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ASAC 1101 : FUNDAMENTALS OF SOIL SCIENCE (2+1)

Level : B.Sc (Ag), I semester

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Topic

**pH, soil acidity and effect of pH on
nutrient availability**

Concepts Covered:

- What is soil acidity?
- Natural and manmade causes of soil acidity
- Pools of soil acidity
- Ameliorating soil acidity

Soil acidity

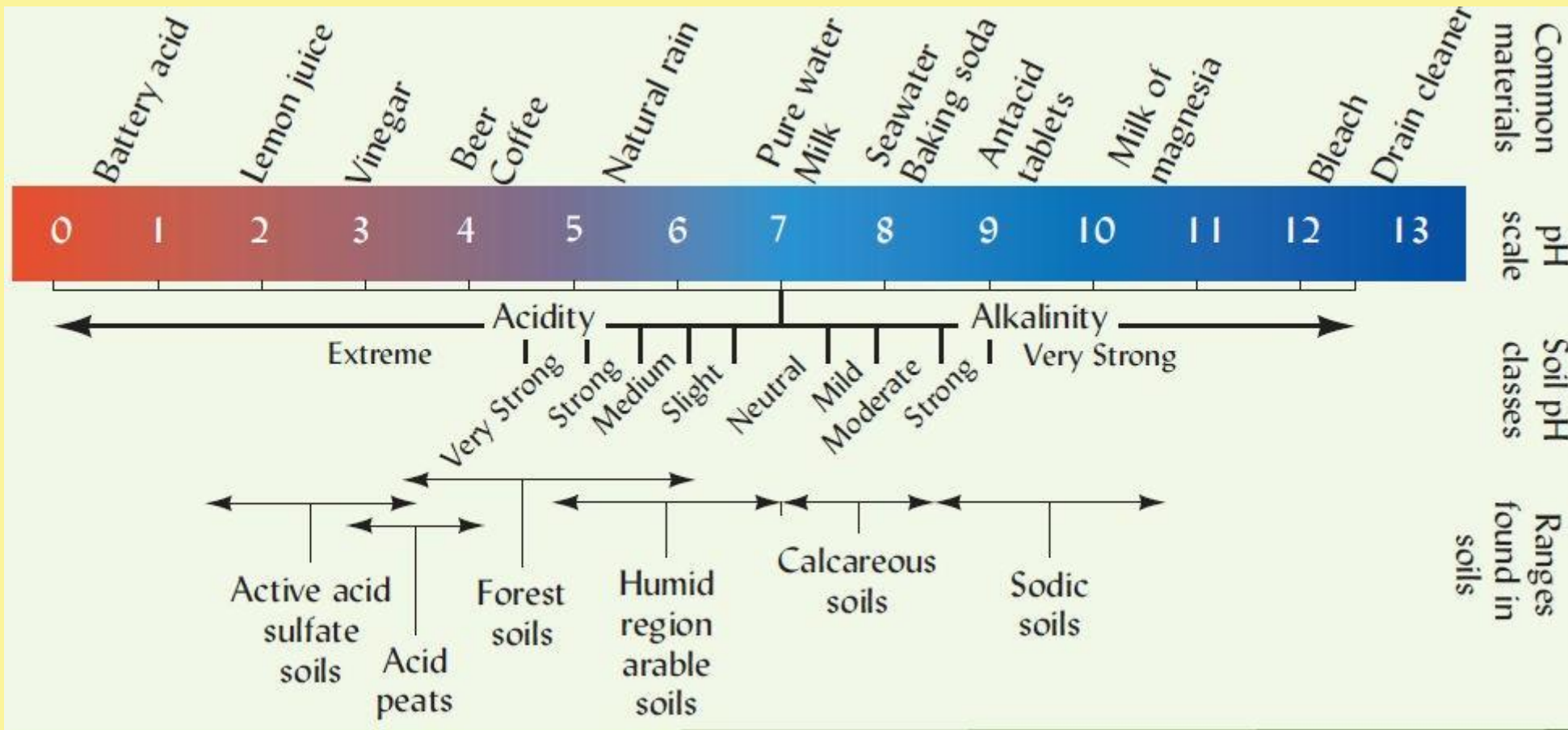
- ❑ Soil acidity is measured in pH units
- ❑ The smaller the pH, the more the acidity

