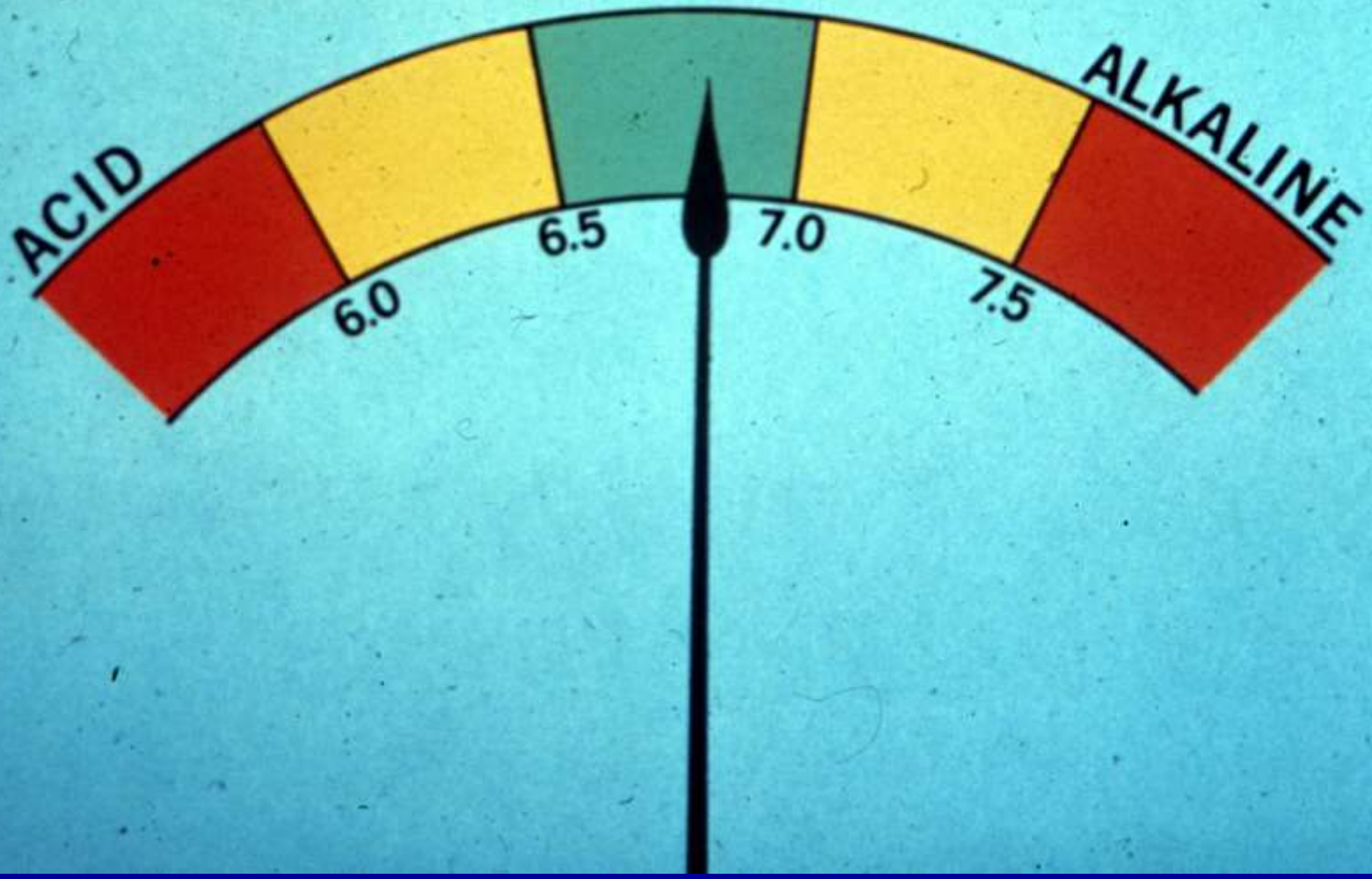
Soil Acidity and Liming

Soil pH

- pH is a measure of soil acidity
- Definition:
  - Acid soil has excess hydrogen ions (H^+) in soil solution
- pH = 1/ (-log[H^+])
- Agricultural soils = 5 - 8
- "Ideal" soil = 6.5 - 7

What is soil pH?



