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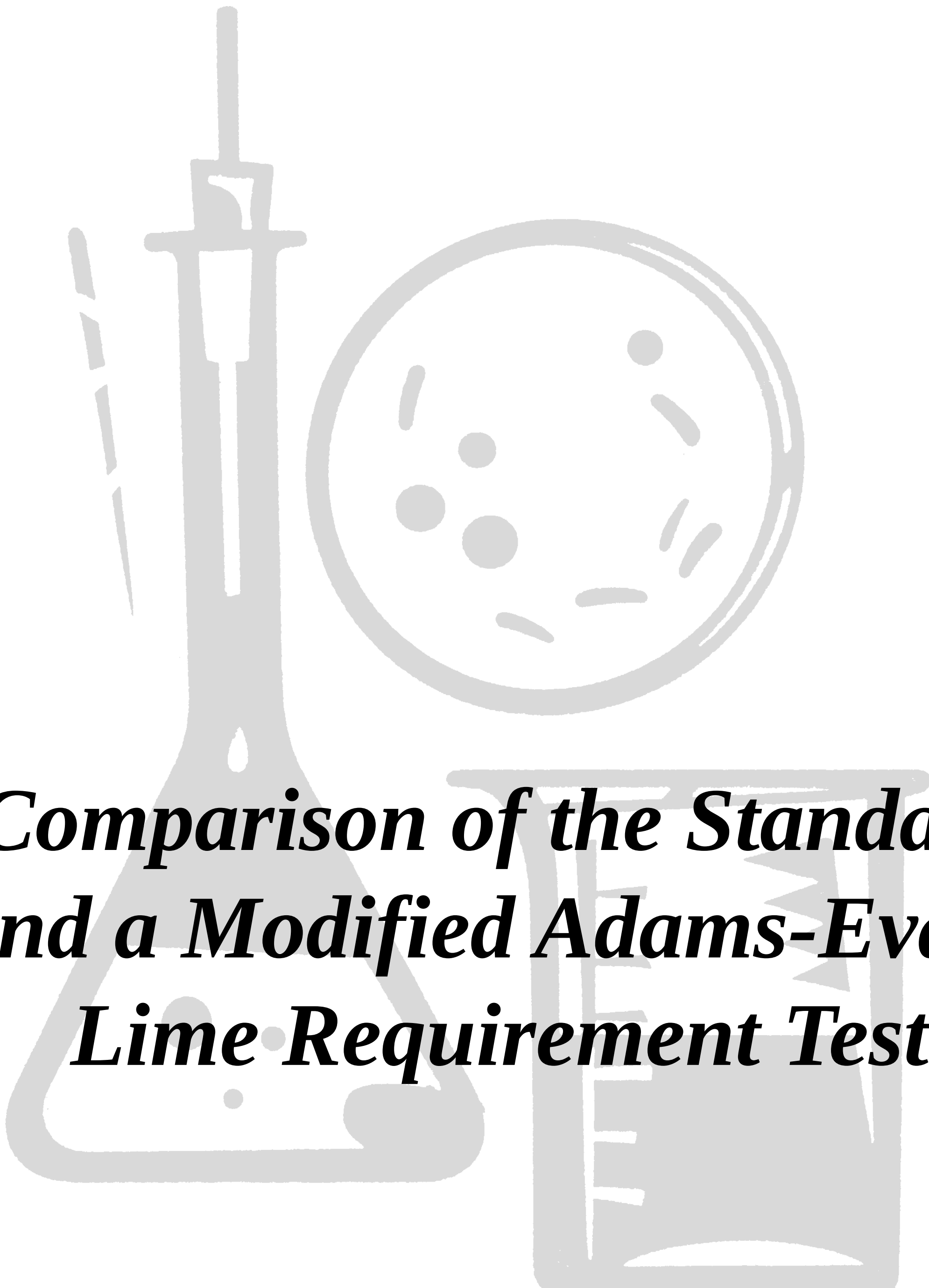

Comparison of the Standard and a Modified Adams-Evans Lime Requirement Test

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INTRODUCTION AND BACKGROUND

The Agricultural Chemical Service Laboratory at Clemson University has used a modification of the Adams-Evans Lime Requirement Test for a number of years. The modified method was believed to underestimate the actual lime requirement but provided a margin of safety against overliming Coastal Plains soils. Overliming tends to induce micronutrient deficiencies in these soils, which are dominated by low activity clays and low organic matter contents. Consequently the soils are poorly buffered and deficiencies of Zn and Mn in corn and soybeans are often encountered when soil pH is raised above 7.

