PENNSTATE

College of Agricultural Sciences

Department of Crop and Soil Sciences

PENN STATE CMEG Crop Management Extension Group

Soil Acidity and Ag Liming Issues

Douglas Beegle

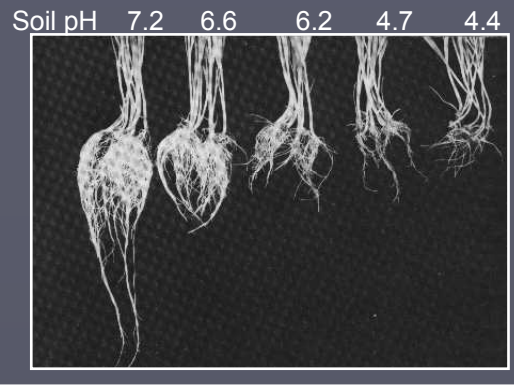
Department of Crop and Soil Science

Penn State University

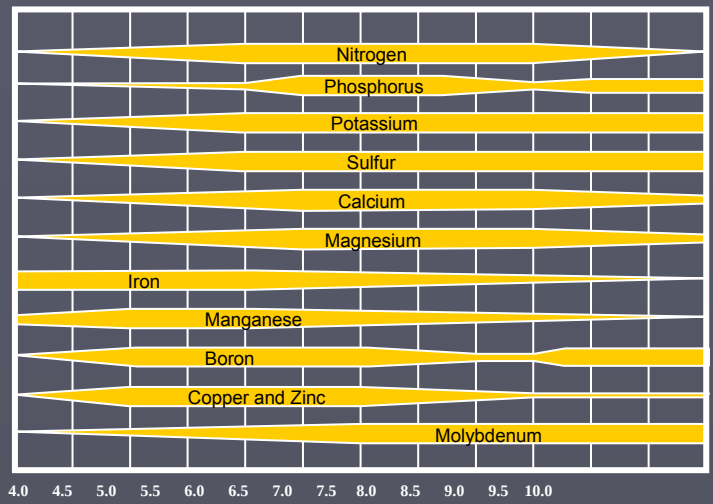
dbb@psu.edu (814) 863-1016

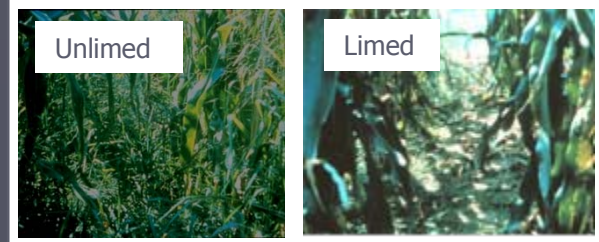
Problems Due to Soil Acidity-Low pH

- Aluminum Toxicity
  - Reduced root growth
- Reduced availability of essential nutrients
- Reduced effectiveness of some key herbicides
- Poor soil conditions for microorganisms
  - Nitrogen availability
- Deficiency of calcium or magnesium
- Poor soil structure



Barley Roots





No-till Corn

Soil pH Summary for PA

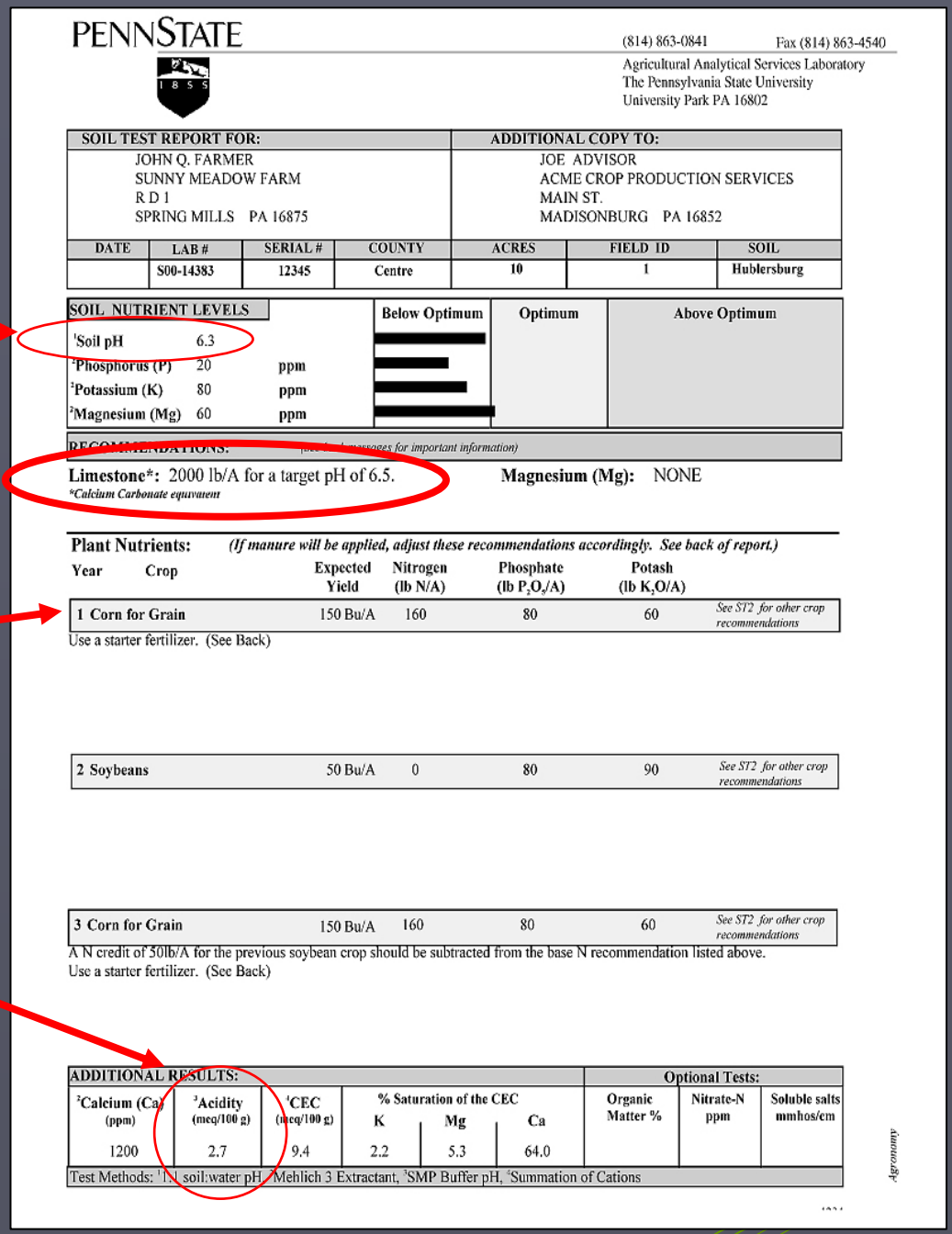
pH Range	% Samples
≤ 5.5	12
5.6-6.0	21
6.1-6.5	30
6.6-7.0	26
7.1-7.5	9
≥7.5	2

⅓ of samples have a pH less than 6.0

Aglime Management

Soil pH and Lime Requirement

- Initial pH
  - Do you need lime or not?
- Target pH
  - Crop Specific
- Buffer Acidity
  - Amount of lime required to reach target?



PENNSTATE

(814) 863-0841 Fax (814) 863-4540

Agricultural Analytical Services Laboratory
The Pennsylvania State University
University Park PA 16802

SOIL TEST REPORT FOR:	ADDITIONAL COPY TO:
JOHN Q. FARMER SUNNY MEADOW FARM R D 1 SPRING MILLS PA 16875	JOE ADVISOR ACME CROP PRODUCTION SERVICES MAIN ST. MADISONBURG PA 16852

DATE	LAB #	SERIAL #	COUNTY	ACRES	FIELD ID	SOIL
	S00-14383	12345	Centre	10	1	Hublersburg

SOIL NUTRIENT LEVELS			Below Optimum	Optimum	Above Optimum
[1]Soil pH	6.3				
[2]Phosphorus (P)	20	ppm			
[2]Potassium (K)	80	ppm			
[2]Magnesium (Mg)	60	ppm			

RECOMMENDATIONS: *(see the messages for important information)*

Limestone*: 2000 lb/A for a target pH of 6.5. **Magnesium (Mg):** NONE

**Calcium Carbonate equivalent*

Plant Nutrients: *(If manure will be applied, adjust these recommendations accordingly. See back of report.)*

Year	Crop	Expected Yield	Nitrogen (lb N/A)	Phosphate (lb P_2O_5/A)	Potash (lb K_2O/A)	
1	Corn for Grain	150 Bu/A	160	80	60	*See ST2 for other crop recommendations*

Use a starter fertilizer. (See Back)

2	Soybeans	50 Bu/A	0	80	90	*See ST2 for other crop recommendations*

3	Corn for Grain	150 Bu/A	160	80	60	*See ST2 for other crop recommendations*

A N credit of 50lb/A for the previous soybean crop should be subtracted from the base N recommendation listed above.
Use a starter fertilizer. (See Back)

ADDITIONAL RESULTS:						Optional Tests:		
[2]Calcium (Ca) (ppm)	[3]Acidity (meq/100 g)	[4]CEC (meq/100 g)	% Saturation of the CEC K	Mg	Ca	Organic Matter %	Nitrate-N ppm	Soluble salts mmhos/cm
1200	2.7	9.4	2.2	5.3	64.0			

Test Methods: [1]1:1 soil:water pH, [2]Mehlich 3 Extractant, [3]SMP Buffer pH, [4]Summation of Cations

Agronomy

PENNSTATE

Soil type and Lime Requirement

Lime Requirement for Target pH of 7.0

Soil pH	Sands	Sandy loams	Loams & Silt loams	Silty clay loams
5.4-5.5	4.0	7.0	11.0	15.0
5.6-5.7	1.0	2.0	3.0	5.5
5.8-5.9	0.8	1.8	2.5	3.5
6.0-6.1	0.6	1.5	2.0	3.0
6.2-6.3	0.5	1.0	1.5	2.5
6.4-6.5	0.3	0.8	1.3	2.0
6.6-6.7	0.2	0.7	1.0	1.5

Cornell Field Crops & Soils Handbook

Aglime Materials

- A product that will neutralize acidity:

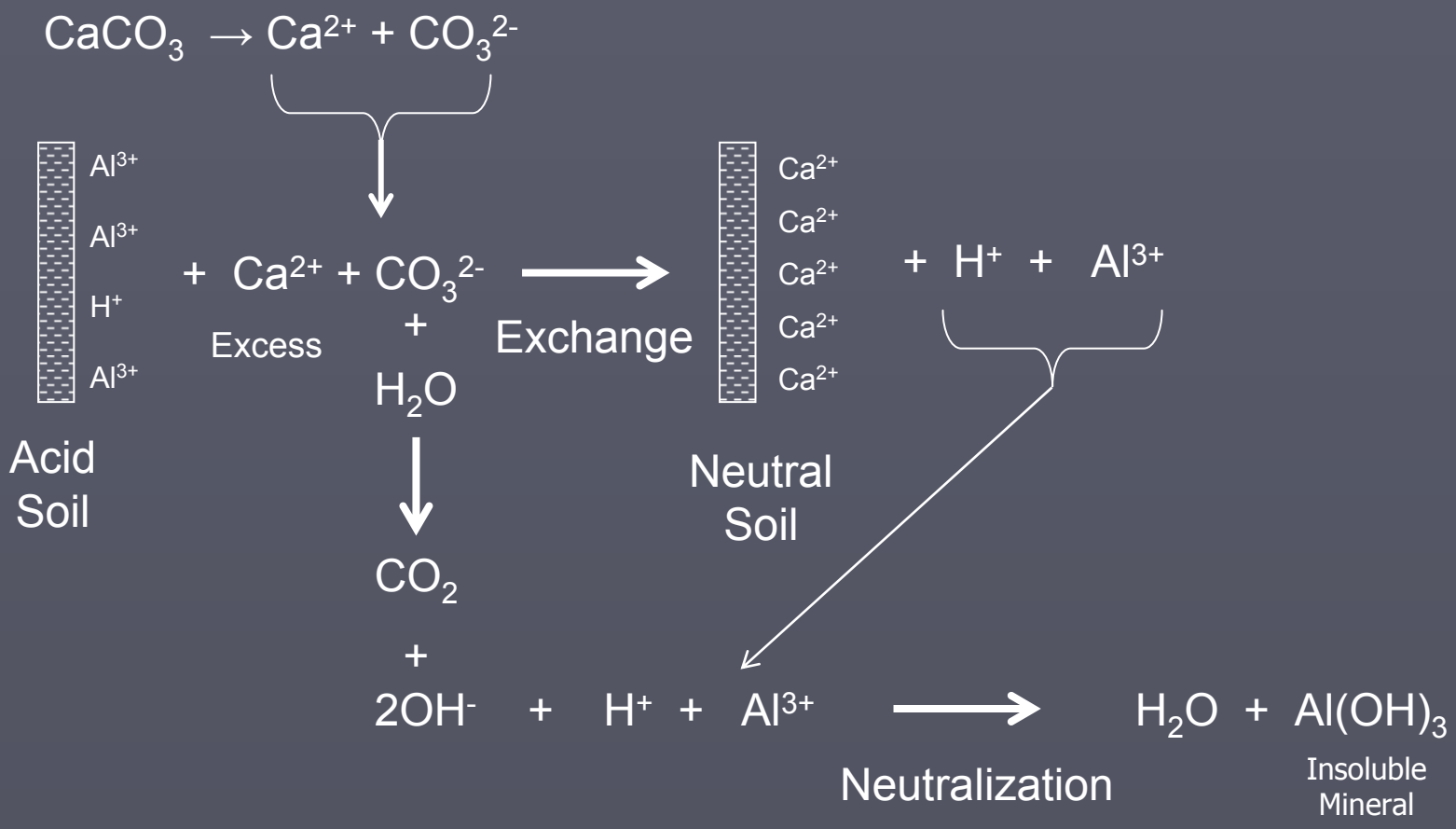
$$H^+ + OH^- \rightarrow H_2O$$

Acid Base Water

  - CaO - Calcium oxide
    (Lime, Burned lime, Quick lime)
    - $CaO + 2H_2O \rightarrow Ca^{2+} + 2OH^-$
  - $Ca(OH)_2$ Calcium hydroxide
    (Hydrated lime, slaked lime)
    - $Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$
  - $CaCO_3$ Calcium carbonate
    (Calcitic limestone)
    - $CaCO_3 \rightarrow Ca^{2+} + CO_3^{2-} + H_2O \rightarrow Ca^{2+} + 2OH^- + CO_2$
  - $CaCO_3$, $MgCO_3$ - Dolomitic limestone

Soil Acidity and Liming

- Soil Liming Reaction



Aglime Quality

- Neutralizing ability
  - The amount of soil acidity the limestone can potentially neutralize.
    - Calcium Carbonate Equivalent (CCE)

      The neutralizing ability of a liming material compared to pure calcium carbonate.