Characteristics of Soil Acidity

- Components:
  - Readily available (H^+)
  - Reserve or potential acidity
- pH buffering: ability of the soil to resist pH change; increases with increasing cation exchange capacity (CEC)
  - Clay content
  - Organic matter content

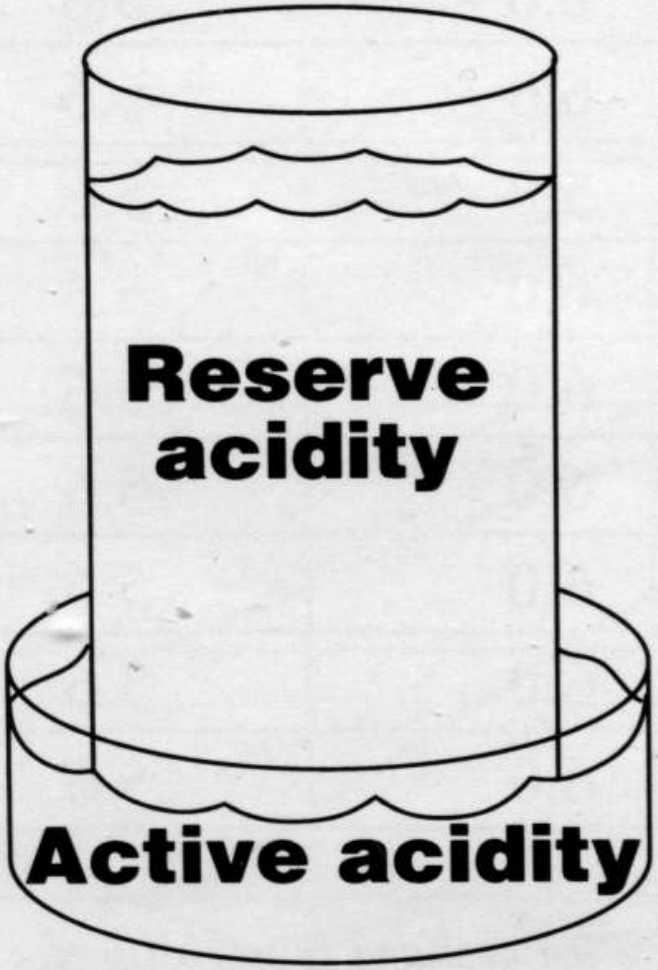


Figure 6-2. Active and reserve acidity in soil compared with a poultry watering fountain.