$$pH = -\log[H^+]$$

[H⁺] : the concentration of H⁺ ions

- ❑ Every unit change in pH indicates a 10 fold change in acidity

Soil acidity



Sources of acidity

1. Carbonic and other organic acids

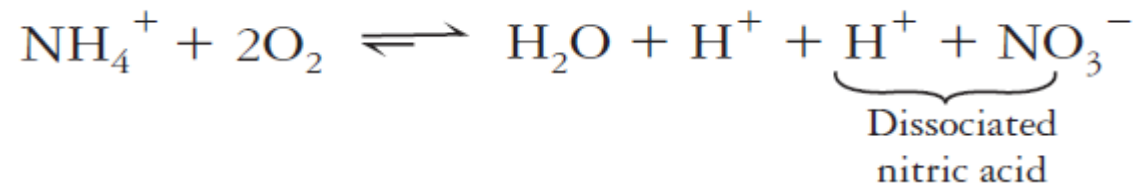
Source: CO₂ from respiration and organic matter decomposition



2. Accumulation of organic matter

3. Nitrification

Source: NH₄⁺ from fertilizers

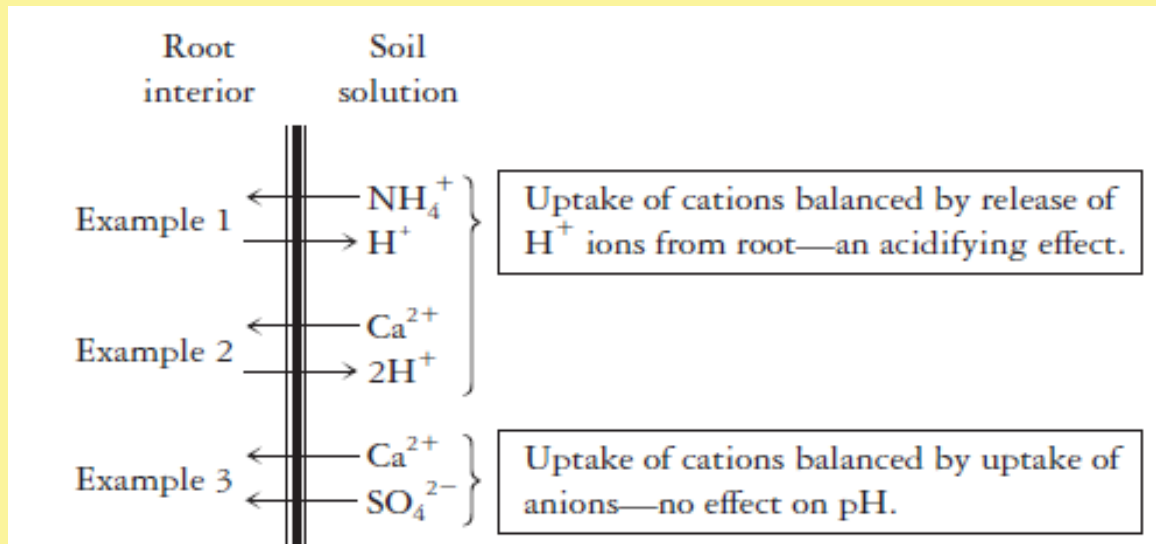


causes acidity

Sources of acidity

6. Plant uptake of cations

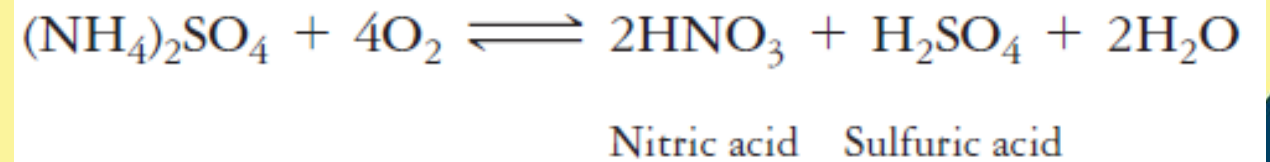
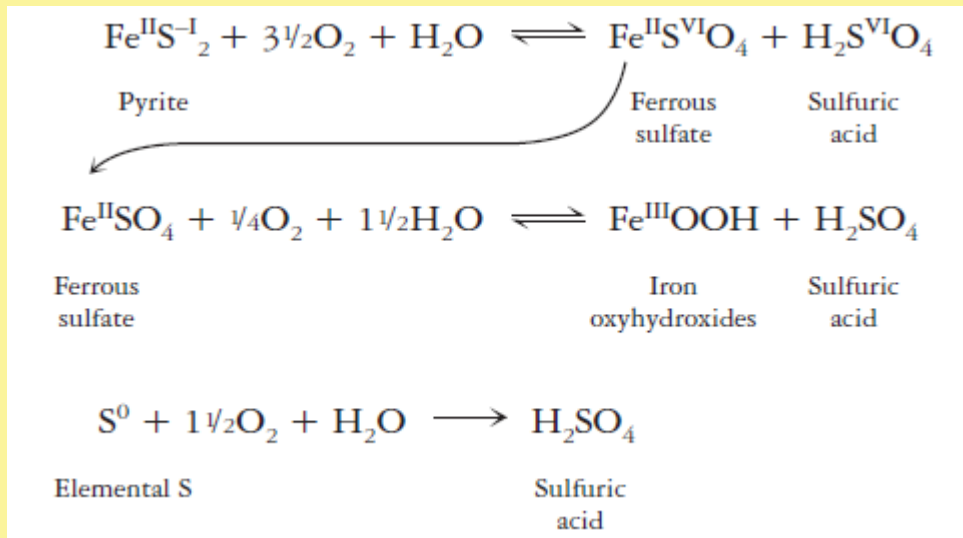
When plant roots take up more cations, they tend to balance it by releasing a H^+ ion, lowering the soil pH