Neutralizing Value of Different Liming Materials

	CCE
$CaCO_3$	100
$MgCO_3$	119
CaO	179
$Ca(OH)_2$	136
$(Ca,Mg)CO_3$	~109
$CaSiO_3$	86

Recommendations and Aglime Quality

- Soil test recommendations are based on limestone quality
  - lb CCE/A
- Therefore, the recommendation must be adjusted for quality of the limestone to be used.
  - Actual Lime needed = 100 x Lime Rec. ÷ CCE

Recommendations and Aglime Quality

- Liming Material Conversion Table

lb/A calcium carbonate equivalent recommended on your soil test	Percent calcium carbonate equivalent (% CCE) of your liming material								Divide total into following number of applications
	70	75	80	85	90	95	100	105	
Actual recommendation (lb/A)									
1000	1400	1300	1200	1200	1100	1100	1000	1000	
2000	2900	2700	2500	2400	2200	2100	2000	1900	
3000	4300	4000	3700	3500	3300	3200	3000	2900	
4000	5700	5300	5000	4700	4400	4200	4000	3800	1
5000	7100	6700	6200	5900	5600	5300	5000	4800	
6000	8600	8000	7500	7100	6700	6300	6000	5700	
7000	10,000	9300	8700	8200	7800	7400	7000	6700	
8000	11,400	10,700	10,000	9400	8900	8400	8000	7600	
9000	12,900	12,000	11,200	10,600	10,000	9500	9000	8600	
10,000	14,300	13,300	12,500	11,800	11,100	10,500	10,000	9500	
11,000	15,700	14,700	13,700	12,900	12,200	11,600	11,000	10,500	
12,000	17,100	16,000	15,000	14,100	13,300	12,600	12,000	11,400	
13,000	18,600	17,300	16.200	15,300	14,400	13,200	13,000	12,400	2
14,000	20,000	18,700	17,500	16,500	15,600	14,700	14,000	13,300	
15,000	21,400	20,000	18,700	17,600	16,700	15,800	15,000	14,300	
16,000	22.900	21,300	20,000	18,800	17,800	16,800	16,000	15,200	
17,000	24,300	22,700	21,200	20,000	18,900	17,900	17,000	16,200	
18,000	25,700	24,000	22.500	21,200	20,000	18,900	18,000	17,100	3
19,000	27,100	25,300	23,700	22,400	21,100	20,000	19,000	18,100	
20,000	28,600	26,700	25,000	23,500	22,200	21,100	20,000	19,000	

To convert to 1000 square feet divide the recommended value in the table by 43.5

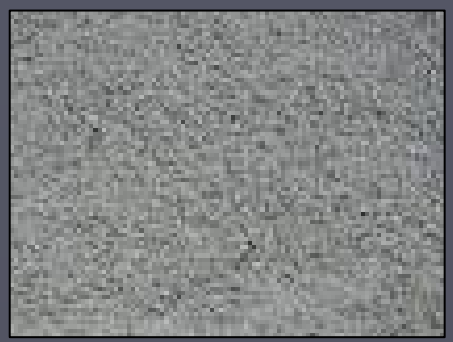
PSU, Agronomy Guide Table 1.2-1

Aglime Quality

- Neutralizing ability
  - Calcium Oxide Equivalent (COE)
    The neutralizing ability of a liming material compared to pure calcium oxide.
  - High quality limestone
    - CCE 100 %
    - COE 56 %
  - COE x 1.78 = CCE

Aglime Quality

- Fineness
  - Finer limestone is ground the faster it will react
  - Finer lime can be more thoroughly mixed with the soil resulting in more complete reaction



Aglime Fineness

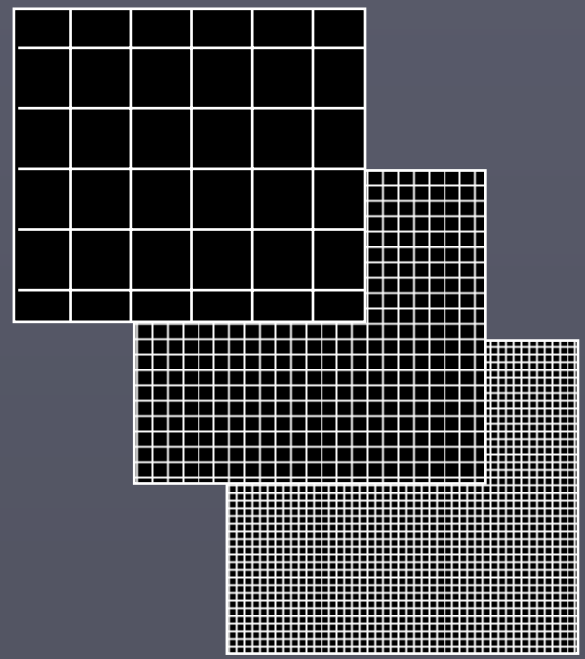
Standard Mesh Sizes

20 mesh sieve
Coarse

60 mesh sieve
- Medium

100 mesh sieve
- Fine

Mesh Size = Wires/in on a sieve



Ag Lime Fineness

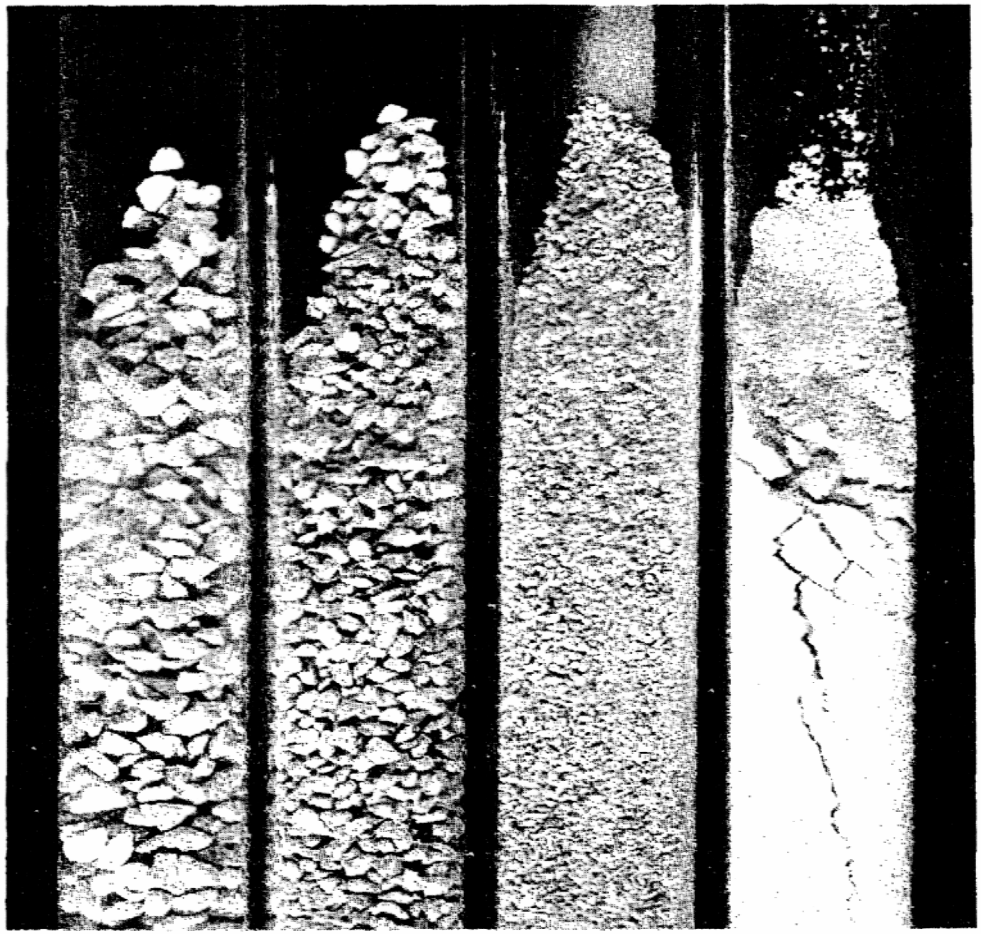
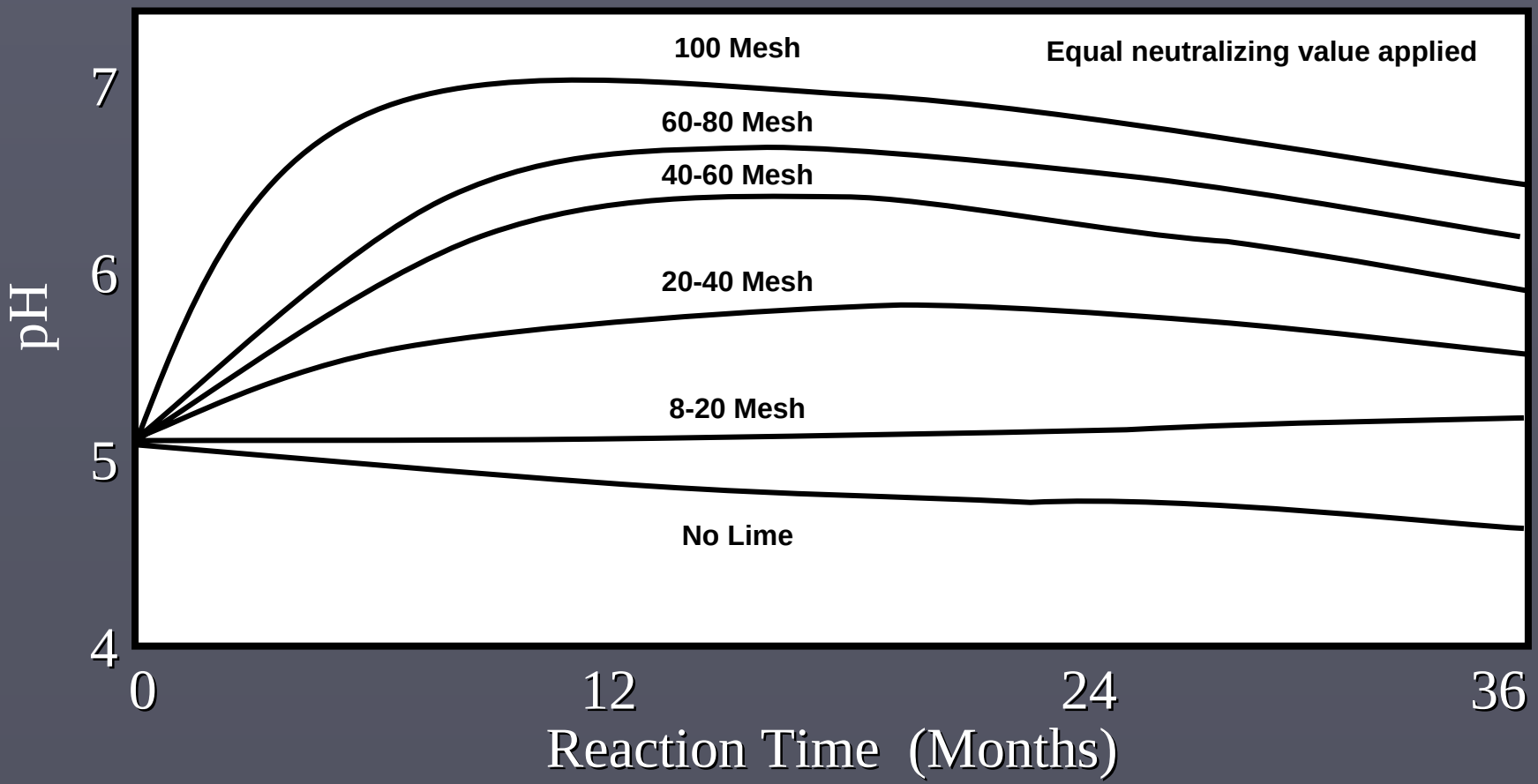


Fig. 7. Limestone of different sizes. From left to right: larger than 8-mesh; 8 to 20-mesh; 20- to 60-mesh; less than 60-mesh.

