A2240

Aglime—Key to Increased Yield and Profits

E.E. Schulte and K.A. Kelling

Aglime is the cornerstone of a good soil fertility program. Aglime and fertilizer work together to build soil productivity—you increase profits because you get higher yields of better quality crops.

Despite the importance of aglime, only 15 percent of Wisconsin cropland that needs aglime actually receives it in any given year.

Aglime Benefits Soils

- It increases yield.
- It reduces soil acidity.
- It creates a favorable environment for microorganisms to efficiently break down organic residue.
- It increases nitrogen fixation by bacteria.
- It improves the availability of certain essential plant nutrients—primarily molybdenum, nitrogen, phosphorus, potassium, and sulfur (figure 1).
- It reduces manganese and aluminum toxicity.
- It improves the performance of triazine herbicides.
- It adds calcium and magnesium, two essential plant nutrients.

Aglime Pays Big Dividends

In quality—

The benefits of aglime include higher quality crops. For example, liming improves alfalfa quality by increasing alfalfa protein (table 1).

Table 1. Effect of soil pH on alfalfa protein content (Marshfield)

	Protein content (%)	
Soil pH	First cut	Second cut
5.1	12.4	14.2
5.6	14.4	17.1
6.0	14.8	18.6
6.5	16.5	20.9
6.9	16.2	20.0

In yields—

Research at the Marshfield Experimental Farm indicates that alfalfa hay yields can be increased more than 0.125 ton per acre for each 0.1 unit increase in soil pH. Other crops also show yield increases when aglime is added to increase soil pH (table2).

In crop establishment and survival—

If you use the recommended amount of aglime and fertilizer, you'll get more alfalfa established and your alfalfa will withstand those cold Wisconsin winters better (table 3).

In disease control—

While liming will not eliminate diseases, it may decrease the amount of damage they do. Some research shows a strong relationship between liming and reduced

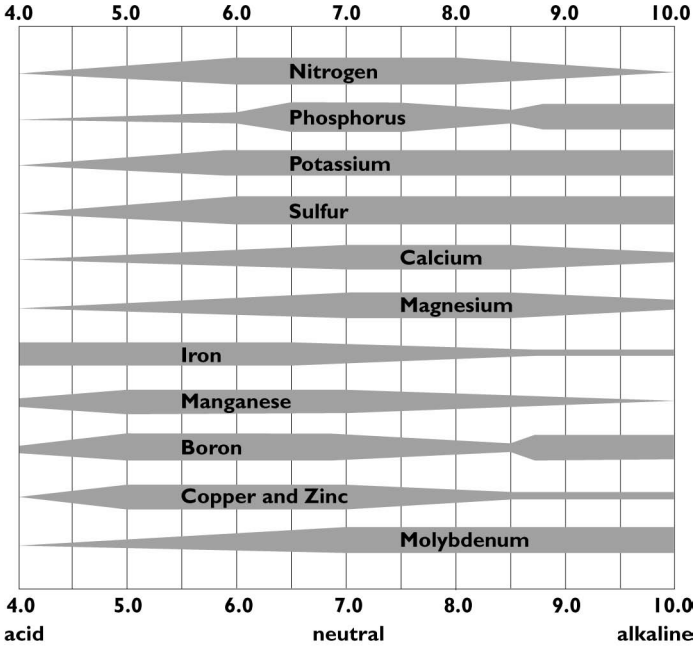

Figure 1. Relation of soil pH and nutrient availability. The width of the bars represents relative nutrient availability. The major plant nutrients—nitrogen, phosphorus and potassium—are most available to plants when the soil pH is between 6.5 and 7.0. These nutrients are still present at other pH levels but in forms used less efficiently by plants.

Table 2. Increases in crop yields when soil pH is increased

Crop	Soil pH	Yield
Alfalfa—3-yr average (Marshfield)	5.0	1.35 t/a
	6.0	2.60 t/a
	6.8	3.05 t/a
Corn—5-yr average (Arlington)	5.0	131 bu/a
	6.0	135 bu/a
Soybean—4-yr average (Arlington)	5.2	38 bu/a
	6.0	40 bu/a
	6.3	41 bu/a

disease severity. A Wisconsin greenhouse study showed that Verticillium wilt was less severe where the soil was limed. Root rot in snap beans at Hancock decreased from 60% of plants affected at pH 4.9 to 11% at pH 7.2.

In profits—

Tables 4 and 5 show that liming to a pH of 6.8 pays off in increased profits. No other practice is more cost effective—especially where alfalfa is a part of the rotation.