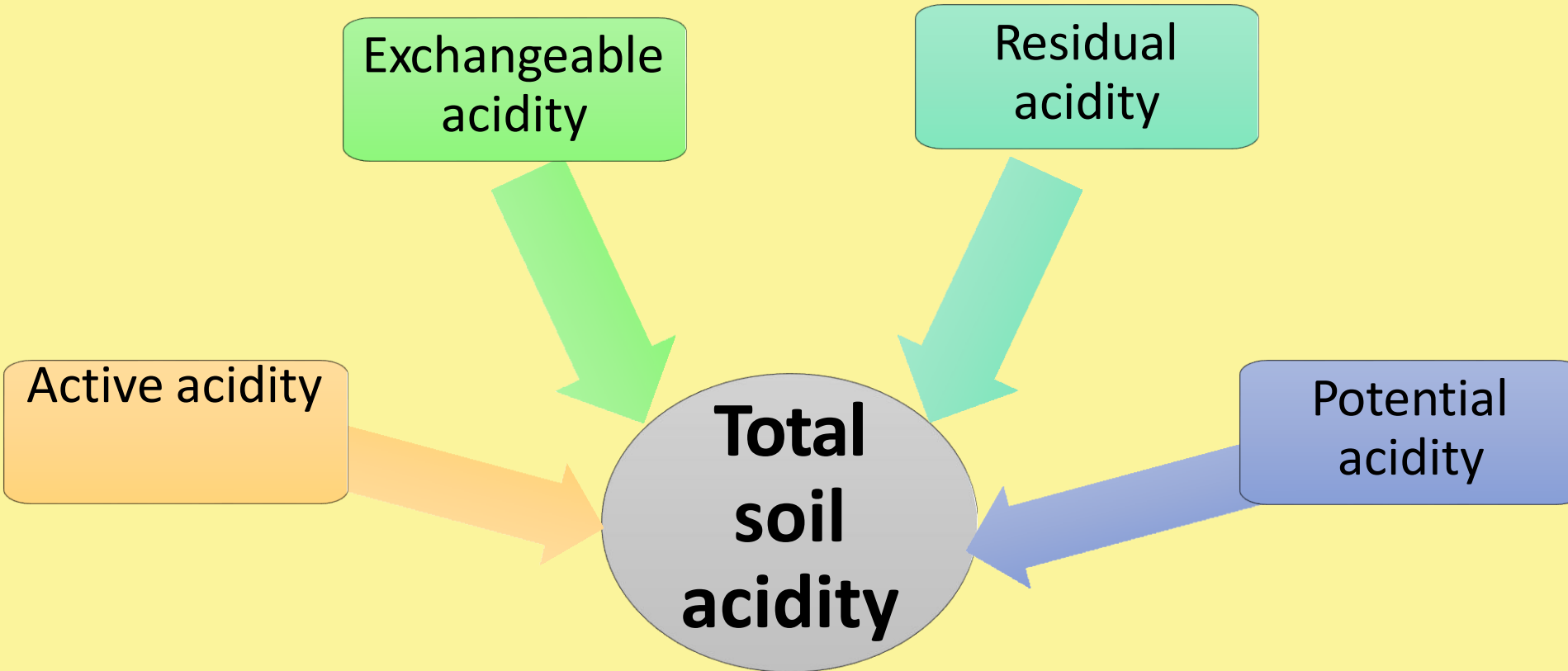
Sources of acidity

7. Human induced acidity

Source: excess nitrogen fertilizers, acid rain, exposing potential acid sulphate soils



Pools of soil acidity



Residual acidity > Exchangeable acidity > Active acidity

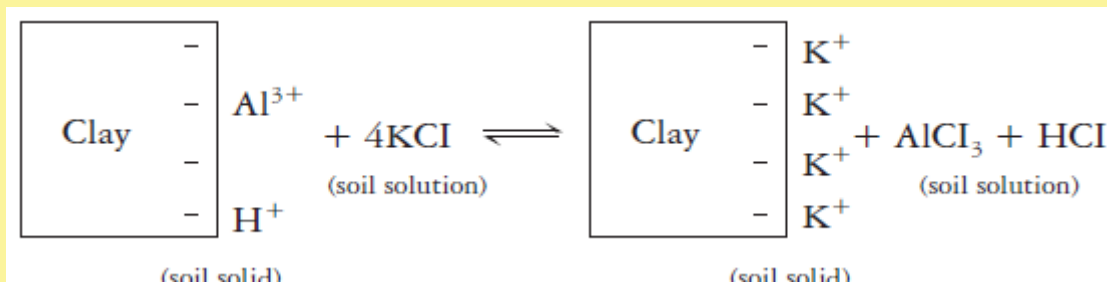
Pools of soil acidity

1. Active acidity

- ❑ This is the acidity usually measured using pH of soil solution
- ❑ Can be easily balanced