For several reasons, we decided to reexamine the degree to which the modified method underestimates the actual lime requirement as indicated by the standard Adams-Evans method. The primary reasons for this study include:

(1) Soil testing is becoming important for regulatory purposes. For example, the land application rate for lime-stabilized biosolids and sewage sludge is determined by the lime requirement of soil to which the waste will be applied. The bioavailability of several metals is sensitive to soil pH. Maintenance of soil pH in the range of 5.8 to 6.5 minimizes the solubility and therefore bioavailability of most of these elements. Lime requirement of soil at the waste application site determines the *Agronomic Rate* as defined by the South Carolina regulation relating to land application of waste. Therefore, soil testing to determine lime requirement is generally a condition of regulatory permits for land application. Methods which are documented in peer-reviewed journals, and generally accepted by the scientific community, are essential for referencing in regulations and guidance documents.

(2) We believe that the standard procedure provides a more accurate estimate of the amount of lime required to achieve a target soil pH.

(3) The standard Adams-Evans buffer system is used by most other public and private soil testing laboratories within the region.

MATERIALS AND METHODS

One hundred samples submitted to the Agricultural Chemical Service Laboratory for soil testing were selected at random. While no special effort was made to select a population of samples that represented major soils within the state, the samples were clearly diverse. Based on appearance, they included a range of colors and clay content.

Our modified method includes using a 16 ml scoop to approximate 20 g of soil. The soil water pH is determined after addition of 20 ml deionized water. The sample is stirred after water is added and immediately before taking the soil pH reading 1 hour later. Following the soil-water pH determination, 10 ml of the Adams-Evans buffer is added to the soil-water suspension. The mixture is stirred immediately after addition of the buffer and again after 30 minutes, just before taking the buffer pH.

An additional 10 ml of Adams-Evans buffer was added to the sample following the initial buffer pH reading. This approximated the soil:solution:buffer ratio of 20 g soil:20 ml water:20 ml buffer used in the standard method. The second buffer pH was read 30 minutes after addition of the second aliquot of buffer. As with the modified method, the sample was stirred twice after addition of the second 10 ml of buffer, once after addition, and again just before reading the pH.

Lime requirements were estimated by referring to published tables for the modified method (2) or by using the standard equation (3) relating lime requirement to acid saturation at the soil-water pH and a target pH of 6.5.

Because other laboratories use a 20 ml scoop, we measured the weight of soil contained by the 16 ml scope. Another 104-sample set, randomly selected, was used to gather that data.

RESULTS

Lime requirements for the 100-sample set are shown in Figure 1. The lime requirements are those for a target pH of 6.5. The entire data set is presented in Appendix C. Obviously there is a significant correlation (r = 0.97, significant at 0.1 percent probability) between the two methods. However, lime requirement determined by the standard method is about 50 percent greater than that estimated by the modified method.

As expected, the modified method underestimated the lime requirement, but by more than we had expected.

