone according to its magnesium content. Local classification schemes often create confusion. Therefore, to select the proper aglime material, you should use the actual magnesium analysis rather than a name (e.g., dolomitic lime, high-magnesium lime).

Magnesium soil-test recommendations are usually given in one of the three different ways: as pounds of Mg per acre, or as pounds of MgO per acre, or as pounds of calcium carbonate equivalent per acre with a specific Mg or MgO content. Liming materials must be labeled to indicate their percentage of Mg; however, additional information on percentage of MgO may also appear. When the recommendation and label are in different forms, a simple conversion is required. To convert Mg into MgO, multiply by 1.67; but to convert MgO into Mg, multiply by 0.602.

4. Moisture

The moisture content of an aglime does not directly affect its effectiveness. However, since lime is sold and applied by weight, including water weight, a high moisture content means less actual liming material per ton. When moisture content approaches 10 percent or more, the application rate of aglime per acre should be adjusted to ensure that the required amount of actual liming material is applied to the soil. Use the following formula to make the adjustment or refer to the example calculations section:

$$\frac{\text{soil test recommendation (CCE/A)}}{100 - \% \text{ moisture}} \times 100$$

THE PENNSYLVANIA LIME LAW

The quality of aglime sold in Pennsylvania is regulated by the state law, Agricultural Liming Materials Rules and Regulations. Since aglime quality cannot be determined by visual inspection, these regulations help to assure farmers (consumers) that they are getting what they pay for. Recently, state lime regulations were changed to keep requirements consistent with laws throughout the northeastern region of the United States. These new labeling requirements will be in full effect by September 1995. The following information is a summary of the new Agricultural Liming Materials Rules and Regulations.

1. Types

Aglime materials must be labeled according to their type (e.g., limestone, hydrated lime, burnt lime, industrial by-products or marl and shells).

2. Elemental calcium and magnesium

Aglime materials must be labeled as to the Total Calcium (Ca) and Total Magnesium (Mg) percentage by weight contained in the product. Oxide and carbonate guarantees may be stated following the elemental guarantee.

3. Fineness

The label must state the classification (fine-sized, medium-sized or coarse-sized materials) of the product and the minimum percentages by weight passing through the US standard 20-, 60-, and 100-mesh sieve. The classification must meet the minimum standards outlined by regulation. (certain special limestone materials for lawn and garden have different quality standards). The following outlines the three groups based on fineness for agronomic liming materials:

Fine-sized materials

- 95% through a 20-mesh sieve
- 60% through a 60-mesh sieve
- 50% through a 100-mesh sieve

Medium-sized materials

- 90% through a 20-mesh sieve
- 50% through a 60-mesh sieve
- 30% through a 100-mesh sieve

Coarse-sized materials

- All liming materials that fail to meet one of the above minimums for fineness.

4. CCE

The label must state the minimum CCE value of the aglime material.

5. Effective neutralizing value (ENV)

The label must state the minimum ENV of the aglime material. [The ENV is a relative value that expresses soil acidity neutralizing capabilities of a liming material and is determined by using the calcium and magnesium oxide content and fineness. ENV is not utilized in Pennsylvania, but it is used by some other states of the region. The term is similar to "effective neutralizing power" (ENP)].

6. Moisture

The label must state the maximum moisture content by weight of the material. A tolerance of 10 percent of the guarantee is set for moisture greater than what is stated on the label.

7. Dry-weight analysis

The guarantees for elemental Ca and Mg, CCE, and ENV must appear on the label under the heading: "Guaranteed Dry Weight Analysis." If oxides and carbonates are guaranteed they should follow the elemental guarantee.

8. Tolerances

A tolerance of 2 percent of the guarantee is allowed for the guaranteed minimum CCE value and minimum fineness value. All other guarantees are allowed a 10-percent tolerance range.

SOIL TEST AGLIME RECOMMENDATIONS

Liming an acid soil to an optimal range is the initial step in creating favorable soil conditions for productive plant growth. The lime recommendation on the soil test report is based on the amount of exchangeable acidity (or exchangeable H⁺) measured by the lime requirement soil test and the optimum soil pH for the crop. For a desired pH of 7.0, the lime requirement can be estimated as follows:

$$\text{Lime requirement} = \text{exchangeable acidity} \times 1,000$$

For a desired pH 6.5, the lime requirement is estimated as follows:

If the exchangeable acidity is greater than 4.0, then:

$$\text{Lime requirement} = \text{exchangeable acidity} \times 840$$

If the exchangeable acidity is less than 4.0 and the soil pH is still less than 6.5, then:

$$\text{Lime requirement} = 2,000 \text{ lb/A}$$

Otherwise, no lime is required.