Aglime Quality

- Fineness



Aglime Fineness

Recommended minimum for normal liming in PA

Fine Sized Materials*

95% - 20 mesh sieve

60% - 60 mesh sieve

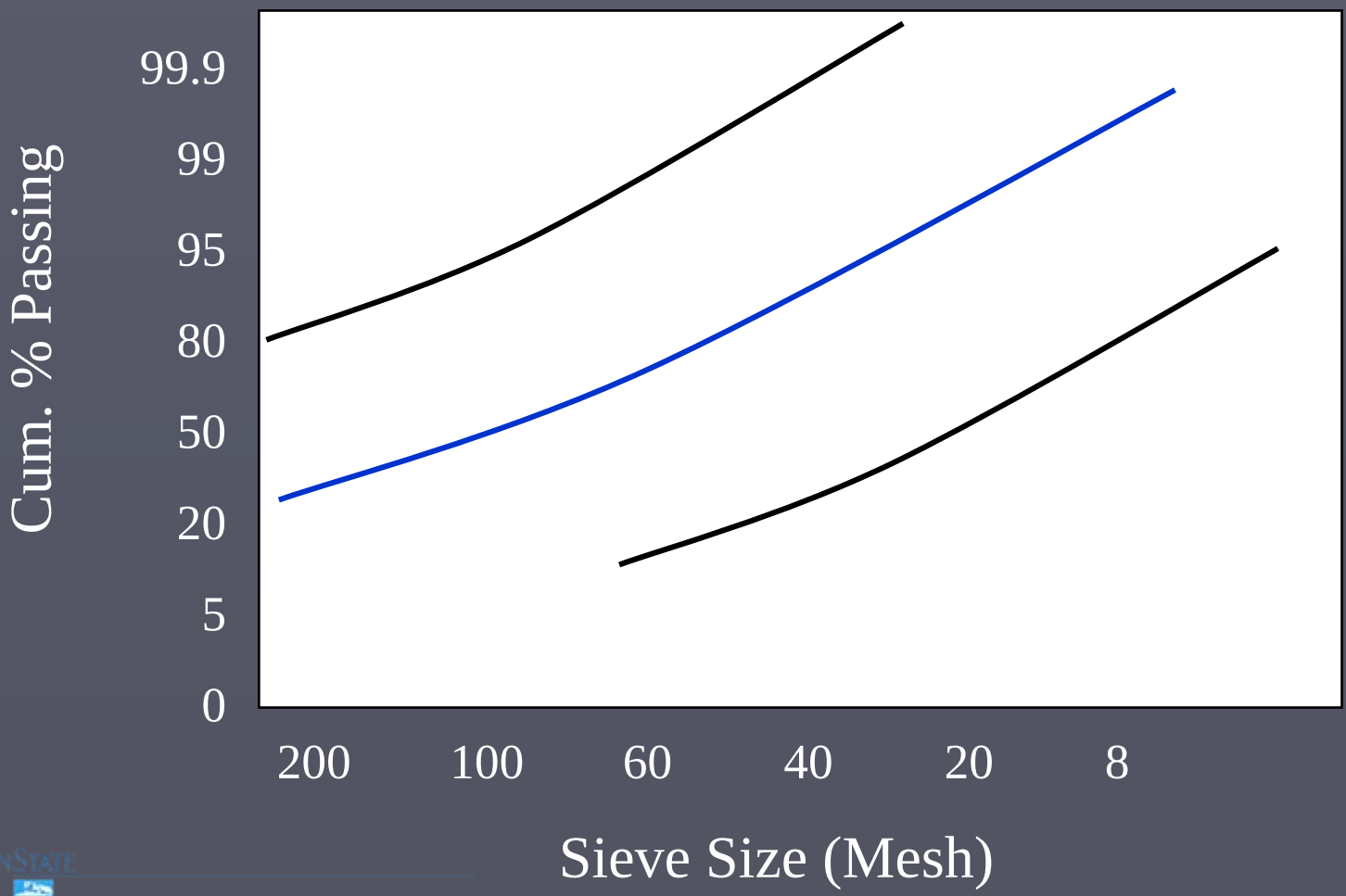
50% - 100 mesh sieve

- Larger than 20 mesh little or no reaction in practical time period
- Smaller than 100 mesh won't provide a practical benefit in faster reaction

* Fineness definition in PA Lime Law

Aglime Fineness

- Grinding limestone very fine (<100 mesh) would result in quick reaction but it is expensive



Normal particle size distribution from grinding

Periodic liming with a fine sized liming material

Other Limestone Quality Issues

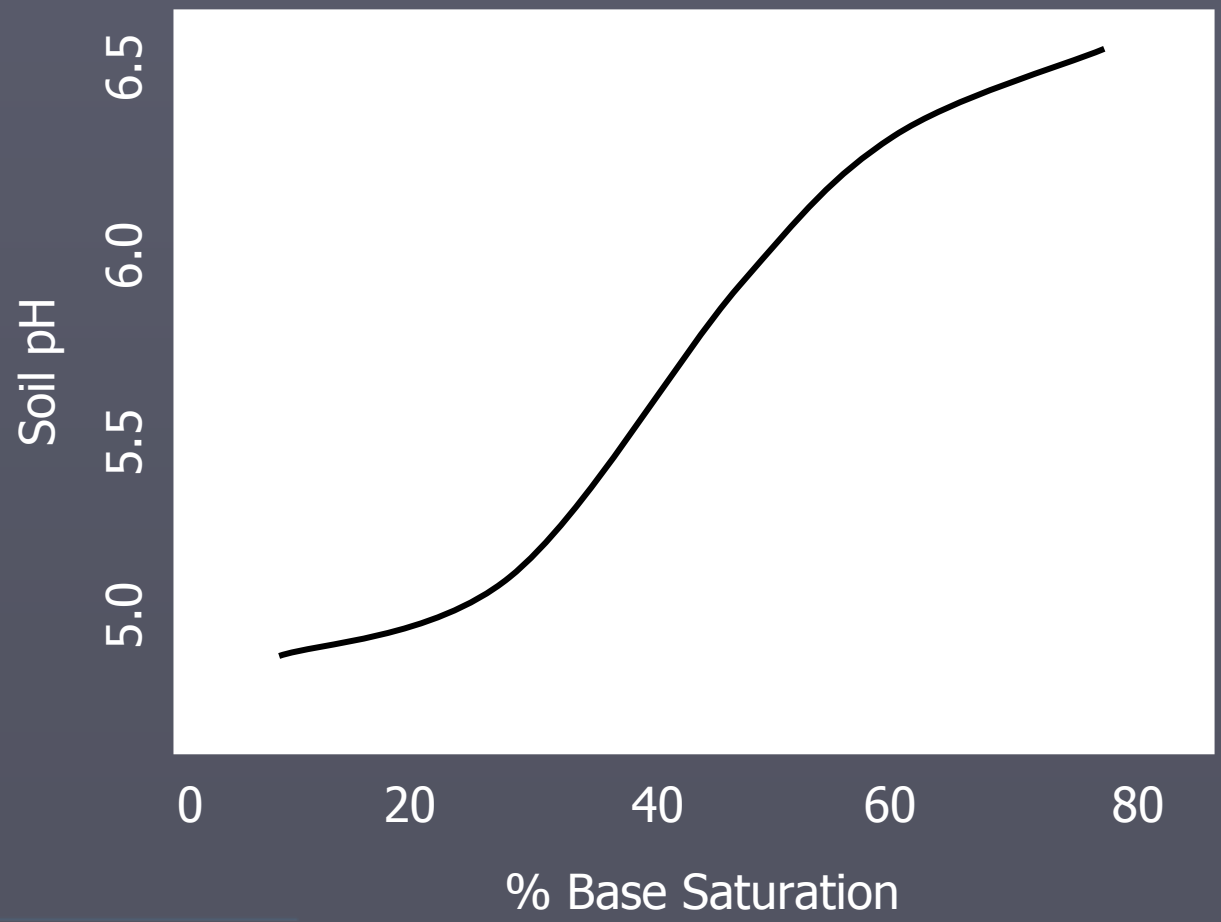
Calcium and Magnesium

- Normal liming practices will also supply required calcium and magnesium
  - At normal liming rates usually adequate Ca will be supplied for most crops
  - Magnesium will depend on the type of limestone used
    - If Mg is required use a dolomitic limestone
    - Go by the Mg analysis, not a name
    - PA: Recommend % Mg in recommended amount of limestone
    - Example:
      - 2000 lb CCE/A Recommended
      - 40 lb Mg/A Recommended
      - Limestone containing at least 2% Mg will meet the Mg recommendation
      - (40 ÷2000 = .02 or 2%)

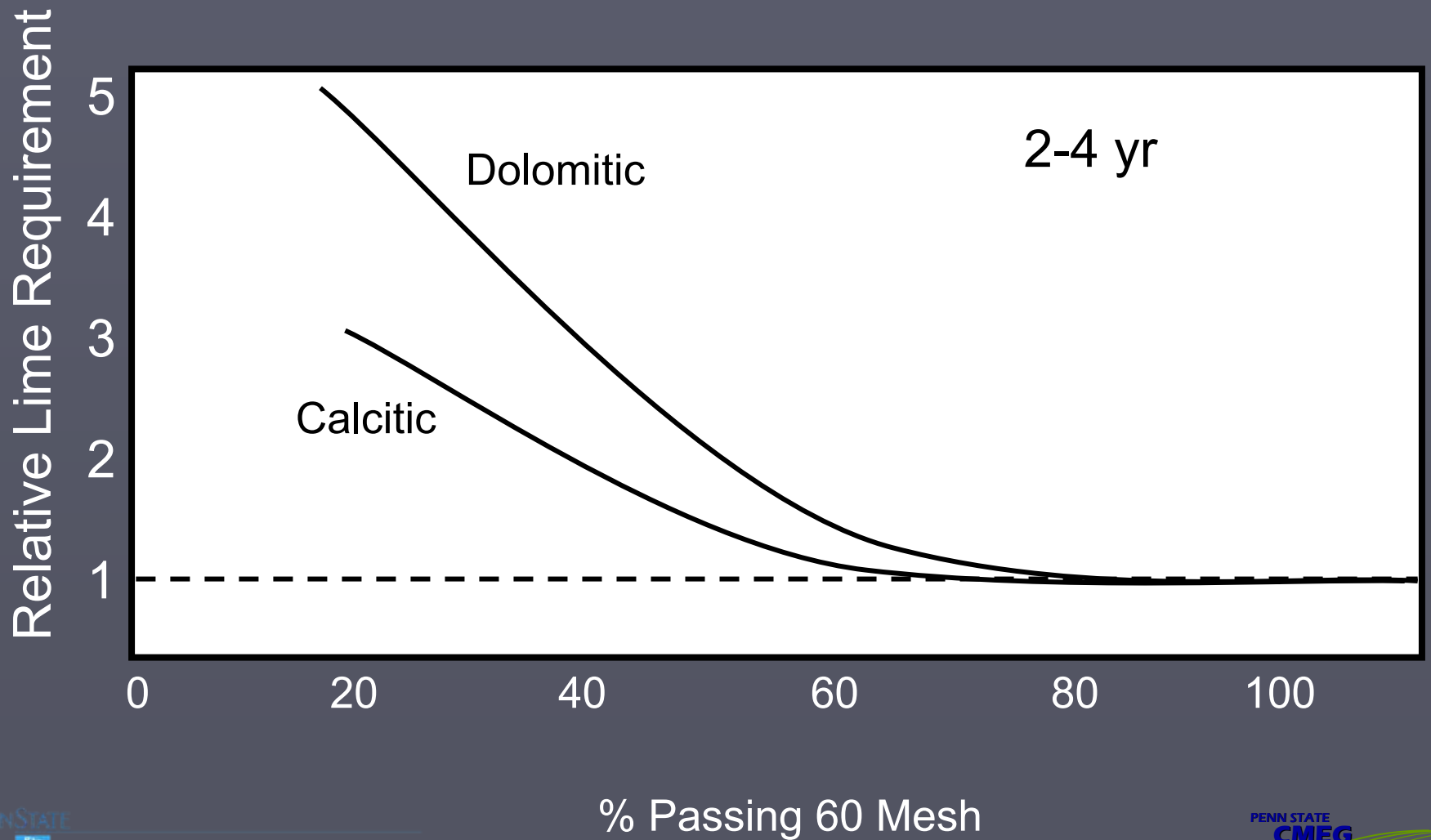
Calcium and Magnesium

- Management Recommendations
  - Maintain optimum pH
  - Maintain at least minimum sufficiency levels of Mg and K
  - For most crops Ca will be more than adequate but not excessive
  - Don't worry about ratios until they are way out of balance
    - Ca:Mg <1
    - Mg:K<1
    - etc.