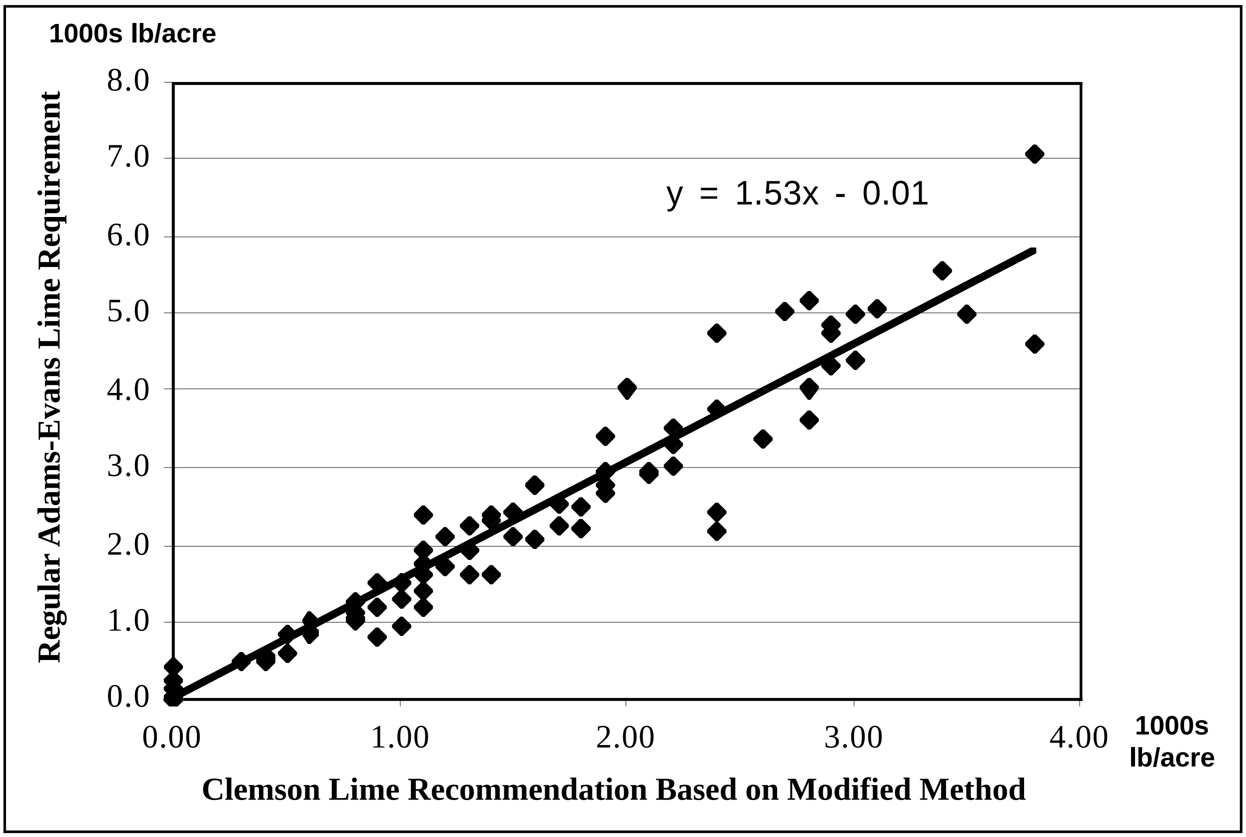

Figure 1. Regular Adams-Evans buffer system versus the Clemson modified Adams-Evans buffer system for 100 soil samples (16 ml each).

Results of the weight determination are plotted in Figure 2. Again, we did not anticipate the degree to which the weight of soil samples deviated from the expected. Conventional wisdom, ours, was that dried, ground soil samples would have a bulk density of about 1.25 g/cm^3 and would weight about 20 g. The average bulk density was actually 1.15 g/cm^3 and the average weight was 16.22 g. (We found the volume of the scoop to be 14.1 ml, not 16 ml.) Although the "true" lime requirement would have exceeded the measured values by 81 percent (16.22/20) by our underestimate of sample weight, the relative comparison between the two methods is still valid since the same sample weight was used for both methods.

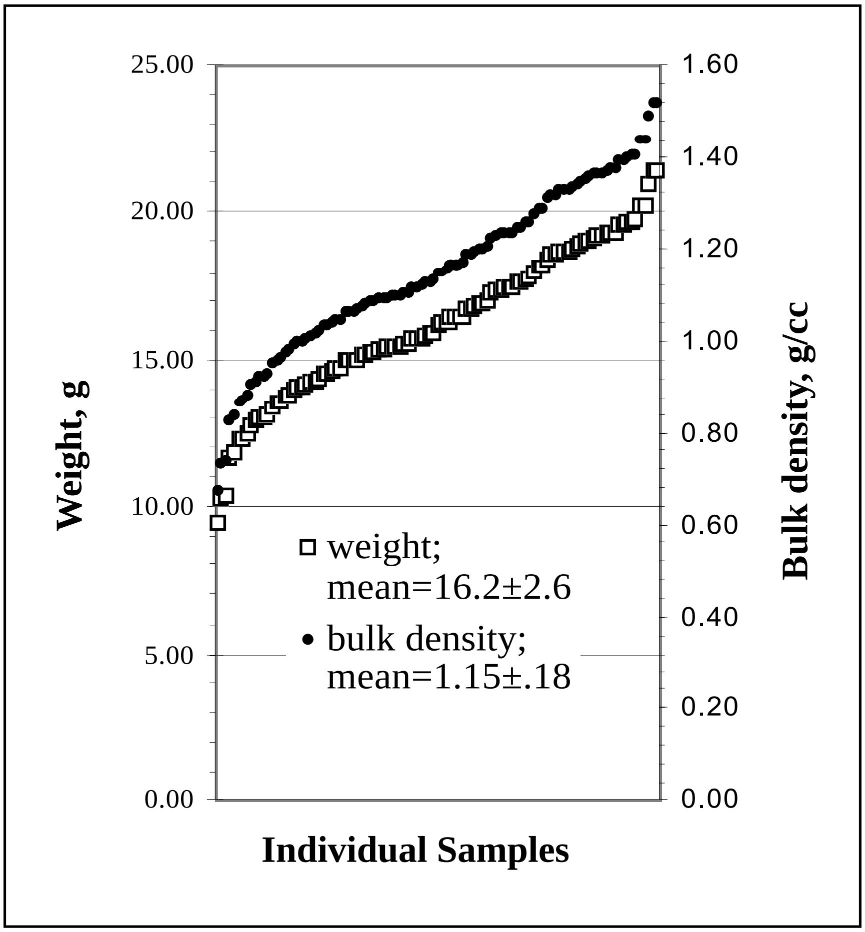

Figure 2. Weight and bulk density of 104 samples measured with a 16 cm^3 scoop.

