PART I: What are acidic soils:

* Soils become acidic because of leaching. H+ is supplied to the soil by many sources

and lowers pH. Since pH is low, aluminum and hydroxide interact and form Al(OH)2+.

H+ and Al(OH)2+ are moved by water and replace basic cations on clay surfaces.

* Where do we have acidic soils:
* Rainfall higher tan 750mm yearly.
* Warm year-round temperatures and high rainfall (tropics and subtropics) where soils are extremely weathered.
* Sources of H+:
* Carbonic acid from CO2 in rain
* CO2 from humus decomposition
* H+ from NH4+ fertilizers
* H+ from plant roots
* Acid rain (pollutants)
* Crop removal of basic cations
* Properties of acidic soils:
* Naturally, acidic soils will remain acidic.
* Acidic soils are leached soils, the more leached the more acidic.
* Basic cations concentrations are low.
* Toxic levels of Al and Mn ions
* Microbial processes such as N2 fixation decrease.
* Plants that grow well in acidic soils have low basic cation requirements and tolerate low nutrient availability
* Low Ca and K demand
* Tolerate high Al and Mn concentrations.

PART II: Treatment of acidic soils:

* Lime materials: Carbonates, oxides, hydroxides, and silicates of calcium and magnesium.
* In agriculture, lime used: (most to least)
* Impure crushed calcium carbonate (powdered limestone).
* Calcium Magnesium carbonates (dolomitic lime).
* Calcium oxide/hydroxide
* Quicklime (CaO): Burned limestone.
* Hydrated lime Ca(OH)2: Quicklime reacted with water result in the hydroxide form.
* Marl (CaCO3): Lime from freshwater bottoms accumulated from waters high in lime.
* Chalk: (CaCO3): Lime deposited long ago in oceans.
* Ground lime by-products: Miscellaneous sources from paper mills, sugar beet plants, ash from coal burning plants…
* Fluid lime: Suspension in water of any fine liming material (<60 mesh).
* Gypsum (CaSO4 2H2O): NOT LIME but used to supply calcium and reduce aluminum toxicity.
* Chemical value of lime is expressed using the calcium carbonate equivalent or total neutralizing power:
* Chemically pure CaCO3 has a calcium carbonate equivalent = 100
* 85% pure CaCO3 has a calcium carbonate equivalent = 85
* Liming material neutralizing power is based on:
* Rate of solubility in chemical compounds of lime

Least soluble Most soluble

Calcium silicate Dolomitic limestone Calcic limestone Calcium carbonate Calcium oxide

* Fine lime particles react in soil faster than lime large lime particles
* Plant growth is reduced in acidic soils. Blueberries, cranberries, watermelon and pineapple are some exception.
* Aluminum toxicity
* Manganese toxicity
* Iron toxicity
* Reduced microorganism activity
* Calcium deficiency
* Magnesium deficiency
* Molybdenum deficiency (legumes)
* Nitrogen, phosphorous and sulfur deficiency due to slow organic decomposition.
* Addition of lime raises soil pH and eliminates:
* Excess toxic aluminum
* Slow microbial activity
* Lime works by replacing adsorbed acidic aluminum ions by calcium ions. H+ release is then neutralized by carbonates.
* Other benefits:
* Raising pH reduces excess manganese and iron since they form insoluble hydroxides
* Dolomitic lime fixes calcium and magnesium deficiencies
* Calcium carbonate fixes calcium deficiency
* Phosphorous is more available since aluminum and iron usually form insoluble compounds with phosphates. Less aluminum and iron means more soluble phosphates.
* Potassium is more efficient
* Lime increases nitrogen availability (More microbial activity)
* Increases available molybdenum
* Liming above pH=6.5 reduces toxic heavy metals (copper, lead nickel…)
* Determining the amount of lime to apply, we consider:
* pH requirement of the crop
* pH of untreated soil
* Texture
* CEC
* Buffer Capacity
* More clay and organic matter means more lime is needed to raise the pH since high CEC means the soil has more exchangeable aluminum and hydrogen ions.
* Soils with high organic matter should have their pH adjusted to a lower value than soils with low organic matter
* <10% OM = Adjust pH to 6.5
* 10% OM = Adjust pH to 6
* 20% OM = Adjust pH to 5.5
* Type of clay also affects the quantity of lime needed:

Vermiculite>Montmorillonite>Illite>Kaolinite>Sesquioxides

* Applying lime:
* Spread it on the soil surface with a truck and a spreading machine
* Newly spread lime should be mixed with the plow layer
* If large amounts are required, add half the amount before plowing and the other after plowing.
* How often to apply lime?

Depends on the rate at which lime is neutralized

The factors that made the soil acidic initially will neutralizer lime:

* Acid formed from the dilution of CO2: Slow
* Leaching: Slow
* Removal in harvested crops: Slow
* Erosion: Acidic subsoil will be exposed
* NH4+ fertilizers: Rapid
* Acidifying soils:
* Soils can be acidified for the following reasons:
* Some plants grow better in acidic soils
* Lessening infections from pathogens
* Micronutrient metals solubility (availability)
* How to acidify:
* Use elemental sulfur
* Use Al
* Use Fe compounds
* Use sulfuric acid