Calcium and Magnesium



Calcitic vs Dolomitic Limestone
Speed of Reaction

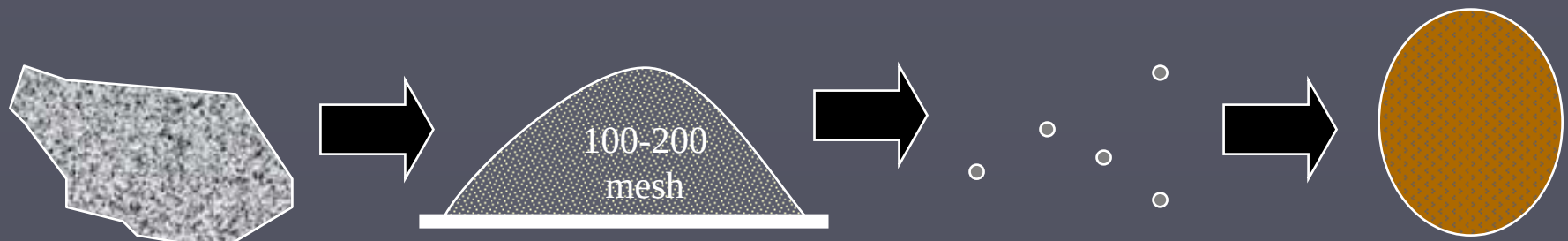


Aglime Fineness and Neutralizing Ability

- For a given amount of acidity an equivalent amount of liming material will be required regardless of fineness.
  - No matter how fine you grind limestone you cannot increase the chemical neutralizing ability
  - Finer the better, because it will react faster, but there are practical limitations
  - Distribution in "Fine Size" Limestone – usually adequate for practical liming for field crops

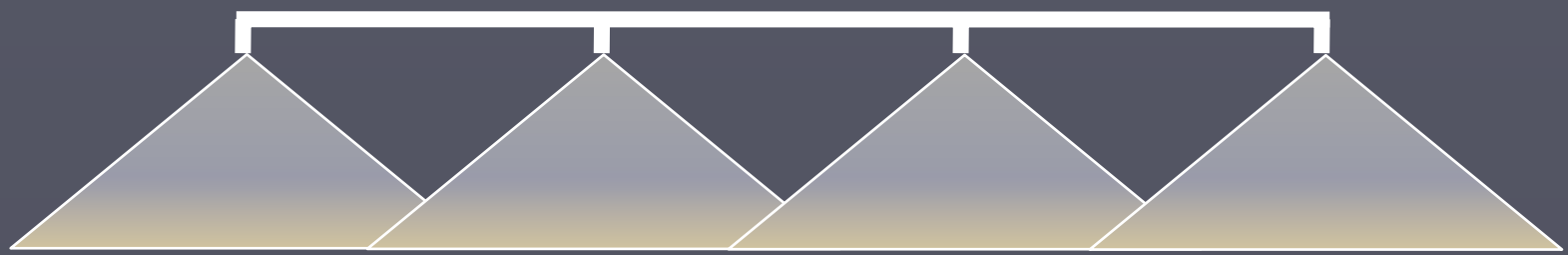
Pellet Lime

- Finely ground limestone
- Glued together into water soluble pellets
- Advantage: Handling, spreading, speed of reaction
- Disadvantage: Cost

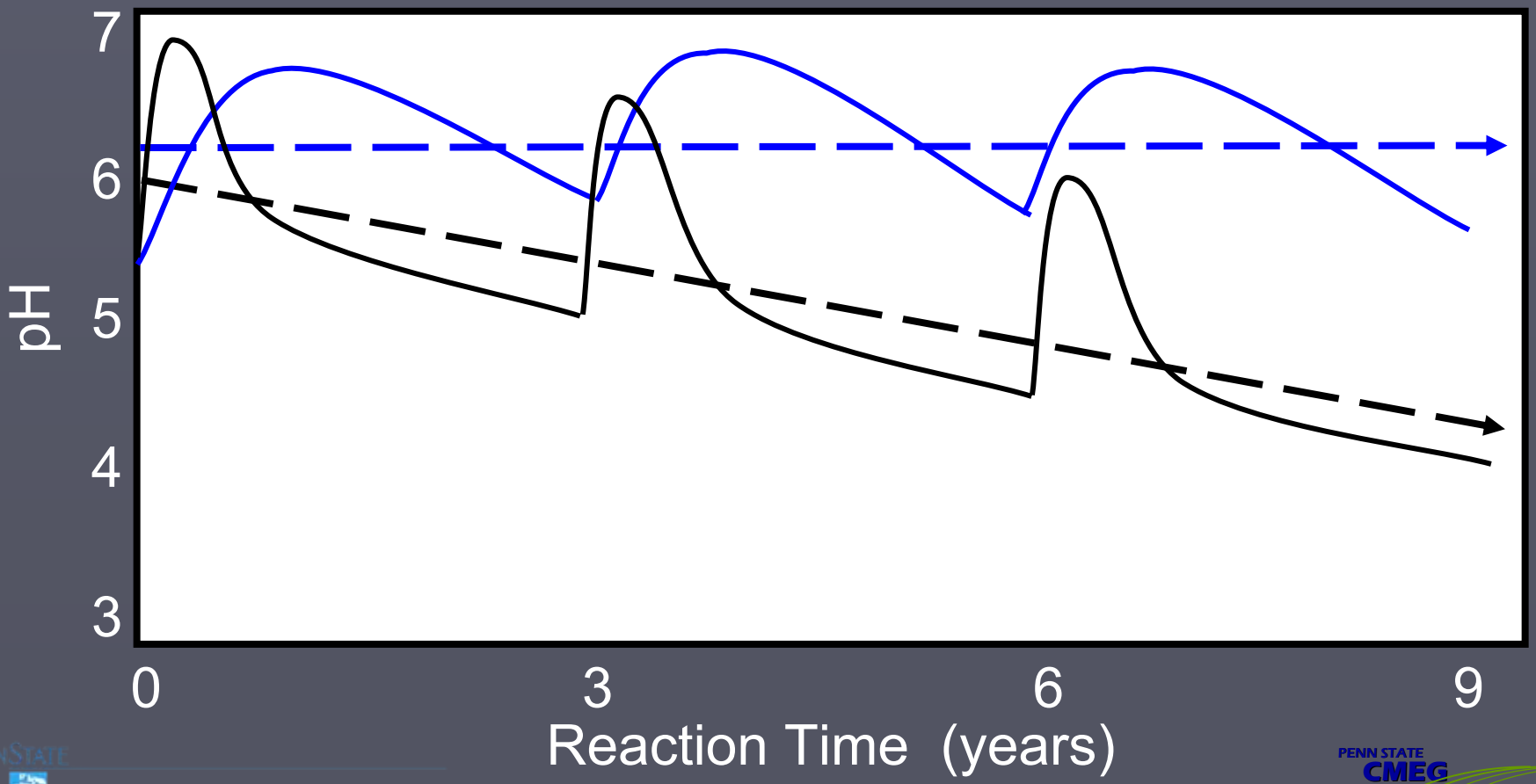


Fluid Lime

- Finely ground limestone
- Suspended in water with clay
- Approx. 1000 lb CCE/ton material
- Advantage: Spreading, speed of reaction
- Disadvantage: Cost



Less than recommended very fine limestone applied compared to normal liming program



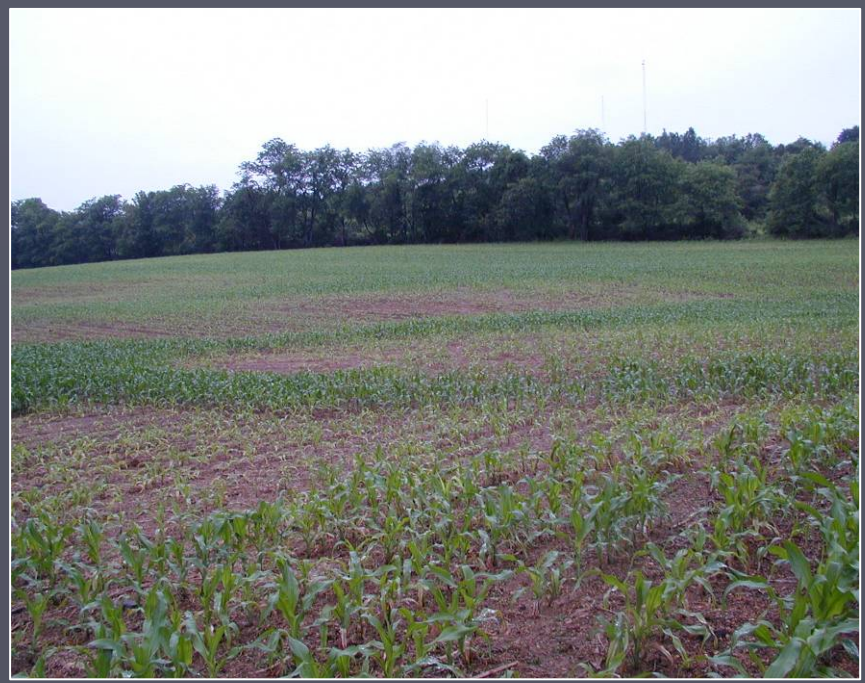
Liming Rented Ground

- Liming by nature is a longer term proposition
- Often a limiting factor on rented ground

Rented Field

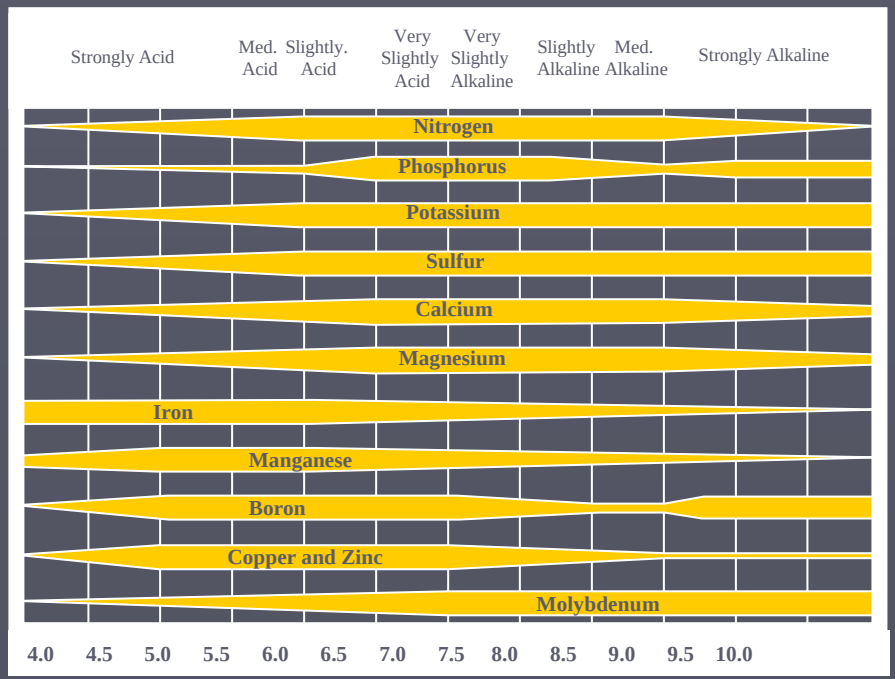
pH 3.8

Disaster



Liming Rented Ground

- Low soil pH often limits efficient use of other nutrients and pesticides
- You can't ignore it!



Limed No-till

Unlimed No-till

Liming Rented Ground

- Critical pH 5.5
- Aluminum toxicity reduces root growth
- Reduces efficiency of nutrient and water uptake

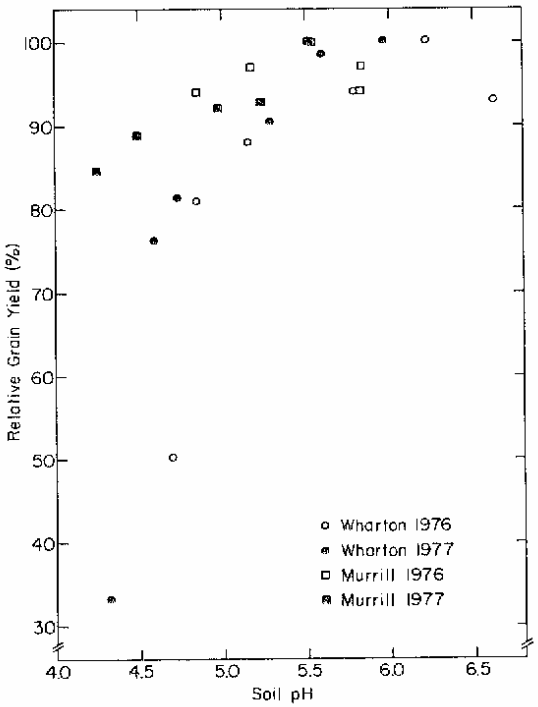


FIG. 1. The relationship between soil pH and relative corn grain yield.

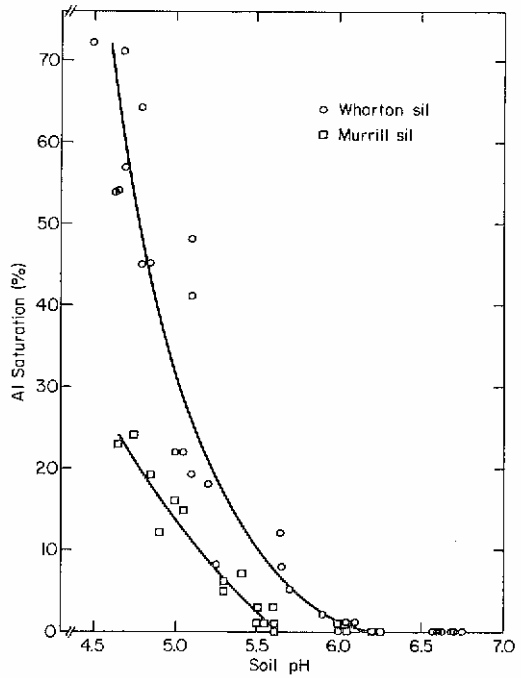
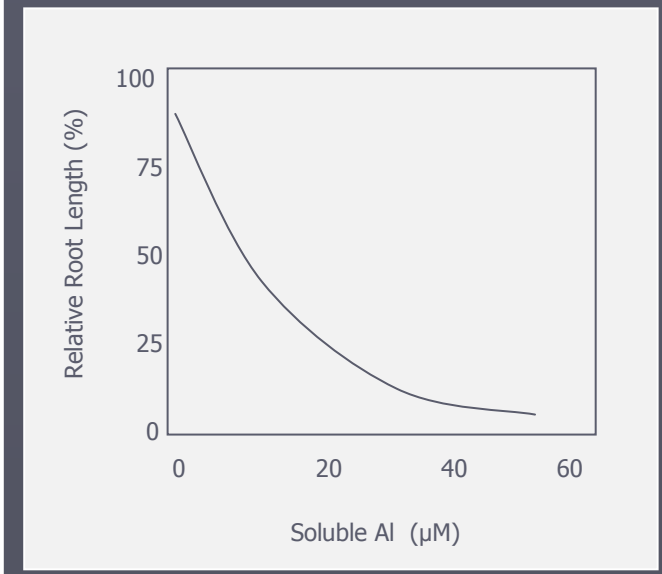


FIG. 2. The relationship between Al saturation and soil pH, 1976.