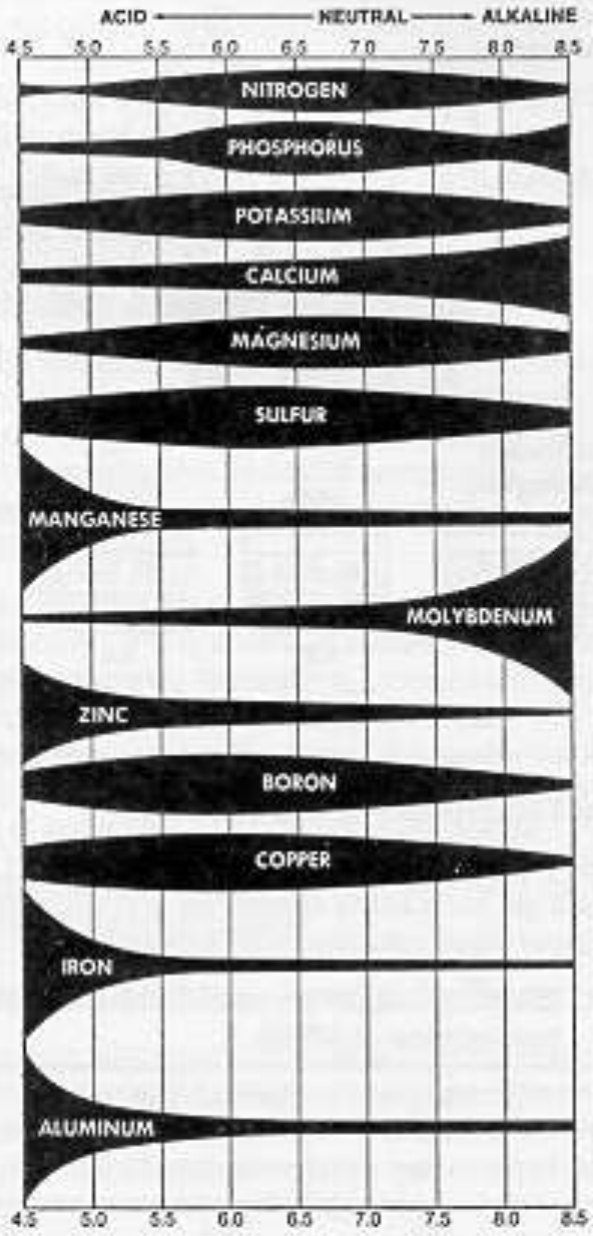
Why Soils Become Acid

- Use of acid-forming fertilizers
- Removal of basic cations (Mg^{++}, Ca^{++}, K^{+})
- Respiration by plant roots

Beneficial Effects of Liming

- Crop yield improvement
- Nutrient availability effects
- Improved microbial activity
- Improved legume fixation
- Calcium & magnesium addition

Figure 1. Relationship of soil pH and nutrient availability.



Calculating Lime Requirements

- See equations: p. 24, A2809
- Inputs needed:
  - Soil pH (active acidity)
  - Organic matter content
  - Buffer pH (reserve acidity)

Calculating Lime Requirements

- Target pH
- Determined by crop rotation
  - Corn – 6.0
  - Alfalfa – 6.8
  - Oats – 5.8
  - Soybean – 6.3

Calculating Lime Requirements

- Target pH 6.8
- 2.0[1.64(6.8-pH)(OM-0.07)-0.046(SMP)]