The net result of these two factors, the difference between the regular and modified method (1.53) and the underestimate of sample weight (16.22 versus 20 grams), result in the current lime requirement being about 53 percent of that which would be estimated by the regular or standard Adams-Evans method.

DISCUSSION

Calculation of Lime Requirement by Standard Method

In this comparison we examined the calculated amount of lime recommended by the standard and modified methods. One component of the Adams-Evans lime requirement method is based on an empirical relationship between soil pH and the fraction of the CEC occupied by acidic cations (1):

$$\text{soil pH} = 7.79 - 5.55\,X + 2.27\,X^2 \qquad [1]$$

where X = the acid saturation (the fraction of the CEC occupied by exchangeable acidic cations). For example, a soil having a CEC of 5 me/100 g with 2 me/100 g of exchangeable acidity has an acid saturation of 40 percent (the base saturation being 60 percent). The acid saturation at the original soil pH (pH in water) and at the target pH (5.5, 6.0, 6.5, etc.) combined with the CEC are used to calculate the amount of the exchangeable acidity that is to be neutralized. The two acid saturation values are determined by solving the quadratic equation [1] for X at the soil-water pH and the target pH. It is important to note that the relationship defined by equation [1] is applicable to soils common to South Carolina and most of the Southeast, which are dominated by kaolinitic and sesquioxidic clay minerals. It is not applicable to soils dominated by other types of clay minerals.

The second component of the Adams-Evans method is the buffer system which measures the amount of exchangeable acidity in the soil. The buffer that Adams and Evans developed exhibits a linear relationship between its change in pH from 8.00 after reaction with the soil and the amount of exchangeable acidity in the soil sample. The buffer, a base, reacts with the exchangeable acidity in the soil. The greater the exchangeable acidity in the soil sample, the more the pH of the buffer decreases from its initial value of 8.00. Each 0.01 change in pH of the buffer is equivalent to 0.008 milliequivalent (me) of exchangeable acidity in a mixture consisting of 10 g soil, 10 ml buffer, and 10 ml water. Most soil testing laboratories use 20 g soil and 20 ml each of the buffer and water, in which case a change in buffer pH of 0.01 is equivalent to 0.016 me of acidity per 20 g soil. The CEC of the soil is calculated from the exchangeable acidity using equation [2]:

$$\text{CEC} = \text{exchangeable acidity}/X_1 \qquad [2]$$

where X_1 is the fraction of the CEC occupied by acidic cations at the original soil pH. Not all of the exchangeable acidity needs to be neutralized. For example, even at a soil pH of 7 our soils have an acid saturation of about 15 percent. The table below shows the acid saturation at different target pH values based on equation [1].

pH	Acid Saturation, %
5.0	71
5.5	53
6.0	38
6.5	26
7.0	15

The amount of acidity to be neutralized is calculated from equation [3] substituting the acid saturation values from equation [1] and the CEC determined from equation [2]:

$$\text{acidity} = \text{CEC x } (X_1\text{-}X_2) \qquad [3]$$

where X_1 is the acid saturation at the original soil pH and X_2 is the acid saturation at the target pH. A sample calculation of lime requirement using these equations and applying further assumptions discussed in the following section is given in Appendix A.

Assumptions Used in Lime Rate Calculations

Although the estimates of exchangeable acidity and the amount of acidity to be neutralized involve some error (1), they are not the major sources of error in calculating a lime requirement. Inherent in any estimation of lime requirement are several assumptions and approximations which can affect the calculation by at least 50 percent, and possibly more. The most important assumptions and their implications are discussed below.

(1) *Reactivity of limestone with soil*. The Adams-Evans estimate of lime requirement incorporates a multiplier of 1.5 to compensate for the assumption that agricultural limestone is only about two-thirds as effective at neutralizing soil acidity as calcium hydroxide. That factor is not to be confused with differences due to calcium carbonate equivalency. Rather, the factor is based on a study of fineness of limestone and its reactivity in soil over time (4). The ineffectiveness of limestone is due to the effect of specific surface area of limestone particles and the amount of time required for the particle to completely react with soil acidity. A factor of 1.5 appears to correspond to a reaction time of about 6 months for typical calcitic agricultural limestone thoroughly mixed with soil (4). Although use of an arbitrary liming factor has been criticized (5), a factor of about 1.5 is used by most laboratories in formulating a lime recommendation.

(2) *Target pH*. The soil pH or pH range that is best for optimum crop performance is not well defined. For many years a pH of 6.5 was believed to be optimal for most major crops. Many states in this region now use a target pH

of 6.0 for most crops except alfalfa. Determining the optimum target pH under field conditions is somewhat elusive due to several uncertainties especially those relating to soil contact and depth of tillage.