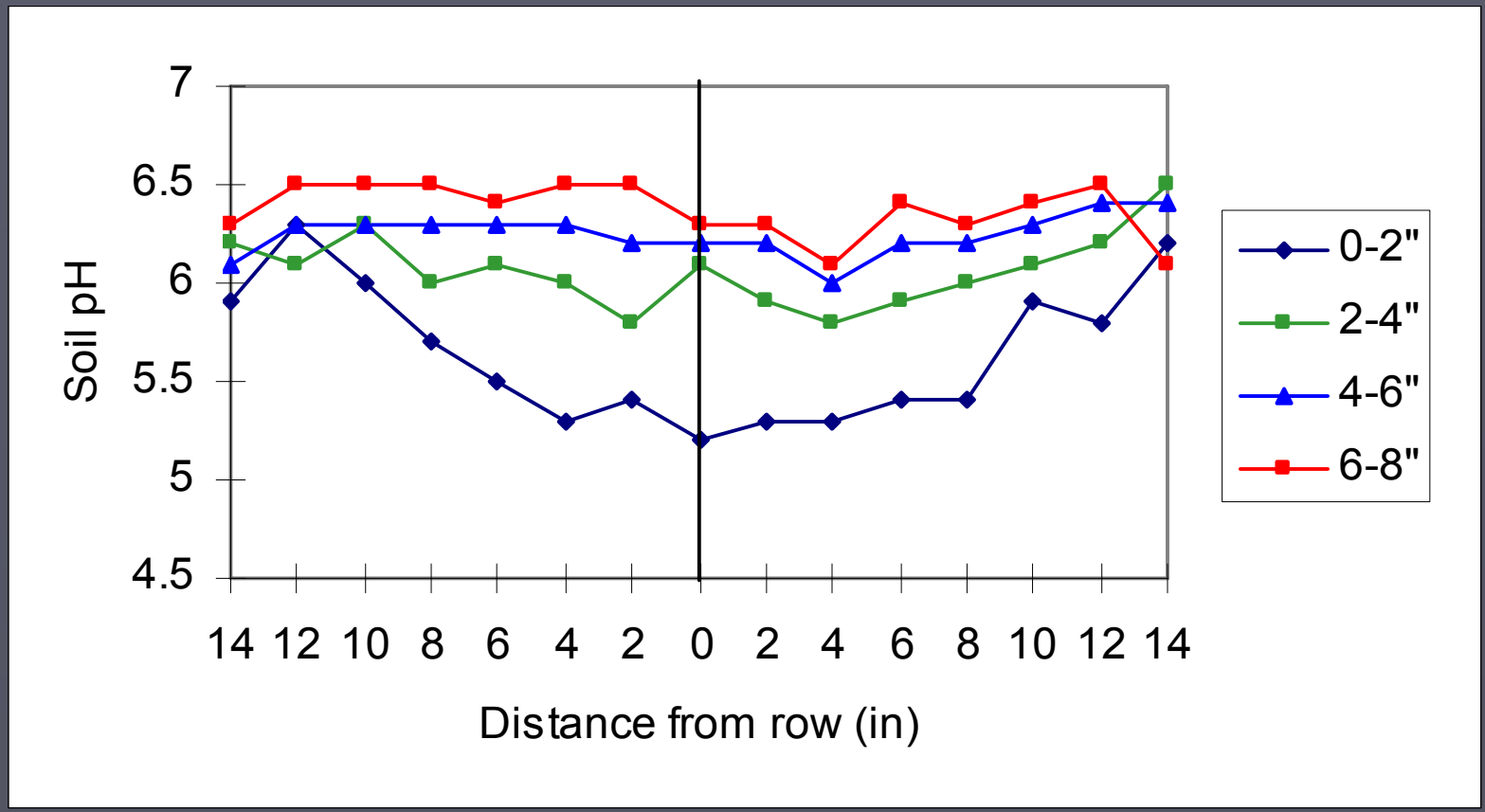
Liming Rented Ground

- Ideal for most agronomic crops is 6.5
  - Most soil testing labs should be able to give a lower lime recommendation
- ***Critical pH for root growth is ~5.5***
- Critical pH for nutrients is ~6.0
- Critical pH for Legumes is ~6.5
- Critical pH for Herbicides is ~variable
  - Atrazine > 6.2
  - Read the label
    - Choose herbicides based on pH or adjust pH based on herbicides

Tillage and pH

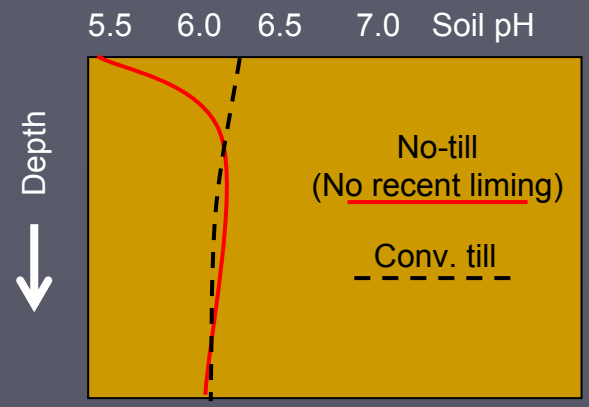
- Unique Conditions in Conservation Tillage Systems
  - No mechanical mixing
  - Stratification of soil pH
  - Stratification of nutrients
  - Organic matter accumulation at the surface
  - Different root distribution
  - Slightly lower pH – 0.1 to 0.3 pH units

Soil pH with No Tillage



Acid Roof

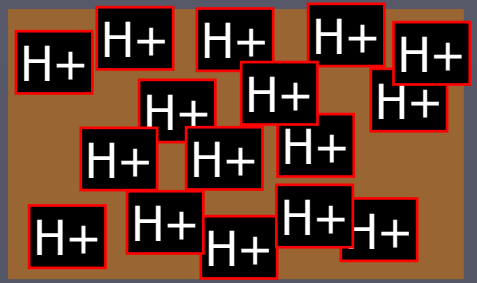
- In reduced tillage systems acidifying effects of nitrogen are concentrated at the soil surface
  - Root growth
  - Herbicide activity
  - Nutrient availability



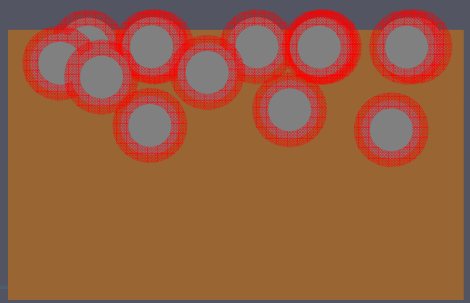
- Sampling for acid roof:
  - If normal "plow depth" soil sample calls for lime, apply as recommended.
  - If normal "plow depth" soil sample does not call for lime, check the pH in the surface 1-2". If the pH is less than 6.0, apply 1 ton of limestone/acre.

Liming No-till

- No Tillage - Low pH, infrequent liming
  - Acid soil

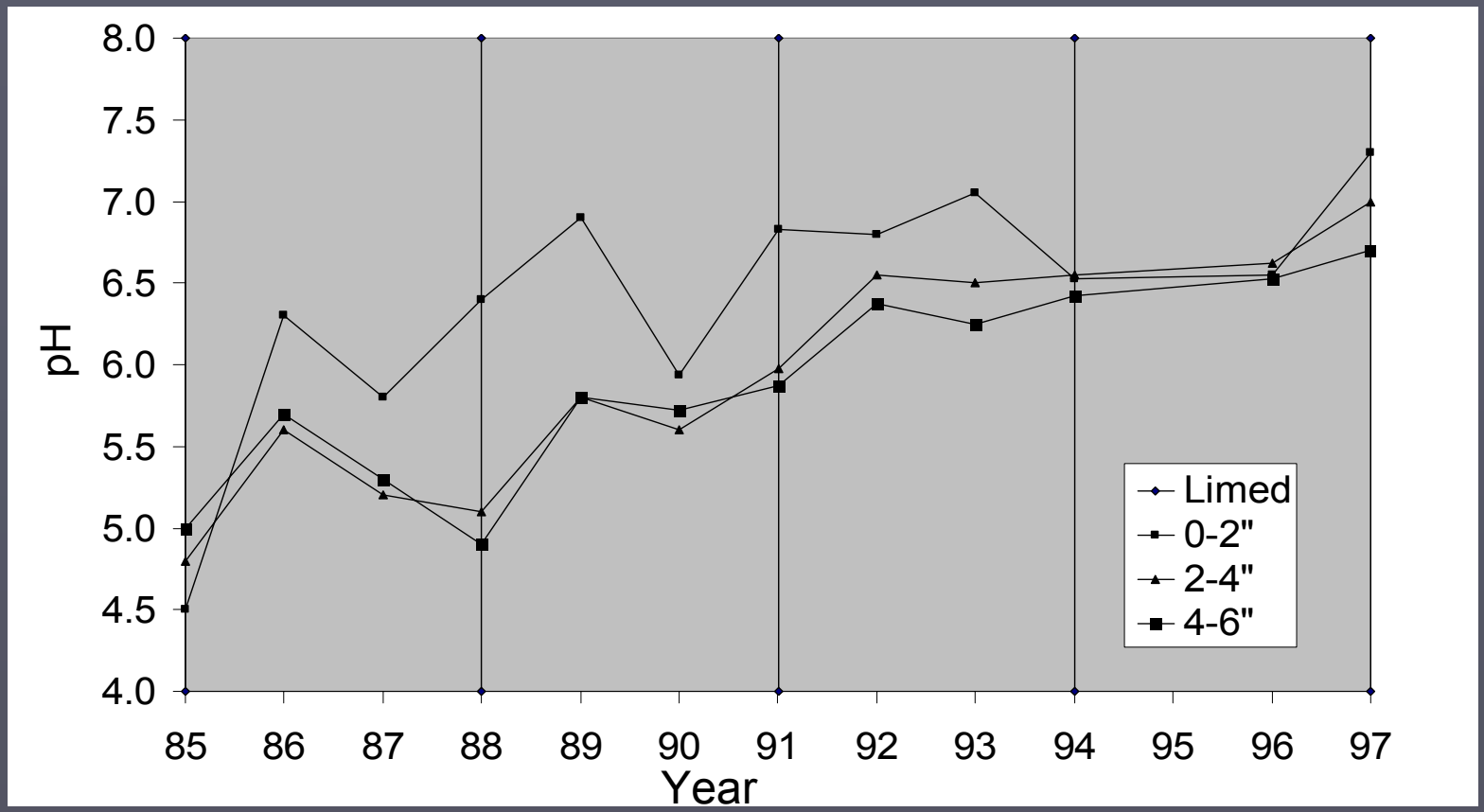


  - No mixing of limestone



Very Slow

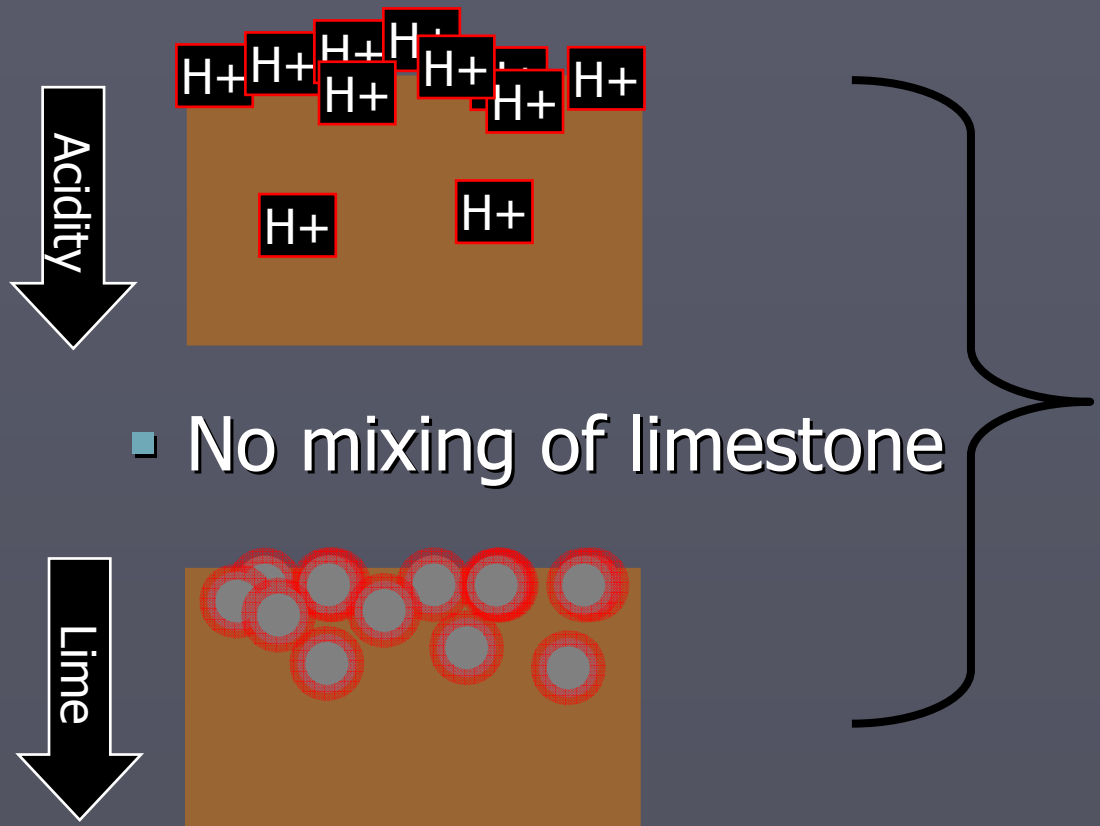
Liming No-till



Beegle, PSU

Liming No-till

- No Tillage - Regular liming
  - Acid Roof



  - No mixing of limestone

By-product Liming Materials

- Quality
  - Liming value
  - Undesirable components

Example: Liming Value

CCE = 5.38%

Fineness: Through 20 Mesh = 98.8%

Through 60 Mesh = 78.2 %

Through 100 Mesh = 63.2%

For 2000 lbs of neutralizing value:

2000 X 100 ÷ 5.38 = 37,174 lbs. or 18.6 tons

Example: Undesirable components - Metals in Aglime

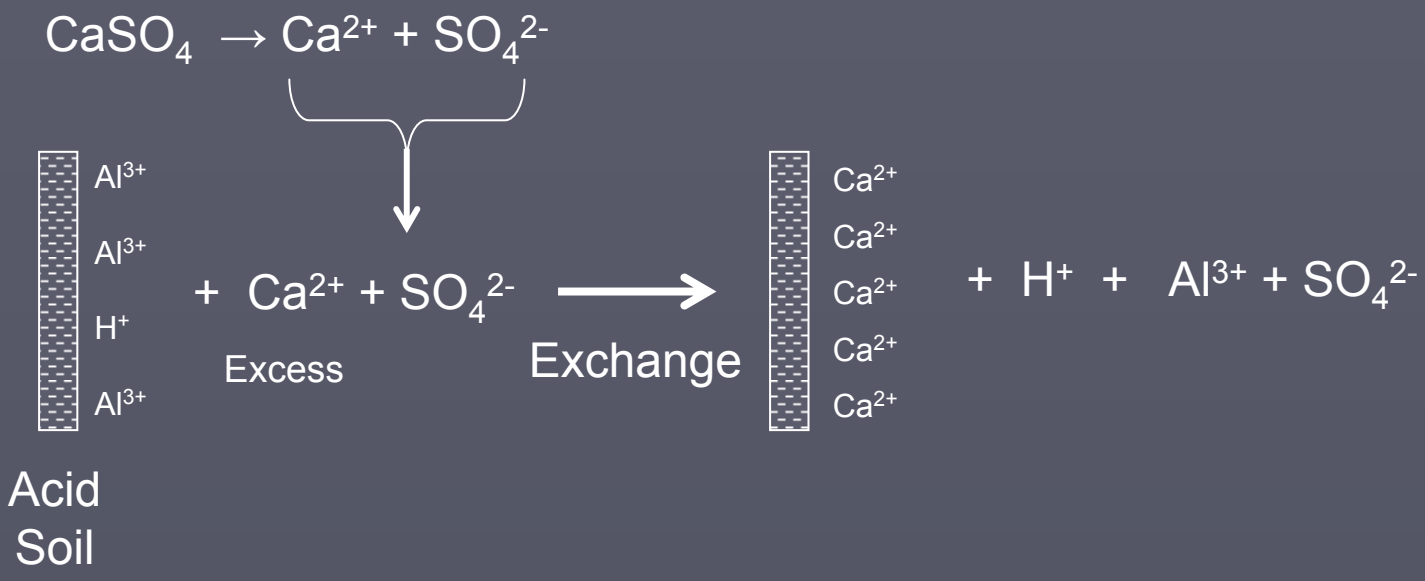
Material	Cu	Zn	Pb	Cr	Ni	Cd
Aglime	.02	.03	.05	.02	.04	.00
Aglime	.02	.02	.05	.02	.04	.00
Aglime	.03	.02	.04	.02	.04	.00
Aglime	.01	.05	.07	.02	.04	.00
Aglime	.01	.05	.07	.02	.04	.00
By-product	.04	.05	.10	.03	.07	.00
By-product	.04	.08	.02	.04	.05	.00
By-product	.03	.00	.07	.03	.05	.00
By-product	.03	.27	.09	.04	.08	.00
By-product	.02	2.62	.08	.02	.06	.01
By-product	68	160	19	2037	435	5

Other Materials

- Biosolids and Water Treatment Sludges
  - Often have significant neutralizing value
  - Must be clean
  - Must be registered if sold as liming materials

Soil Acidity and Liming

- Gypsum



- Adds Ca and S but does not neutralize acidity
- Gypsum is <u>not</u> a liming material

Gypsum

- Soil Quality
  - Gypsum promoted as a soil conditioner
  - Used for renovating saline/sodic & sodic soils
    - High Na disperses the soil resulting in poor physical properties – Chemical compaction
    - Add Ca to replace Na resulting in flocculation, the first step in aggregate formation
  - No effect on physically compacted soils if Ca is adequate

Ca Source and Soil Quality

- In acid soils the best source of Ca is limestone because we need the acid neutralizing value
  - No need for additional Ca for the soil
  - Calcium carbonate 40% Ca (800 lb Ca/ton of limestone)
- High pH but low calcium soils use gypsum as a source of Ca for the soil and the crop (West)
- Low pH, acid loving crops or highly weathered soils, use gypsum as a source of Ca for the soil and the crop (Tropics) no change in pH

Other Materials
Organic Calcium Compounds

- Promesol 30, Liquid Lime
  - Trihydroxy glutaric acid 25% Ca
  - 1 gallon = 500-750 lb CCE?
- Liqui-Til
  - Trihydroxy glutaric acid
  - Neutralizes pH in alkaline soil?
- KK Organic Soil Builder
  - Neutralizes both acidic and alkaline soils?
- Liqui-Cal
  - 8% Ca
  - 1 gallon = 500 lb $CaCO_3$?
- Liquid Calcium
  - 1 gallon = Ca in 500 lb $CaCO_3$?
  - Suggest it is a lime substitute
- Golden Cal
  - Glucoheptomic acid
  - 1 gallon = 500 lb CCE?
- pH Plus
  - 1 gallon = 500-750 lb CCE?

Other Materials

- Remember fundamental chemistry: 1 Eq. of base is required to neutralize 1 Eq. of acid
  - 1000 lb CCE/A for every 1 meq H^+/100g soil

- Watch out for materials that contain Ca with unwritten or suggestive claims for liming value

Summary

- Soil Acidity is still a major limitation to optimum crop production
- Liming materials vary in quality
  - Calcium carbonate equivalent (CCE)
  - Fineness
  - Mg content
- Soil test liming recommendations assume a certain quality eg. Lb CCE/A
- Adjust application rates for liming material quality
  - Excess fineness does not increase neutralizing value
- Compare materials based on quality adjusted rate

Summary

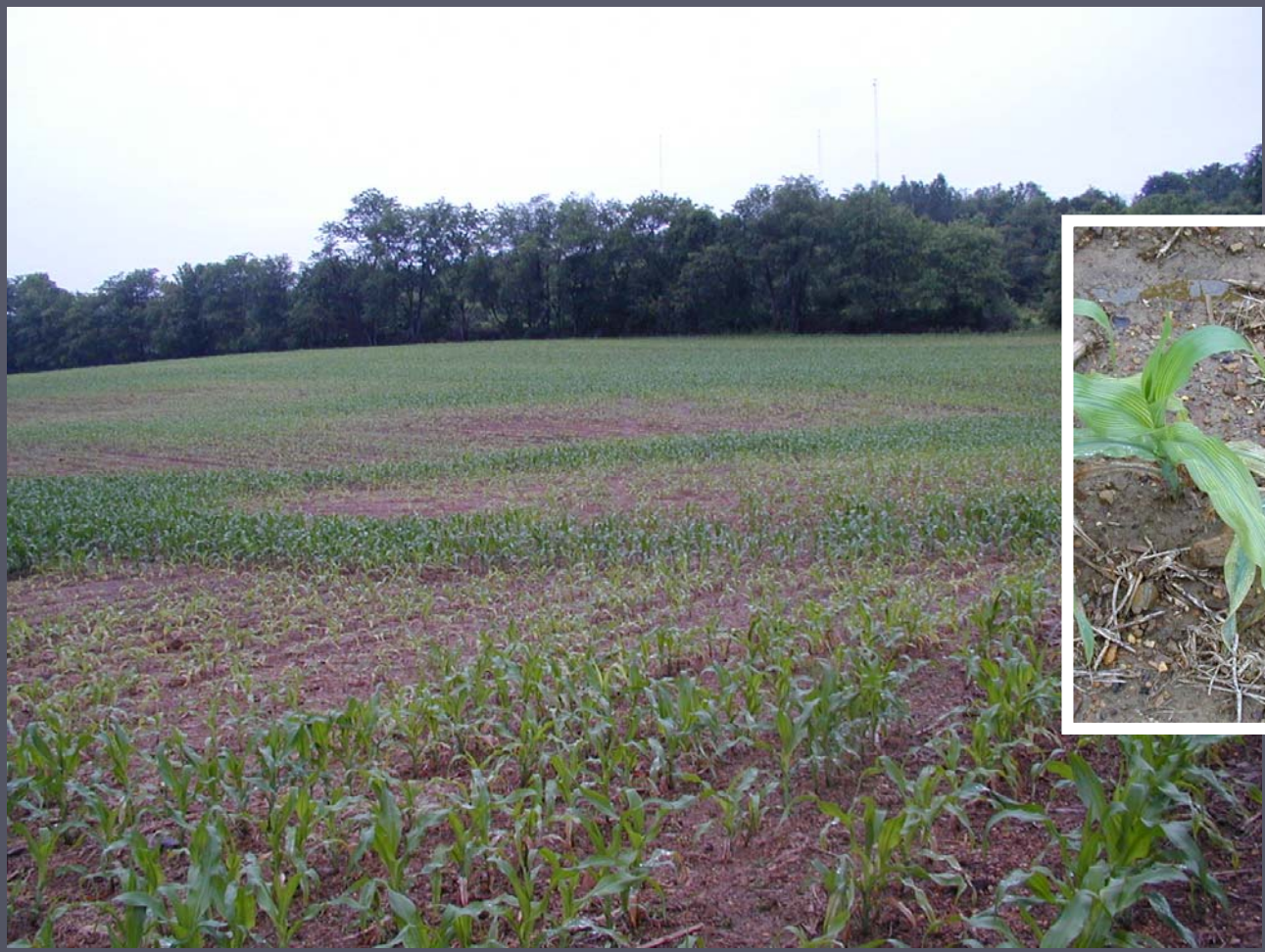
- Understand critical pH issues when adjusting liming programs
  - Rented ground never go below pH 5.5 for agronomic crops
- Check for liming quality and anti-quality agents in by-products used for liming
- Be aware of Ca containing materials sold as liming materials
- 1 Equivalent of Acid requires 1 Equivalent of Base for neutralization

Questions?

College of Agricultural Sciences

Department of Crop and Soil Sciences

Low pH Syndrome



Causes of Soil Acidity

- Leaching of basic cations
  - Ca^{2+}, Mg^{2+}, K^{+} leaving behind Al^{3+}
- Crop uptake of basic cations and release of acids
- Decay of plant residues
- Acid rain
- Reaction of nitrogen fertilizer

Acid forming reaction of N fertilizer Biggest Source of Acidity in Ag

Approx. Lbs $CaCO_3$ to Neutralize 1 Lb N/A

Fertilizer Material	lbs.
Ammonium Nitrate	3
Urea	3
UAN	3
Anhydrous Ammonia	3
Ammonium Sulfate	6
Manure	3*

* Effects vary with type of manure

Soil Acidity and Liming

- Aglime Fineness
  - Pulverized Limestone
    - Normal ground Limestone
  - Granular Limestone
    - Coarser ground limestone
    - Easy spreading for homeowners
    - Slower to react

Aglime Fineness

Fineness definitions for PA

Fine Sized Materials	Medium Sized Materials
95% - 20 mesh sieve	90% - 20 mesh sieve
60% - 60 mesh sieve	50% - 60 mesh sieve
50% - 100 mesh sieve	30% - 100 mesh sieve