Soil test recommendations should take into account that aglime quality varies significantly. Most soil test recommendations for aglime are based on 100 percent calcium carbonate equivalent acid neutralizing ability, as well as based on liming an acre-furrow slice approximately seven inches deep. The Penn State aglime recommendations are given as pounds of calcium carbonate equivalent per acre. Thus, you must adjust the recommendation when using an aglime material with a CCE different from 100 percent CCE. The following formula is used to calculate the adjusted amount of an aglime material needed to meet the soil test recommendation:

$$\frac{\text{soil test limestone recommendation} \times 100}{\text{CCE of aglime to be used}}$$

Refer to the example calculations section for a detailed example.

This adjusted recommendation can be calculated from this formula or read directly from Table 3. The Agricultural Analytical Services Laboratory at Penn State includes a copy of this formula and table as part of the recommendations with each soil test

The soil test recommendation assumes that the agliming material meets the minimum standard requirements for fine-sized liming materials specified in the lime law.

If the aglime material will be incorporated with a large volume of soil (i.e., if the plow depth is more than nine inches), the recommendation is adjusted according to the following formula:

$$\frac{\text{Actual plow depth (inches)}}{7} \times \text{Basic requirement lime} = \text{Adjusted lime requirement}$$

or one can use the guidelines that follow:

Plow depth	Adjusted aglime requirement
Less than 9 inches	No adjustment
9 to 11 inches	Basic requirement x 1.5
More than 12 inches	Basic requirement x 1.8

EXAMPLE CALCULATIONS FOR ADJUSTING AGLIME MATERIALS

• Soil test recommendation:

Limestone — apply 6,000 pounds of calcium carbonate equivalent per acre.

• Information known:

Calcium carbonate equivalent of aglime material = 90%

Moisture content of aglime material = 15%

Incorporate to 10 inches

• Adjusting material to recommended percentage of CCE example:

$$\frac{\text{Soil test limestone recommendation} \times 100}{\text{CCE of aglime to be used}}$$

$$\frac{6,000 \times 100}{90} = 6,667 \text{ or } 6,700 \text{ lb/A of liming material needed}$$

• Moisture adjustment example:

$$\frac{\text{Soil test recommendation (CCE/A) or adjusted material to recommended \%CCE} \times 100}{100 - \% \text{ moisture}}$$

$$\frac{6,700 \times 100}{100 - 15} = 7,882 \text{ or } 7,900 \text{ lb/A of liming material needed}$$

• Adjusting for incorporation with large soil volume example:

$$\frac{\text{Actual plow depth (inches)}}{7} \times \text{Basic lime requirement} = \text{Adjusted lime requirement}$$

$$\frac{10 \times 7,900}{7} = 11,286 \text{ or } 11,300 \text{ lb/A of liming material needed}$$

In this example, after all the adjustments were made, a total of 11,300 pounds per acre would be necessary to neutralize the soil acidity. Since the requirement is a large quantity, it would be best to use split-applications at two different time periods approximately six months apart or by tillage operations. Smaller, more frequent applications are suitable for no-till situations. Notice that by incorporating the lime to depth greater than seven inches causes an increase of over 1 1/2-times the original lime requirement. Therefore, be sure that your plow depth is accurate and that overapplication of aglime will not occur.

Table 3. Liming material conversion.

Find your soil test limestone recommendation in the left-hand column and then read across the table on that line until you come to the column headed by the percentage CCE nearest to that of your liming material. The number at that point is the pounds of liming material required to meet the limestone recommendation on your soil test.

Because there is generally little advantage in applying more than 8,000 pounds of CCE per acre in any one application to agricultural land, this table is divided into three sections suggesting how the total liming material required can be split for more efficient use. Separate the applications by six months or at least by tillage operations (see the right-hand column). In no-till, the recommended aglime can be applied in smaller, more frequent applications.