Relime Soils

Intensive cropping and improved management techniques result in increased crop yields—which mean greater demands on soils. To meet these demands, you must add extra aglime and nutrients. A soil test will tell you when to relime and how much to apply. For example, while high rates of nitrogen help increase corn yields, it also means you must add larger amounts of aglime. Deeper plowing also creates a need for greater amounts of aglime (figure 2).

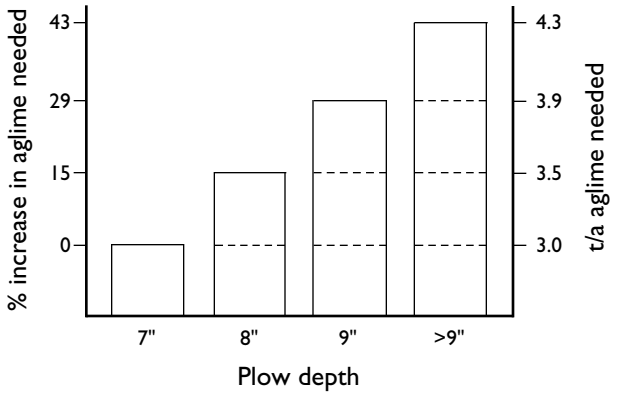

Figure 2. Relation of plow depth to aglime needed. Numbers on the right side of the graph are an example for a soil requiring 3.0 t/a aglime when plowed 7" deep.

Table 3. Effect of soil pH on establishment and persistence of alfalfa (Marshfield)

Soil pH	Establishment yr (crowns/sq ft)	Second hay yr (crowns/sq ft)	Survival[a] (%)
4.9	4.9	0.1	2
5.2	8.9	0.4	4
5.5	11.1	1.1	10
6.0	11.0	4.2	38
6.9	9.2	3.3	36

[a]Survival is calculated as percent of alfalfa present at the last count compared to the first count.

Nitrogen Lowers Soil pH

Nitrogen lowers the soil pH—or makes it more acidic. Table 6 shows the change in soil pH of a prairie silt loam soil at Arlington, Wisconsin, after nitrogen was applied for 5 years. To return the soil pH to its original level (pH 6.11) required 10.8 pounds of aglime (with a neutralizing index zone of 60–69) per pound of ammonium nitrogen added. Nitrate forms of nitrogen do not increase soil acidity because the nitrogen is already oxidized. Ammonium nitrate, for example, produces only half as much acidity as ammonium sulfate per pound of nitrogen applied, because only half of the nitrogen is in the ammonium form.

If nitrogen is broadcast on the soil surface and not incorporated, as in some reduced tillage systems, an acid layer may develop at the surface. To test for this possibility, take a sample of the top 2 inches of soil, and request a lime requirement test. Be sure to tell the lab that the sample came from only the top 2 inches of the soil. If the recommended amount of aglime is incorporated before converting to a reduced tillage system, it should be possible to maintain the soil pH by periodic additions of 1 to 2 tons of topdressed aglime based on nitrogen use and soil tests.

Crops Remove Soil Nutrients

High crop yields remove large amounts of calcium and magnesium from Wisconsin soils. Aglime is needed to replace these soil nutrients, as well as those lost through leaching and soil erosion.

For example, 4 tons per acre of alfalfa remove 112 pounds of calcium and 32 pounds of magnesium each year. This is the equivalent of 425 pounds of aglime per year.

On the other hand, 15 tons of corn silage per acre remove 65 pounds of calcium and 30 pounds of magnesium. This is the equivalent of 275 pounds of aglime per year.

Soil Test Determines Aglime Needs

It's important to test the acidity and nutrient status of your soil at least every 3 to 4 years. Testing indicates whether your soils need aglime and how much you should apply.

Check Extension publication *Sampling Soils for Testing* (A2100) for guidelines on sampling your soil. This publication is available from your county Extension agent. Samples should be analyzed by laboratories that give aglime recommendations for Wisconsin soils.

Computerized soil test reports provide aglime recommendations to reach a soil pH between 5.2 and 6.8 depending on the crop to be grown.

Determine Aglime Quality

Once you know the soil test aglime recommendations, you should adjust these according to aglime quality. The quality of aglime is determined by how fine the aglime is ground and its chemical composition. The higher the quality of aglime, the more efficient it is in neutralizing soil acidity.