(3) *Amount of soil to be treated*. One of the most important assumptions affecting lime requirement is the extent to which applied lime is mixed with the soil. Many states in this region assume a mixing depth of 8 inches, but others assume the more traditional 6 inches or 2 million pounds of soil. Even more important is whether any mixing takes place. For example, limestone tilled into the soil will react with soil acidity much more rapidly than limestone allowed to remain on the surface of no-tilled cropland. Lime applied to pastures, hay fields, and no-tilled fields may require many years to fully react with soil.

In addition to the uncertainties described above, variations in soil properties, both natural and artificial, affect estimates of lime requirement. For example, natural variation in soil depth and clay content can affect soil pH and exchangeable acidity. Likewise, failure to achieve uniformity of application of both lime and acid-generating fertilizers across a field can introduce considerable variation in soil acidity.

We rely on a composite of soil samples from 10 to 20 spots in a field to obtain a representative sample for laboratory analysis. Depending on the degree of soil variability, the composite sample is not likely to be representative of all locations in the field. That is particularly relevant when comparing two composite samples taken in different years.

CONCLUSIONS

Most often, laboratory error is assumed to be the major reason why soil pH does not reach the target pH, or why soil pH in a field does not change as anticipated with time following lime application. Actually, the several sources of uncertainty cited above introduce much more error than does the laboratory analysis.

When the various assumptions and sources of error are taken into account, it becomes obvious that a lime recommendation, by necessity, is a rather crude approximation. Practitioners need to take this into account if soil pH values do not match the target pH upon which a lime recommendation is based. Smaller, more frequent applications of lime, combined with periodic soil testing can provide effective management of soil pH.

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APPENDIX A

Calculation of Lime Requirement: Example

Consider the case of a soil having a pH (in water) of 5.0, a buffer pH of 7.7, and that the desired target pH is 6.5. Assume that the procedure used 20 g soil and 20 ml each of the Adams-Evans buffer and water. The three equations needed are:

$$\text{soil pH} = 7.79 - 5.55\,X + 2.27\,X^{2} \qquad [1]$$

$$\text{CEC} = \text{exchangeable acidity} / X_1 \qquad [2]$$

$$\text{acidity} = \text{CEC} \times (X_1 - X_2) \qquad [3]$$

Acid Saturation: Equation [1] is solved using the quadratic equation to calculate the acid saturation of the soil first at original pH, 5.0, and again for the desired target pH, 6.5. (Solutions for these pH values were given in the main section.)

At pH 5:

$$5.0 = 7.79 - 5.55\,X_1 + 2.27\,X_1^{2}$$
$$X_1 = 0.71$$

At pH 6.5:

$$6.5 = 7.79 - 5.55\,X_2 + 2.27\,X_2^{2}$$
$$X_2 = 0.26$$

Exchangeable Acidity: A change in buffer pH of 0.01 is equivalent to 0.016 me of acidity per 20 g soil. Since the buffer pH decreased by 0.30 units (8.00-7.70), the exchangeable acidity is:

$$\left(\frac{0.016\text{ me}/20\text{ g}}{0.01\text{ pH}}\right) \times 0.30\text{ pH} = 0.48\text{ me}/20\text{ g soil}$$

In conventional units 0.48 me/20 g soil is equal to 2.40 me/100 g soil. Equation [2] is used to calculate the CEC:

$$\text{CEC} = 2.40\text{ me}/100\text{ g} / X_1$$
$$\text{CEC} = 2.40\text{ me}/100\text{ g} / 0.71$$
$$\text{CEC} = 3.38\text{ me}/100\text{ g}$$

Acidity to be Neutralized: The amount of acidity to be neutralized is calculated using equation [3] and the acid saturations at pH 5.0 and 6.5:

$$\text{acidity} = \text{CEC} \times (X_1 - X_2)$$
$$= (3.38\text{ me}/100\text{ g}) \times (0.71-0.26)$$
$$= 1.52\text{ me}/100\text{ g}$$

Now, 1 me of $CaCO_3$ weighs 50 milligrams. (The equivalent weight is 1/2 of the molecular weight since each mole of $CaCO_3$ will neutralize 2 moles of acidity; thus the equivalent weight is 50g/equivalent or 50 mg/milliequivalent.). Therefore, the amount of $CaCO_3$ needed to neutralize an acidity of 1.52 me/100 g is:

(1.52 me/100 g) x 50 mg/me = 76 mg/100 g soil

Recognizing that a milligram is 1/1000 of a gram, 76 mg/100 g soil is a ratio as 760 parts per million or 1,520 parts per 2,000,000, the weight of the classic acre furrow slice (6 inches deep). If limestone were 100 percent effective in neutralizing the soil acidity, and we desired to raise the soil pH of a 6-inch layer of soil, 1,520 lb/acre would be the lime required. For most recommendations a factor of 1.5 is included to compensate for lime effectiveness and another factor of 8/6 is included to lime an 8-inch layer of soil. When these factors are included the lime recommendation is:

(1,520 lb/acre) x 1.5 x 8/6 = 3,040 lb/acre

Note: the lime tables (Appendix B) indicate a limestone requirement of 3,000 lb/acre for a soil pH of 5.0, a buffer pH of 7.7, and a target pH of 6.5. The recommendations given in the tables are rounded to the nearest 100 lb/acre.