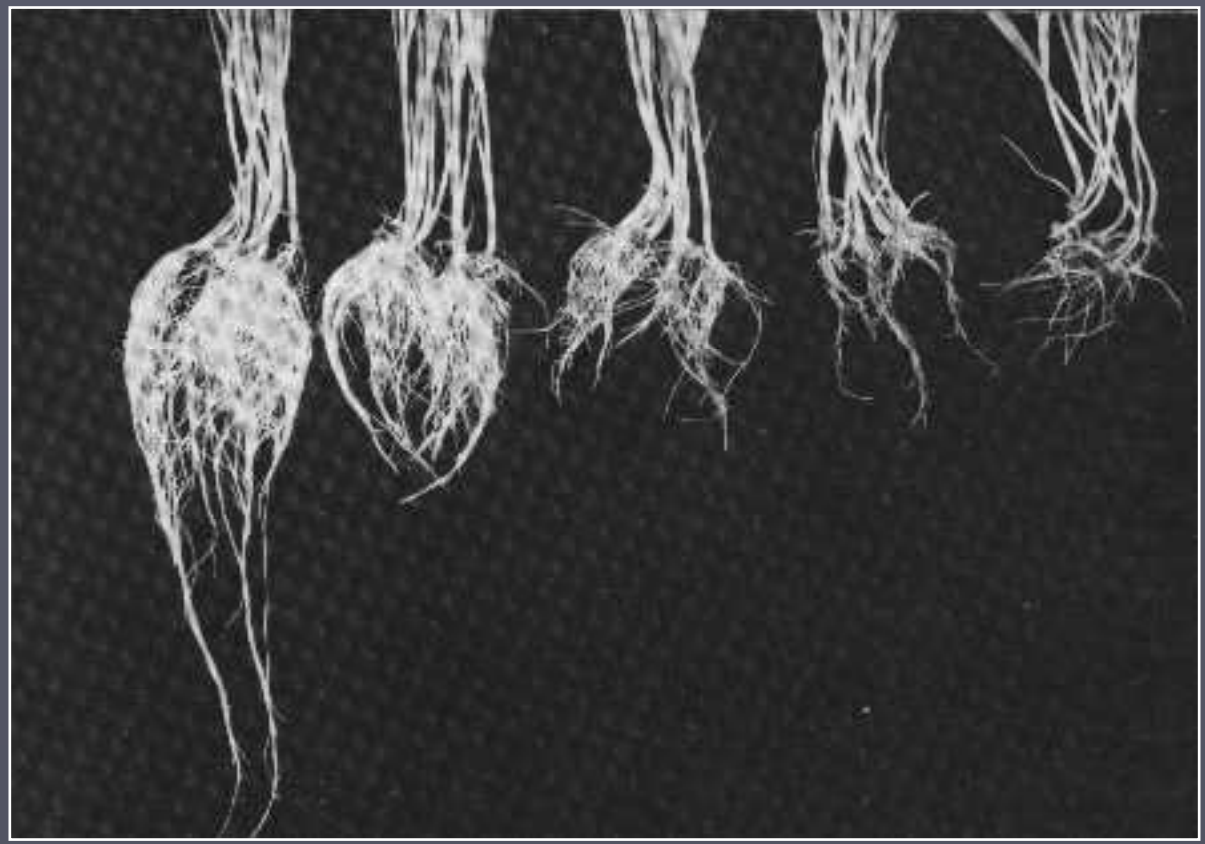
Coarse sized materials - all liming materials failing to meet the above fineness criteria

Lime Management Tips

- Soil Test and Maintain pH in the optimum range
- Apply lime a year to 6 months ahead of sensitive crops in rotation
- Mix lime thoroughly with the soil if possible
- For no-till the pH should be optimum before eliminating tillage
- Split high rates of lime (> 4 ton/A)
- Fall is an excellent time to lime
- Spread lime evenly
- Pay attention to Aglime Quality

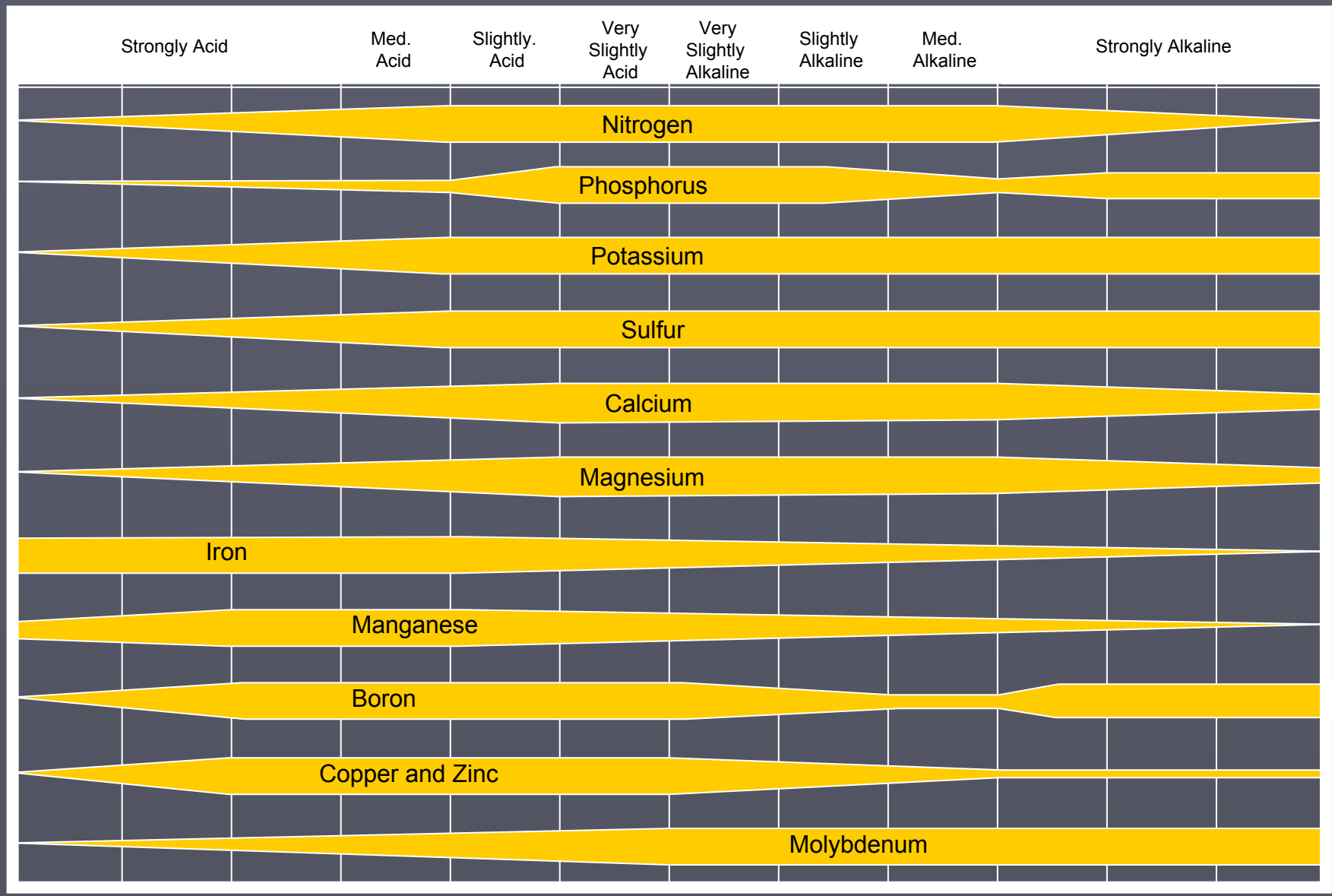
Aluminum toxicity reduces root growth

Soil pH 7.2 6.6 6.2 4.7 4.4



Barley Roots

pH vs Availability of Nutrients



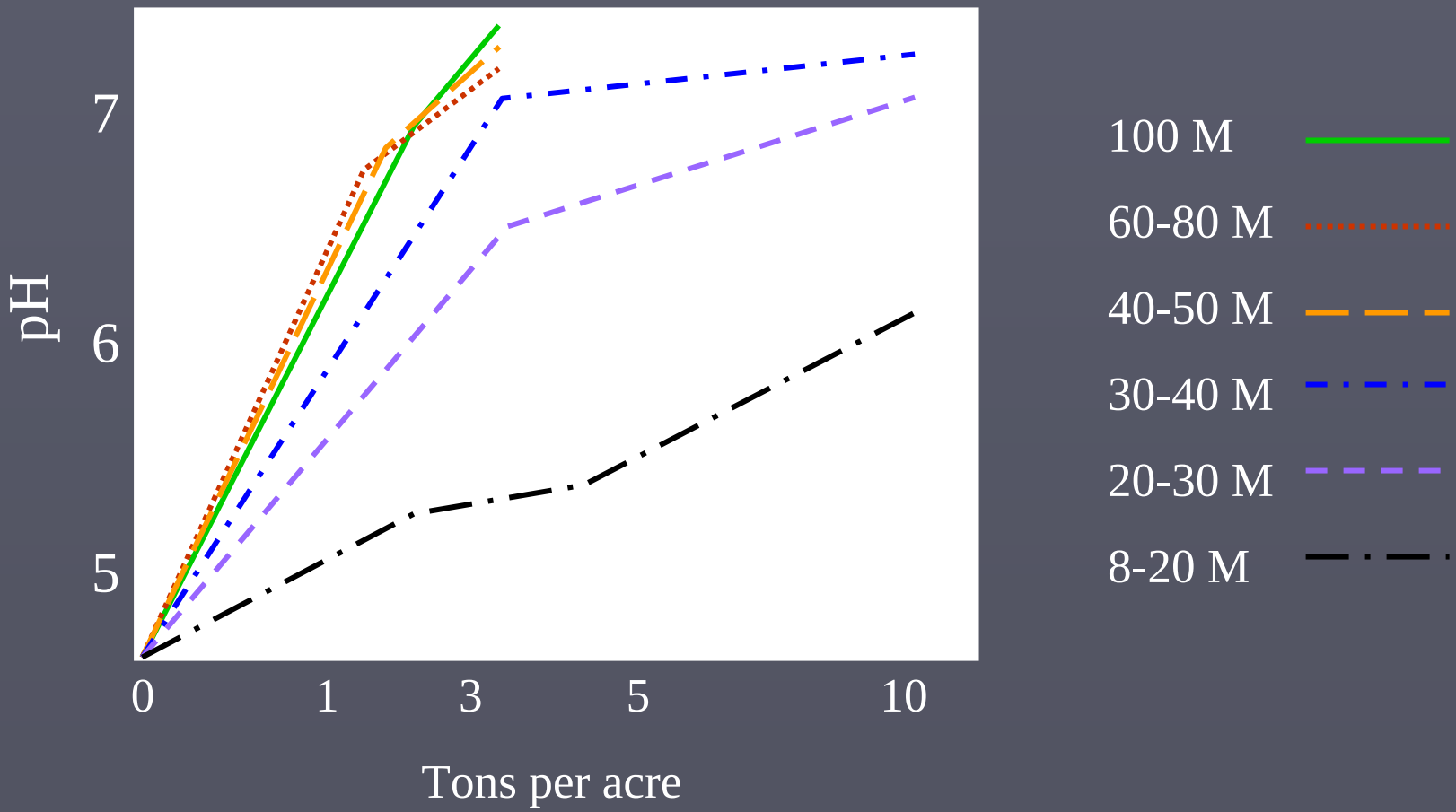
Acidity and Herbicide Activity

Unlimed no-till corn

Limed no-till corn

Aglime Fineness

Effect of limestone fineness on soil pH change



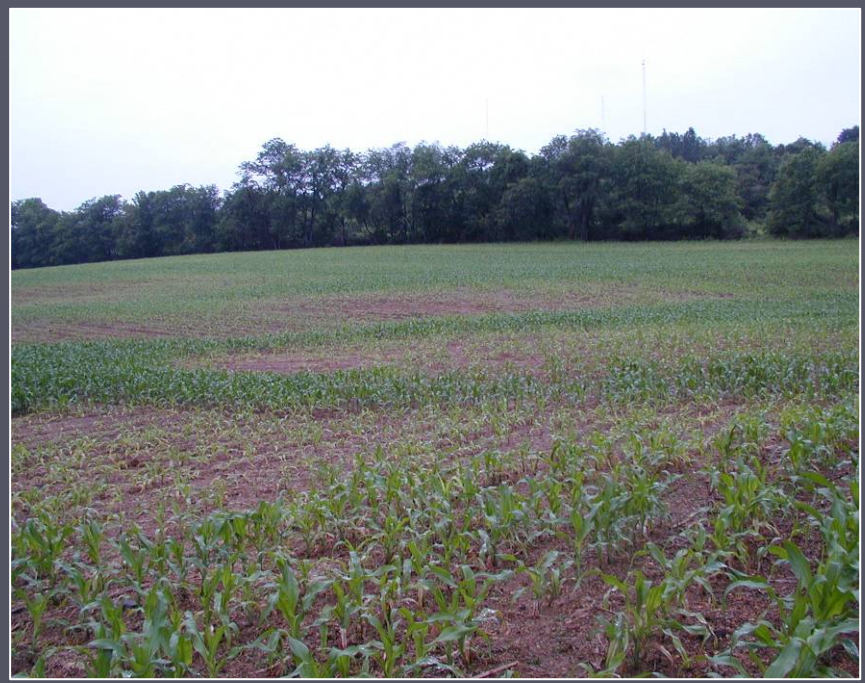
Liming Rented Ground

- Liming by nature is a longer term proposition
- Often a limiting factor on rented ground

Rented Field

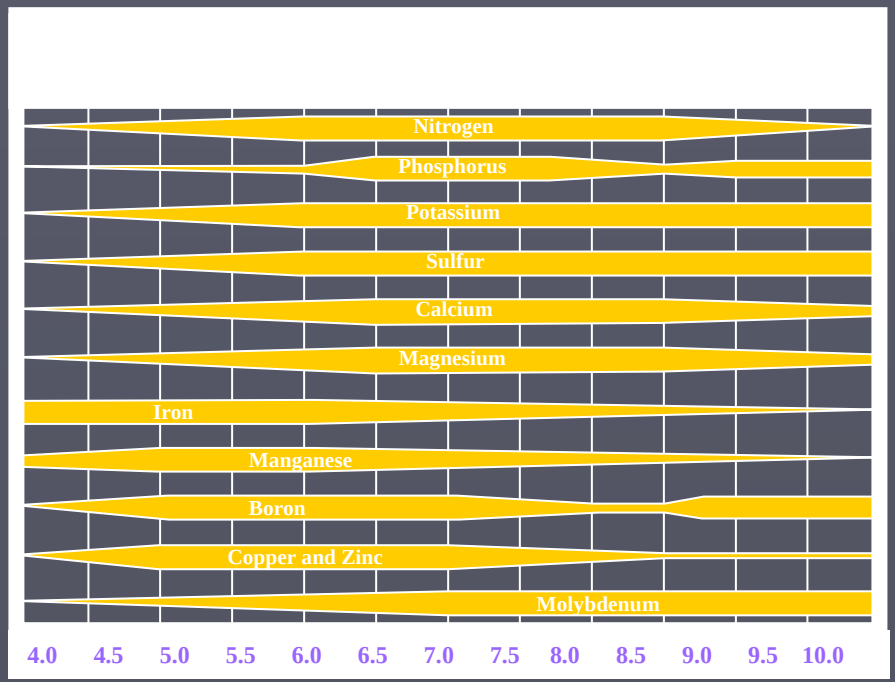
pH 3.8

Disaster



Liming Rented Ground

- Low soil pH often limits efficient use of other nutrients and pesticides
- You can't ignore it!