You can determine the quality of aglime by its "neutralizing index zone." This is a set of numbers that indicates its neutralizing efficiency. Neutralizing index zones usually range from 50–59 through 90–99 in Wisconsin. The higher the zone number, the higher the quality. For example, 0.7 ton of 90–99 aglime neutralizes the same amount of soil acidity as 1.0 ton of 60–69 aglime. Wisconsin ASCS-approved labs give recommendations for zone 60–69 and 80–89 aglimes. Use the aglime conversion data in table 7 if your lime vendor has a different grade of lime.

When and How to Apply Aglime

Apply aglime anytime you can get equipment on the field without damaging either soils or crops. Spread aglime for the crop in the rotation that is most sensitive to acid, normally the legume. Apply the aglime at least 6 months to 1 year before the legume seeding.

Thoroughly mix the aglime throughout the plow layer. The easiest way to do this is to use a digger or cultivator first, and then plow under the aglime.

If you have to apply aglime in the fall or spring of a seeding year, spread it before plowing. Then, to assure a good job of mixing the aglime, the fields should be dug twice with a field cultivator, and plowed and disked before seeding the grain and legume crop.

For more information, see Extension publication *When and How to Apply Aglime* (A2458).

Table 4. Yield increases from liming an acid silt loam soil from pH 5.0 to 6.8[a]

		Crop yields		
Lime applied	**Soil pH**	**Alfalfa**	**Corn**	**Soybean**
(t/a)		(t/a)	(bu/a)	(bu/a)
Plano soil (Arlington)				
0	5.0	3.76	131	38.0
12	6.8	4.20	139	42.6
Yield increase due to liming:		0.44	8	4.6
Value of yield increase:[b]		$119	$32	$30
Withee soil (Marshfield)				
0	5.0	1.35	78	27.3
15	6.8	3.05	96	35.9
Yield increase due to liming:		1.70	18	8.6
Value of yield increase:[b]		$459	$72	$56

[a]For a corn-corn-soybean-alfalfa-alfalfa-alfalfa rotation.

[b]Based on an estimated sale price of $90.00/t for alfalfa, $2.00/bu for corn, and $6.50/bu for soybean. The value was calculated by multiplying the yield increase by the estimated sale price per ton or bushel, and then multiplying that figure by the number of years the crop was planted in the six-year rotation.

Table 5. Profit from liming acid Plano and Withee soils[a]

	Plano	**Withee**
Total increased value:[b]	$181	$587
Cost of lime:[c]	108	180
Net profit/acre/6 years:	$73	$407
Net profit/acre/year:	$12	$68

[a]Data from table 4

[b]Total "Value of yield increase" for alfalfa, corn, and soybean for the six-year rotation (table 4).

[c]Based on a purchase price of $15/a at Arlington and $20/a at Marshfield. After estimating the total cost of the lime (purchase price x amount applied), the total is prorated over 10 years, and the annual cost is multiplied by 6 to determine the cost for the six-year rotation.

Table 6. Effect of nitrogen on soil pH

Nitrogen application (lbs/acre/year)[a]	**Soil pH after 5 yrs**	**Aglime needed to return pH to 6.11**
0	6.11	0.00
40	6.10	0.31
80	6.02	0.65
120	5.98	0.96
160	5.81	2.03
200	5.68	2.72

[a]Nitrogen application as ammonium nitrate occurred each year for 5 years.

Table 7. Aglime conversion table for different neutralizing index zones

Lime recommendation[a]	Zones of lime quality according to neutralizing index values						
	40–49	50–59	60–69	70–79	80–89	90–99	100–109+
(t/a)	t/a lime to apply						
1	1.4	1.2	1.0	0.9	0.8	0.7	0.6
2	2.9	2.4	2.0	1.7	1.5	1.4	1.2
3	4.3	3.5	3.0	2.6	2.3	2.1	1.9
4	5.8	4.7	4.0	3.5	3.1	2.7	2.5
5	7.2	5.9	5.0	4.3	3.8	3.4	3.1
6	8.7	7.1	6.0	5.2	4.6	4.1	3.7
7	10.1	8.3	7.0	6.1	5.4	4.8	4.3
8	11.6	9.5	8.0	6.9	6.1	5.5	5.0
9	13.0	10.6	9.0	7.8	6.9	6.2	5.6
10	14.4	11.8	10.0	8.7	7.6	6.8	6.2

[a]Soil test recommendations are made for lime having a neutralizing index zone of 60–69. To convert a recommendation to a liming material with a different grade, read across the table to the appropriate column. For example, if you receive a recommendation for 4 t/a of 60–69 lime, you would only need 2.7 t/a of 90–99 lime.

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