2. Exchangeable acidity

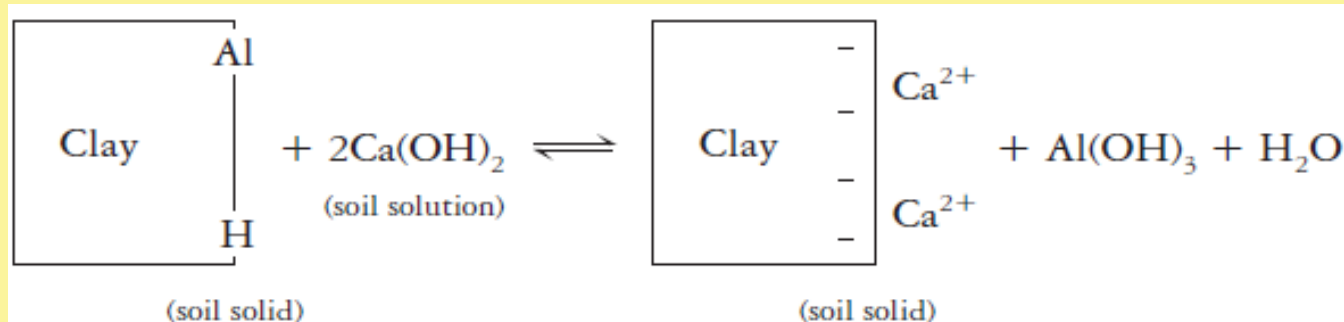
- ❑ Primarily caused by the Al^{3+} and H^+ ions in exchangeable sites in soil minerals (exchangeable cations)
- ❑ Can be measured by using unbuffered salts like KCl



Pools of soil acidity

3. Residual acidity

- ❑ Primarily caused by Al^{3+} and H^+ in non-exchangeable sites in soil colloid (bound cations)
- ❑ Released using liming materials



4. Potential acidity

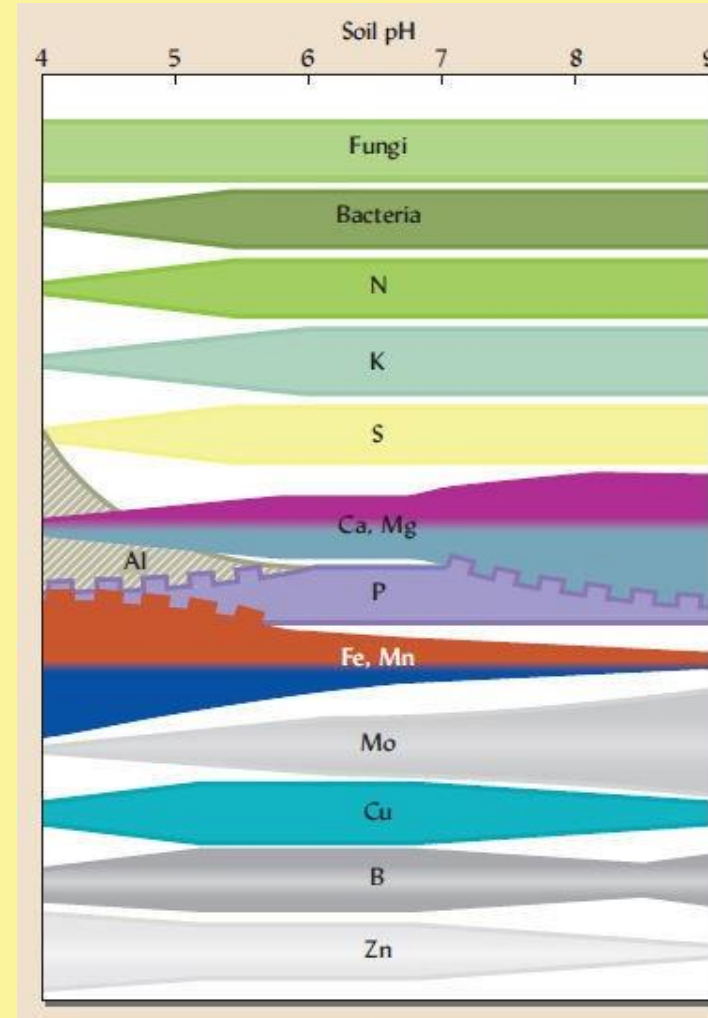
- ❑ the maximal amount of acidity which a partly or totally reduced soil may contain after it has been completely oxidized

Why should we consider soil buffering capacity?