Actual lb/A calcium carbonate equivalent recommended on your soil test	PERCENTAGE CALCIUM CARBONATE EQUIVALENT (% CCE) OF YOUR LIMING MATERIAL												Divide total into the following number of applications
	50	55	60	65	70	75	80	85	90	95	100	105	
1,000	2,000	1,800	1,700	1,500	1,400	1,300	1,200	1,200	1,100	1,100	1,000	1,000	1
2,000	4,000	3,600	3,300	3,100	2,900	2,700	2,500	2,400	2,200	2,100	2,000	1,900	
3,000	6,000	5,500	5,000	4,600	4,300	4,000	3,700	3,500	3,300	3,200	3,000	2,900	
4,000	8,000	7,300	6,700	6,200	5,700	5,300	5,000	4,700	4,400	4,200	4,000	3,800	
5,000	10,000	9,100	8,300	7,700	7,100	6,700	6,200	5,900	5,600	5,300	5,000	4,800	
6,000	12,000	10,900	10,000	9,200	8,600	8,000	7,500	7,100	6,700	6,300	6,000	5,700	
7,000	14,000	12,700	11,700	10,800	10,000	9,300	8,700	8,200	7,800	7,400	7,000	6,700	
8,000	16,000	14,500	13,300	12,300	11,400	10,700	10,000	9,400	8,900	8,400	8,000	7,600	
9,000	18,000	16,400	15,000	13,800	12,900	12,000	11,200	10,600	10,000	9,500	9,000	8,600	
10,000	20,000	18,200	16,700	15,400	14,300	13,300	12,500	11,800	11,100	10,500	10,000	9,500	
11,000	22,000	20,000	18,300	16,900	15,700	14,700	13,700	12,900	12,200	11,600	11,000	10,500	
12,000	24,000	21,800	20,000	18,500	17,100	16,000	15,000	14,100	13,300	12,600	12,000	11,400	
13,000	26,000	23,600	21,700	20,000	18,600	17,300	16,200	15,300	14,400	13,200	13,000	12,400	
14,000	28,000	25,500	23,300	21,500	20,000	18,700	17,500	16,500	15,600	14,700	14,000	13,300	
15,000	30,000	27,300	25,000	23,100	21,400	20,000	18,700	17,600	16,700	15,800	15,000	14,300	
16,000	32,000	29,100	26,700	24,600	22,900	21,300	20,000	18,800	17,800	16,800	16,000	15,200	
17,000	34,000	30,900	28,300	26,200	24,300	22,700	21,200	20,000	18,900	17,900	17,000	16,200	
18,000	36,000	32,700	30,000	27,700	25,700	24,000	22,500	21,200	20,000	18,900	18,000	17,100	3
19,000	38,000	34,500	31,700	29,200	27,100	25,300	23,700	22,400	21,100	20,000	19,000	18,100	
20,000	40,000	36,400	33,300	30,800	28,600	26,700	25,000	23,500	22,200	21,100	20,000	19,000	

EXAMPLE CALCULATIONS FOR COMPARING AGLIME MATERIALS

To compare aglime materials, convert the materials to “per ton of CCE” and then compare the total cost per ton of CCE. Keep in mind that the material must meet the mini-

imum fineness requirements. As long as these minimums are met, fineness would not be a major consideration except in an emergency that requires extremely rapid reaction. Following is an example comparing three liming materials:

	Material A	Material B	Material C
Liming material specifications	CCE: 10% Fineness: 100% through 20 mesh 90% through 60 mesh 80% through 100 mesh Price: \$2/ton	CCE: 75% Fineness: 95% through 20 mesh 70% through 60 mesh 50% through 100 mesh Price: \$12/ton	CCE: 105% Fineness: 95% through 20 mesh 60% through 60 mesh 50% through 100 mesh Price: \$20/ton
Dealers are required by law to supply the above information.			
Calculations Calculate the actual material required per ton of CCE from the formula given in the previous section. The actual material required for products with a CCE between 50 and 105 percent can be read directly from Table 3, “Liming material conversion.” All calculations may be rounded to the nearest 100 pounds. Formula: $\text{Actual material required per ton of CCE} = \frac{2,000 \times 100}{\text{CCE}}$ For each of these materials these calculations are as follows:	$\frac{2,000 \times 100}{10} = \begin{matrix} 20,000 \text{ lbs} \\ \text{actually} \\ \text{required} \\ (10 \text{ tons}) \end{matrix}$	$\frac{2,000 \times 100}{75} = \begin{matrix} 2,700 \text{ lbs} \\ \text{actually} \\ \text{required} \\ (1.35 \text{ tons}) \end{matrix}$	$\frac{2,000 \times 100}{105} = \begin{matrix} 1,900 \text{ lbs} \\ \text{actually} \\ \text{required} \\ (0.95 \text{ tons}) \end{matrix}$
Cost per ton of CCE	$10 \text{ tons} \times \$2/\text{ton} = \$20.00/\text{ton of CCE}$	$1.35 \text{ tons} \times \$12/\text{ton} = \$16.20/\text{ton of CCE}$	$0.95 \text{ tons} \times \$20/\text{ton} = \$19.00/\text{ton of CCE}$

In this example, material B would be the best buy.

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