What determines the quality of a liming material

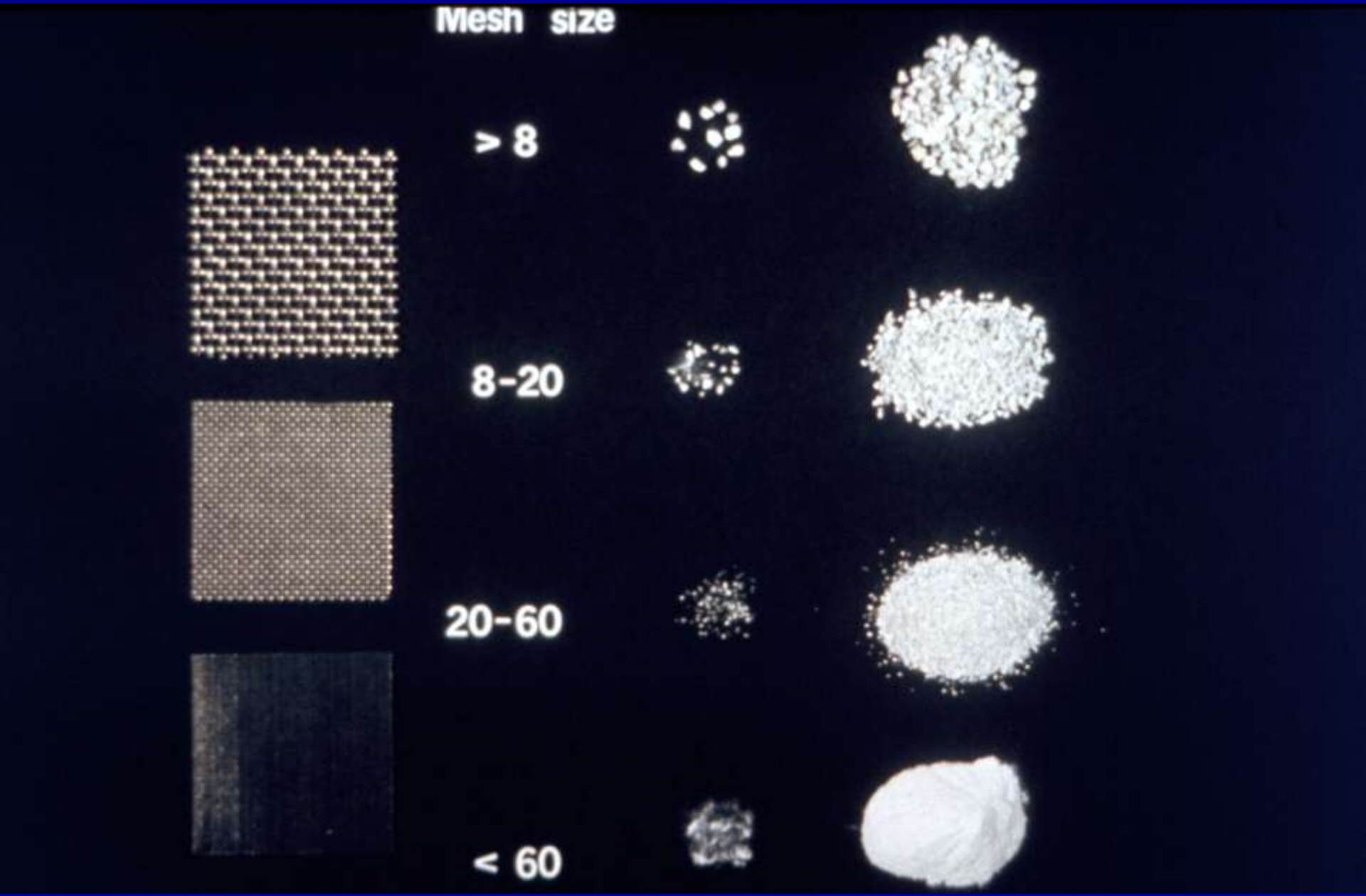
- Purity
  - Calcium carbonate ($CaCO_3$) equivalent (CCE)
- Fineness
- N.I.= Neutralizing index e.g., N.I. = 60-69