Equivalent Weight of Calcium Carbonate: The reaction of lime (calcium carbonate, $CaCO_3$) with soil involves several steps beginning with dissolution in soil water, its hydrolysis to form calcium bicarbonate, and displacement of acidic cations (for example, hydrogen, aluminum, and aluminum hydrous oxide ions) by calcium. The following simplified reaction shows the net result of liming an acidic soil:

$$CaCO_3 + 2\ \text{H-soil} = \text{Ca-soil} + H_2O + CO_2$$

The exchangeable acidic cations, represented by H, are replaced by Ca while the acidic cations form water or other neutral species. The CO_2 escapes to the atmosphere. Thus each mole of lime will neutralize 2 moles of acidity, so it's equivalent weight is one-half of its molecular weight (100 g/mole).

APPENDIX B

Limestone required to raise the pH of surface 8 inches of soil to **7.0** based on the Adams-Evans method.

Buffer pH	**Soil pH in Water** 6.4	6.2	6.0	5.8	5.6	5.4	5.2	5.0	4.8	4.6	4.4
	pounds/acre										
7.95	400	400	500	500	600	600	600	600	600	700	700
7.90	700	900	1,000	1,000	1,100	1,200	1,200	1,300	1,300	1,300	1,400
7.85	1,100	1,300	1,400	1,600	1,700	1,700	1,800	1,900	1,900	2,000	2,100
7.80	1,500	1,700	1,900	2,100	2,200	2,300	2,400	2,500	2,600	2,700	2,800
7.75	1,900	2,200	2,400	2,600	2,800	2,900	3,000	3,100	3,200	3,300	3,500
7.70	2,200	2,600	2,900	3,100	3,300	3,500	3,600	3,800	3,900	4,000	4,200
7.65	2,600	3,000	3,400	3,700	3,900	4,100	4,200	4,400	4,500	4,700	4,900
7.60	3,000	3,500	3,900	4,200	4,400	4,700	4,900	5,000	5,200	5,300	5,600
7.55	3,300	3,900	4,300	4,700	5,000	5,200	5,500	5,700	5,800	6,000	6,300
7.50	3,700	4,300	4,800	5,200	5,500	5,800	6,100	6,300	6,500	6,700	7,000
7.45	4,100	4,800	5,300	5,700	6,100	6,400	6,700	6,900	7,100	7,400	7,700
7.40	4,500	5,200	5,800	6,300	6,700	7,000	7,300	7,500	7,800	8,000	8,400
7.35	4,800	5,600	6,300	6,800	7,200	7,600	7,900	8,200	8,400	8,700	9,100
7.30	5,200	6,100	6,800	7,300	7,800	8,200	8,500	8,800	9,100	9,400	9,800
7.25	5,600	6,500	7,200	7,800	8,300	8,700	9,100	9,400	9,700	10,000	10,000
7.20	5,900	6,900	7,700	8,300	8,900	9,300	9,700	10,000	10,000	10,000	10,000
7.15	6,300	7,400	8,200	8,900	9,400	9,900	10,000	10,000	10,000	10,000	10,000
7.10	6,700	7,800	8,700	9,400	10,000	10,000	10,000	10,000	10,000	10,000	10,000
7.05	7,100	8,200	9,200	9,900	10,000	10,000	10,000	10,000	10,000	10,000	10,000
7.00	7,400	8,700	9,600	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000

Limestone required to raise the pH of surface 8 inches of soil to **6.5** based on the Adams-Evans method.