Limed No-till

Unlimed No-till

Liming Rented Ground

- Ideal for most agronomic crops is 6.5
- ***Critical pH for root growth is ~5.5***

Liming Rented Ground

- Aluminum toxicity reduces root growth below pH 5.5
- Reduces efficiency of nutrient and water uptake

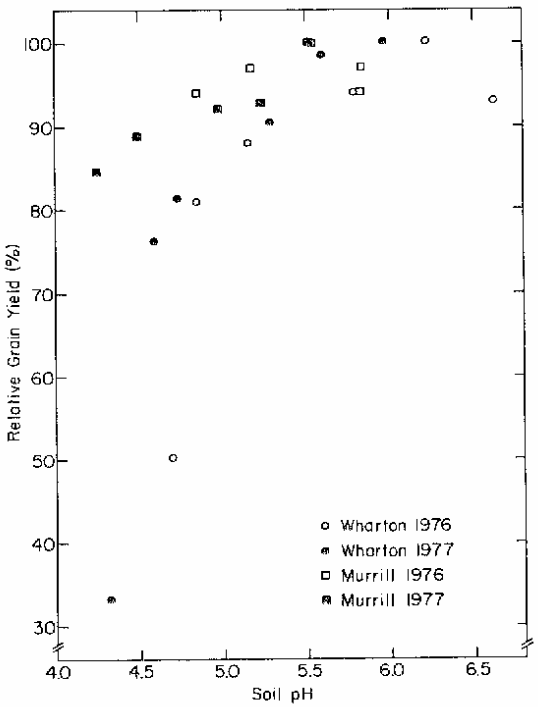


FIG. 1. The relationship between soil pH and relative corn grain yield.

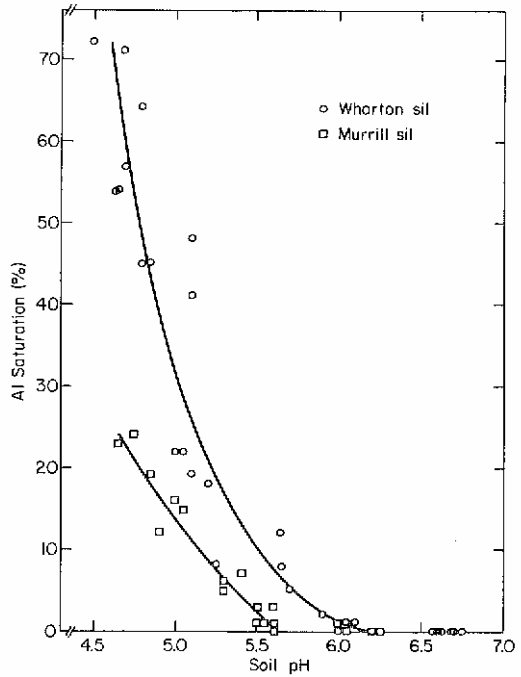
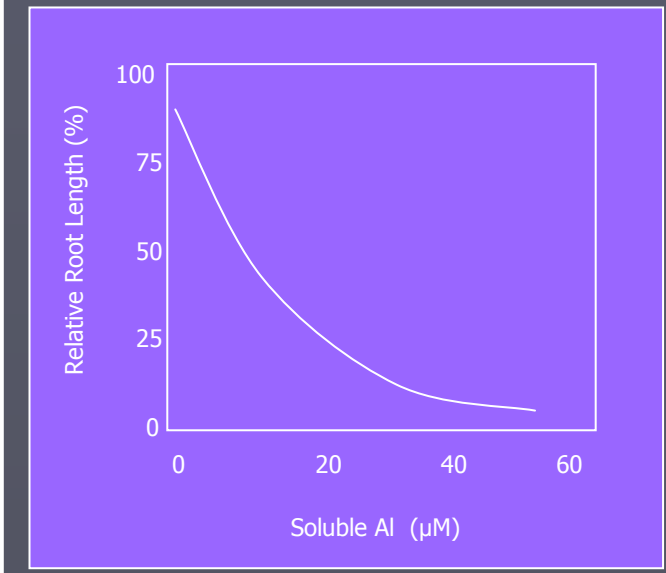


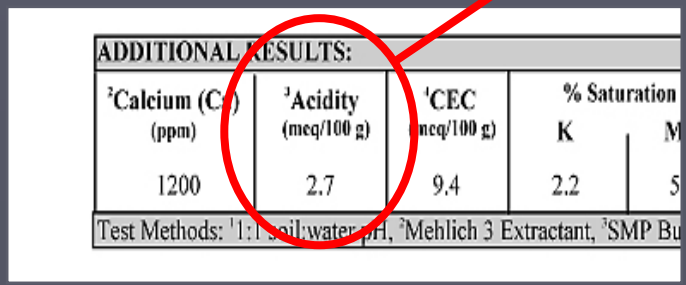
FIG. 2. The relationship between Al saturation and soil pH, 1976.



Liming Rented Ground

- Ideal for most agronomic crops is 6.5
- ***Critical pH for root growth is ~5.5***
- Critical pH for nutrients is ~6.0
- Critical pH for Legumes is ~6.5
- Critical pH for Herbicides is ~variable
  - Atrazine > 6.2
  - Read the label
    - Choose herbicides based on pH or adjust pH based on herbicides

PSU Lime Requirement Table



ADDITIONAL RESULTS:

[2]Calcium (Ca) (ppm)	[3]Acidity (meq/100 g)	[1]CEC meq/100 g)	% Saturation K	M
1200	2.7	9.4	2.2	5

Test Methods: [1]1:1 soil:water pH, [2]Mehlich 3 Extractant, [3]SMP Bu

LIME RECOMMENDATIONS

Limestone recommendations are made based on the pH goal and the amount of exchangeable acidity measured by the Mehlich Buffer soil test. The pH goal varies with the crop. The pH goal is given on the crop sheet for each crop in this handbook. If the soil pH is already at or above the pH goal, no limestone is recommended. If the soil pH is below the pH goal for the crop, look in the left hand column and find the acidity as reported on the bottom of the soil test report then go across to the appropriate "pH Goal" column to determine the limestone recommendation. The recommendations are given as pounds of calcium carbonate equivalent (CCE) per acre. If the limestone to be used is significantly different from 100% CCE, the recommendation must be adjusted for this difference. ST-2 "Liming Material Conversion Table" explains how to make this adjustment.

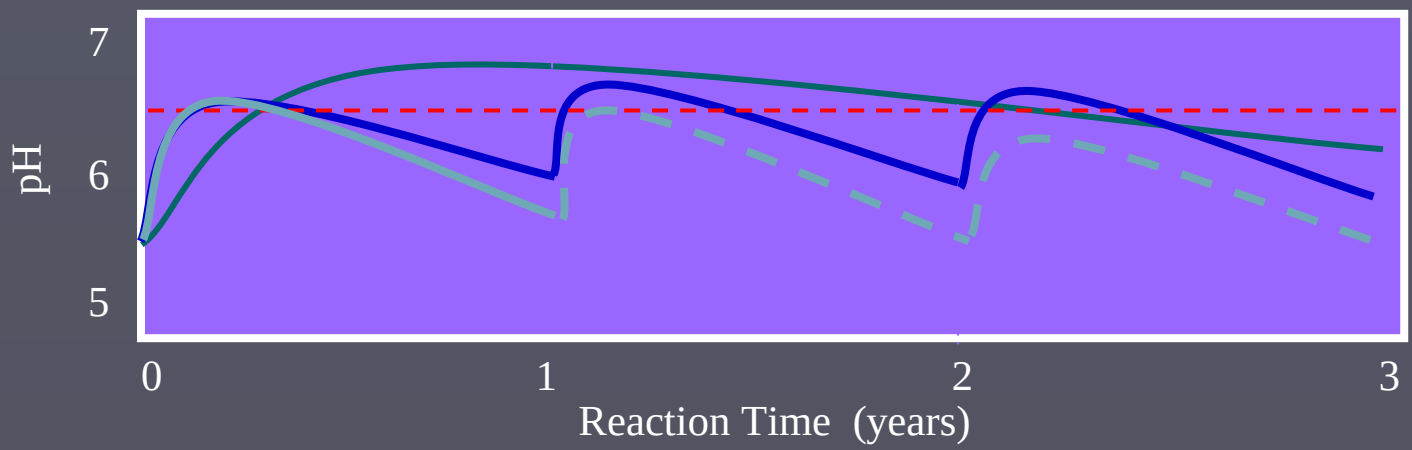
Table 1. Lime Recommendation (lb CCE/A)

Acidity (meq/100 g)	pH Goal 7.0	pH Goal 6.5	pH Goal 6.0	pH Goal 5.5	pH Goal 5.0
2.0	2,000	2,000	2,000	2,000	2,000
2.6	3,000	2,000	2,000	2,000	2,000
3.3	3,000	2,000	2,000	2,000	2,000
3.9	4,000	3,000	2,000	2,000	2,000
4.6	5,000	3,000	2,000	2,000	2,000
5.2	5,000	4,000	2,000	2,000	2,000
5.8	6,000	4,000	2,000	2,000	2,000
6.5	7,000	5,000	3,000	2,000	2,000
7.1	7,000	5,000	4,000	2,000	2,000
7.8	8,000	6,000	4,000	2,000	2,000
8.4	8,000	6,000	5,000	3,000	2,000
9.0	9,000	7,000	5,000	3,000	3,000
9.7	10,000	8,000	6,000	4,000	3,000
10.3	10,000	8,000	6,000	4,000	3,000
11.0	11,000	9,000	7,000	4,000	3,000
11.6	12,000	9,000	7,000	5,000	4,000
12.3	12,000	10,000	8,000	5,000	4,000
12.9	13,000	11,000	8,000	6,000	4,000
13.5	14,000	11,000	9,000	6,000	5,000
14.2	14,000	12,000	9,000	6,000	5,000
14.8	15,000	12,000	10,000	7,000	6,000
15.5	16,000	13,000	10,000	7,000	6,000
16.1	16,000	14,000	11,000	8,000	6,000
16.8	17,000	14,000	11,000	8,000	6,000
17.4	17,000	15,000	12,000	8,000	7,000
18.0	18,000	15,000	12,000	9,000	7,000
18.7	19,000	16,000	13,000	9,000	7,000
19.3	19,000	17,000	13,000	10,000	8,000
20.0	20,000	17,000	14,000	10,000	8,000

http://www.aasl.psu.edu/Agro%20Crops/Lime%20Recs.PDF

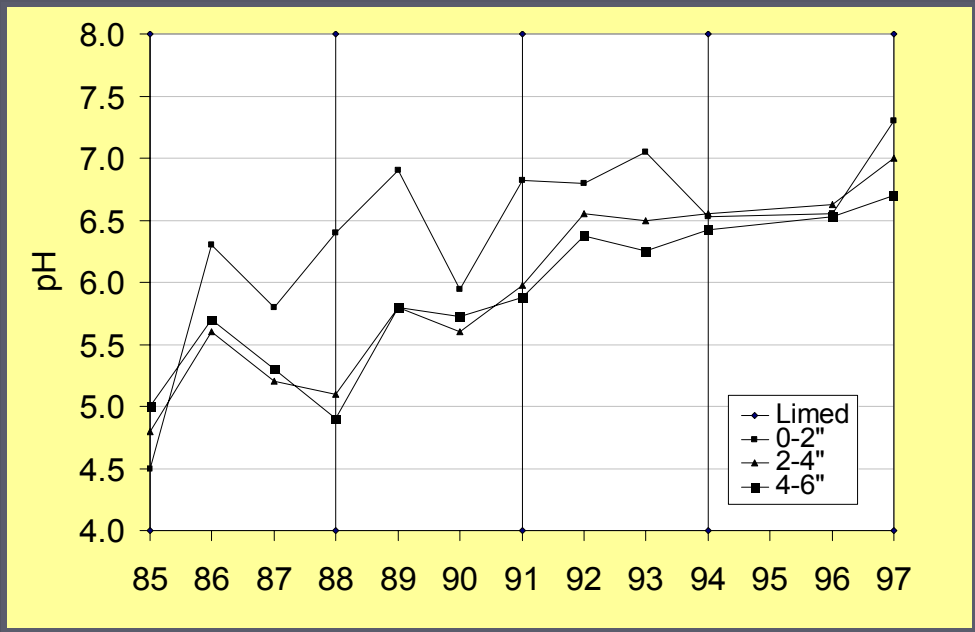
Split applications of extra fine limestone

- Lower annual costs
  - Only paying for 1 year at a time
- Greater cost over time
  - Similar amount of limestone required over time
  - More expensive limestone required - finer grind
  - Greater application costs - annual application
- Monitor with annual soil tests



Incorporate Lime

- Mixing limestone with the soil increases the short term effectiveness
- Very difficult to correct a low pH in no-till or perennials in the short term
- Probably more effective to incorporate low rates of lime with secondary tillage or chisel plow
  - At least the pH in the critical establishment zone will be improved
  - If the soil below this is very acid you may still have serious root growth problems



pH and Acidity

pH Scale

(1 unit change in pH = 10 X change in acidity)

0 - - - - - - - - - - 7 - - - - - - - - - - -14

Acid Neutral Alkaline

NE Soils Slightly Acid

Commonly pH 5 – 7

PA Average 6.3

Liming Rented Ground

- Ideal for most agronomic crops is 6.5
- ***Critical pH for root growth is ~5.5***