The purity factor ($CaCO_3$) Equivalent

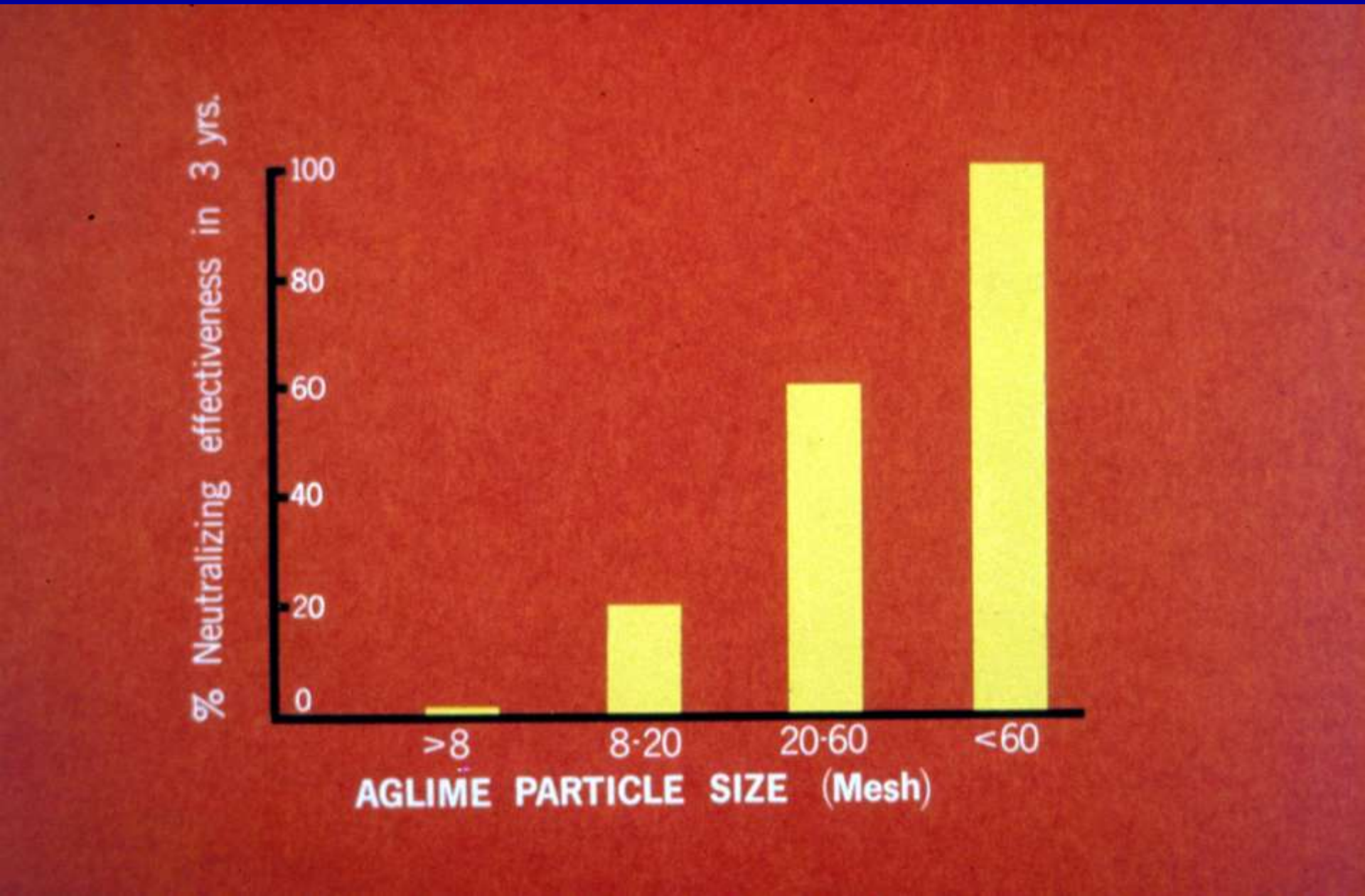
Table 6-5. Liming materials and their calcium carbonate ($CaCO_3$) equivalent

Liming material	Neutralizing agent	$CaCO_3$ equivalent of pure material (%)
Dolomitic limestone	$CaCO_3 \cdot MgCO_3$	110–118
Papermill lime sludge	Mainly $CaCO_3$	*
Marl	Mainly $CaCO_3$	variable
Calcitic limestone	$CaCO_3$	100
Water treatment lime waste	$CaCO_3$	variable
Wood ash	K_2CO_3, $CaCO_3$, $MgCO_3$	20–90
Fly ash	CaO, $Ca(OH)_2$, $CaCO_3$	variable
Hydrated lime	$Ca(OH)_2$	135
Air-slaked lime	$Ca(OH)_2 + CaCO_3$	100–135

* *According to the Wisconsin Lime Law, one cubic yard of papermill lime sludge is equivalent to one ton of aglime having a neutralizing index of 60–69.*


Mesh size
> 8
8-20
20-60
< 60

Lime Effectiveness over a three-year period



Calculating the Neutralizing Index of a liming material

Example 2: Lime B (90% calcium carbonate equivalent)

Screen size	Screen analysis		Effectiveness factor		
	%				
greater than 8 mesh	5.0	x	0.0	=	0.0
8 to 20 mesh	25.0	x	0.2	=	5.0
20 to 60 mesh	20.0	x	0.6	=	12.0
less than 60 mesh	50.0	x	1.0	=	50.0
			Total	=	67.0

NI = 67.0 x 90% = 60.3

Lime Requirement Conversions

- Recom. = 4 tons/acre, 60-69 lime
- Convert to requirement as 70-79 lime
- LR (70-79) = 4 x 65/75 = 3.47 tons/acre

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Table 6-7. 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+
(ton/a)	ton/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.*

Depth of tillage affects the lime requirement of soils

Tillage depth (inches)	Factor used to adjust lime recommendations for depth of tillage
<7.1	1.00
7.1–8.0	1.15
8.1–9.0	1.31
>9.0	1.46

HOW LIMESTONE WORKS