- Better buffered the soil, better it resists acidity from external factors
- Buffering capacity helps us determine the amount of lime to be applied to raise the pH
- Higher the CEC, more the buffering capacity of soil
- Compensating only active acidity will have little consequence while liming. Therefore, we should also consider other pools

Effects of acidity

- Aluminium toxicity
- Manganese, Iron and Hydrogen toxicity
- Nutrient availability to plants affected
- Affects microbial growth
- Optimal pH for plants affected



Amelioration of acidity

1. Application of liming materials

□ Example: CaCO_3 , $\text{CaMg}(\text{CO}_3)_2$, CaO , MgO , CaSiO_3 etc.



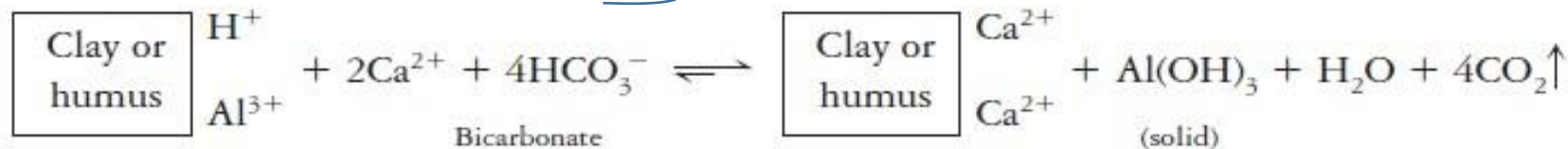
Dolomitic limestone

Bicarbonate

Bicarbonate

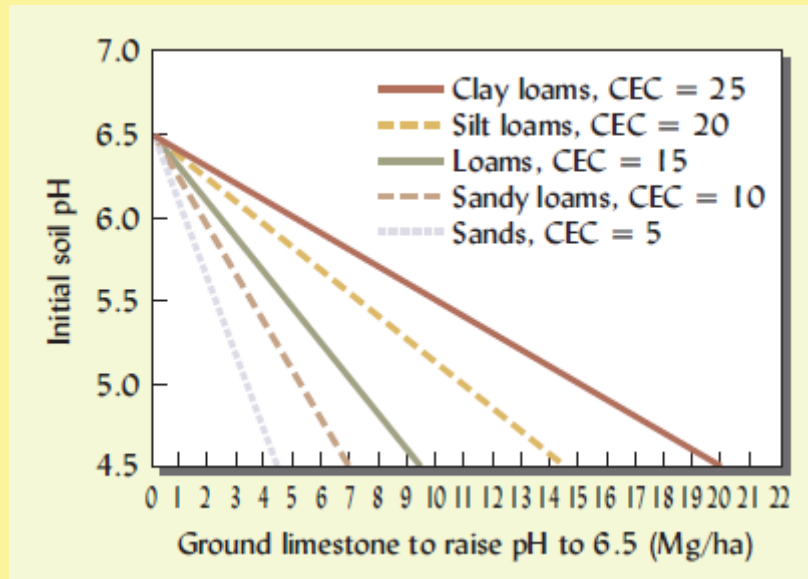
High CO_2 drives the reaction to right

Bicarbonate is very reactive in removing the Residual and exchangeable acidity



Amelioration of acidity

1. Amount of lime used depends on pH target, depth of application, buffer capacity of soil, lime material used and fineness of liming material



Fine textured soils need more liming as their buffer capacity to resist change is more.
Split application of lime recommended

Amelioration of acidity

2. Using organic matter

- They bind with Al and reduce their mobility
- They complex Al into non-toxic forms

3. Growing adapted plants

- A very practical solution
- Crops native to acid soils can be cultivated
- Through genetic engineering, new resilient varieties are also developed

Reference:

The Nature and Properties of Soils by Nyle C. Brady and Ray R. Weil

THANK YOU