Buffer pH	Soil pH in Water 6.4	6.2	6.0	5.8	5.6	5.4	5.2	5.0	4.8	4.6	4.4
	pounds/acre										
7.95	100	200	300	300	400	400	500	500	500	600	600
7.90	100	300	500	600	800	900	900	1,000	1,100	1,100	1,300
7.85	200	500	800	1,000	1,100	1,300	1,400	1,500	1,600	1,700	1,900
7.80	300	700	1,000	1,300	1,500	1,700	1,900	2,000	2,200	2,300	2,500
7.75	300	900	1,300	1,600	1,900	2,100	2,300	2,500	2,700	2,900	3,100
7.70	400	1,000	1,500	1,900	2,300	2,600	2,800	3,000	3,200	3,400	3,800
7.65	500	1,200	1,800	2,300	2,700	3,000	3,300	3,500	3,800	4,000	4,400
7.60	500	1,400	2,000	2,600	3,000	3,400	3,700	4,000	4,300	4,600	5,000
7.55	600	1,500	2,300	2,900	3,400	3,800	4,200	4,600	4,900	5,200	5,600
7.50	700	1,700	2,600	3,200	3,800	4,300	4,700	5,100	5,400	5,700	6,300
7.45	700	1,900	2,800	3,600	4,200	4,700	5,200	5,600	5,900	6,300	6,900
7.40	800	2,100	3,100	3,900	4,600	5,100	5,600	6,100	6,500	6,900	7,500
7.35	900	2,200	3,300	4,200	4,900	5,600	6,100	6,600	7,000	7,500	8,100
7.30	900	2,400	3,600	4,500	5,300	6,000	6,600	7,100	7,600	8,000	8,800
7.25	1,000	2,600	3,800	4,800	5,700	6,400	7,000	7,600	8,100	8,600	9,400
7.20	1,000	2,800	4,100	5,200	6,100	6,800	7,500	8,100	8,600	9,200	10,000
7.15	1,100	2,900	4,300	5,500	6,400	7,300	8,000	8,600	9,200	9,800	10,000
7.10	1,200	3,100	4,600	5,800	6,800	7,700	8,400	9,100	9,700	10,000	10,000
7.05	1,200	3,300	4,900	6,100	7,200	8,100	8,900	9,600	10,000	10,000	10,000
7.00	1,300	3,400	5,100	6,500	7,600	8,500	9,400	10,000	10,000	10,000	10,000

APPENDIX B, continued

Limestone required to raise the pH of surface 8 inches of soil to **6.0** based on the Adams-Evans method.

Buffer pH	Soil pH in Water									
	6.4	6.2	6.0	5.8	5.6	5.4	5.2	5.0	4.8	4.6	4.4
					pounds/acre						
7.95				100	200	300	300	400	400	500	500
7.90				200	400	500	600	700	800	900	1,100
7.85				300	500	800	900	1,100	1,300	1,400	1,600
7.80				400	700	1,000	1,300	1,500	1,700	1,900	2,200
7.75				500	900	1,300	1,600	1,800	2,100	2,300	2,700
7.70				600	1,100	1,500	1,900	2,200	2,500	2,800	3,300
7.65				700	1,300	1,800	2,200	2,600	2,900	3,300	3,800
7.60				800	1,500	2,000	2,500	2,900	3,300	3,800	4,300
7.55				900	1,600	2,300	2,800	3,300	3,800	4,200	4,900
7.50				1,000	1,800	2,500	3,100	3,700	4,200	4,700	5,400
7.45				1,100	2,000	2,800	3,400	4,000	4,600	5,200	6,000
7.40				1,200	2,200	3,000	3,800	4,400	5,000	5,600	6,500
7.35				1,300	2,400	3,300	4,100	4,800	5,400	6,100	7,100
7.30				1,400	2,500	3,500	4,400	5,100	5,900	6,600	7,600
7.25				1,500	2,700	3,800	4,700	5,500	6,300	7,000	8,100
7.20				1,600	2,900	4,000	5,000	5,900	6,700	7,500	8,700
7.15				1,700	3,100	4,300	5,300	6,200	7,100	8,000	9,200
7.10				1,800	3,300	4,500	5,600	6,600	7,500	8,400	9,800
7.05				1,900	3,500	4,800	5,900	7,000	7,900	8,900	10,000
7.00				2,000	3,600	5,000	6,300	7,400	8,400	9,400	10,000

Limestone required to raise the pH of surface 8 inches of soil to **5.5** based on the Adams-Evans method.

Buffer pH	Soil pH in Water									
	6.4	6.2	6.0	5.8	5.6	5.4	5.2	5.0	4.8	4.6	4.4
					pounds/acre						
7.96						-	100	200	300	300	400
7.90						100	300	400	600	700	900
7.85						100	400	600	800	1,000	1,300
7.80						200	500	800	1,100	1,400	1,800
7.75						200	700	1,000	1,400	1,700	2,200
7.70						300	800	1,200	1,700	2,100	2,700
7.65						300	900	1,400	1,900	2,400	3,100
7.60						400	1,000	1,600	2,200	2,800	3,600
7.55						400	1,200	1,800	2,500	3,100	4,000
7.50						500	1,300	2,100	2,800	3,400	4,500
7.45						500	1,400	2,300	3,000	3,800	4,900
7.40						600	1,600	2,500	3,300	4,100	5,400
7.35						600	1,700	2,700	3,600	4,500	5,800
7.30						600	1,800	2,900	3,900	4,800	6,300
7.25						700	2,000	3,100	4,100	5,200	6,700
7.20						700	2,100	3,300	4,400	5,500	7,100
7.15						800	2,200	3,500	4,700	5,900	7,600
7.10						800	2,300	3,700	5,000	6,200	8,000
7.05						900	2,500	3,900	5,200	6,600	8,500
7.00						900	2,600	4,100	5,500	6,900	8,900

APPENDIX C

Soil pH in water and lime requirements based on the standard Adams-Evans method (1) and the Clemson modification of the Adams-Evans method. The modified method used 20 g soil:20 ml water:10 ml buffer; the standard method used 20 g soil:20 ml water:20 ml buffer. In both cases the buffer was that designed by Adams-Evans (1). The soil weight was approximated with a 16 ml scoop.

Lab No.	Soil pH	Lime Requirement Modified	Lime Requirement Standard
		1,000 lb/acre	
700601	5.1	1.5	2.4
700602	5.0	1.8	2.5
700603	4.6	2.8	5.2
700604	4.8	2.4	4.8
700605	4.3	2.4	4.0
700606	5.1	2.1	2.9
700607	4.4	3.5	5.0
700608	5.1	1.5	2.4
700609	6.3	0.5	0.6
700610	6.6	0.0	0.0
700611	4.4	3.0	5.0
700612	5.0	3.1	5.1
700613	5.4	1.9	3.4
700614	5.3	1.8	2.2
700615	5.1	1.3	2.0
700616	4.9	1.6	2.1
700617	5.2	1.6	2.8
700618	4.6	2.8	4.0
700619	5.6	1.3	2.3
700620	5.5	0.9	1.2
700621	5.4	1.5	2.1
700622	5.0	2.2	3.5
700623	5.7	1.2	2.1
700624	5.4	1.9	3.0
700625	5.2	1.6	2.8
700626	4.9	1.6	2.1
700627	5.5	1.4	1.6
700628	5.6	1.0	1.5
700629	4.7	2.2	3.3
700630	4.5	2.9	4.8
700631	4.4	3.0	4.4
700632	5.1	1.3	2.0
700633	5.4	2.1	3.0
700634	5.2	1.9	2.8
700635	5.6	1.7	2.3
700636	6.7	0.0	0.0
700637	5.5	1.1	2.4
700638	5.7	1.1	1.8
700639	5.9	1.2	1.7
700640	5.3	1.8	2.2
700641	4.8	2.4	3.8
700642	5.7	1.1	1.8
700643	5.9	0.6	0.9
700644	6.0	1.0	1.5
700645	6.6	0.0	0.0
700646	4.6	3.8	4.6
700647	6.0	0.8	1.3
700648	5.5	1.1	1.2
700649	4.7	3.4	5.6
700650	5.0	2.0	4.0
700651	5.8	1.3	1.6
700652	5.4	1.7	2.6
700653	5.7	1.1	1.4
700654	5.7	1.1	1.8
700655	5.5	1.4	2.4
700656	4.8	2.9	4.3
700657	4.7	2.7	5.0
700658	5.1	2.6	3.4
700659	5.0	2.2	3.0
700661	7.1	0.0	0.0
700662	6.1	0.5	0.9
700663	6.0	0.9	1.5
700664	6.8	0.0	0.0
700665	5.8	1.1	1.9
700666	6.0	0.6	1.0
700667	5.2	1.6	2.8
700668	5.1	2.4	2.4
700669	4.9	2.8	3.7
700670	6.5	0.0	0.0
700671	7.0	0.0	0.0
700672	6.9	0.0	0.0
700673	6.8	0.0	0.0
700674	6.9	0.0	0.0
700675	5.9	1.4	2.3
700676	7.0	0.0	0.0
700677	6.9	0.0	0.0
700678	5.0	3.8	7.1
700679	4.8	2.9	4.9
700680	6.3	0.4	0.5
700681	6.2	0.8	1.0
700682	6.4	0.0	0.1
700683	5.7	0.8	1.1

APPENDIX C, continued

Lab No.	Soil pH	Lime Requirement		Lab No.	Soil pH	Lime Requirement	
		Modified	Standard			Modified	Standard
		1,000 lb/acre				*1,000 lb/acre*	
700684	5.8	1.0	1.0	700696	5.9	0.4	0.6
700685	6.1	0.0	0.3	700697	6.3	0.0	0.2
700686	6.3	0.0	0.2	700698	4.8	1.9	2.7
700687	5.5	0.9	0.8	700699	6.1	0.6	0.9
700688	6.4	0.0	0.1	700700	5.6	1.0	1.5
700689	5.6	0.8	1.1				
700690	5.9	0.6	0.9				
700691	5.5	1.1	1.6				
700692	5.8	1.0	1.3				
700693	6.2	0.4	0.5				
700694	6.4	0.0	0.0				
700695	6.0	0.3	0.5				

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