



Better Yields Through Better Soils

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GROW IT • EAT IT

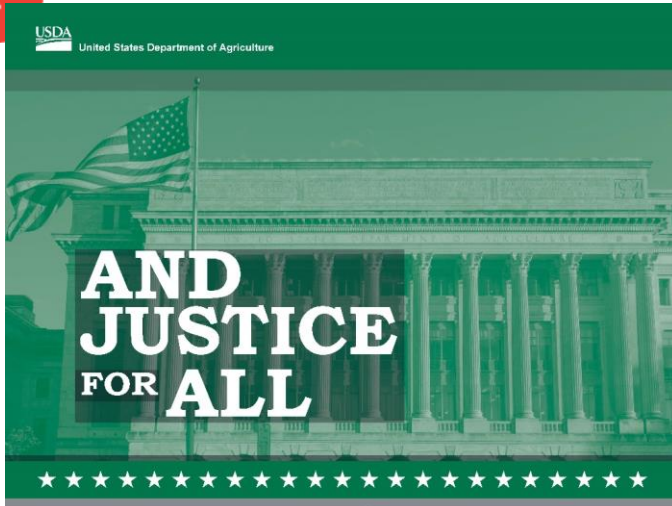
A MASTER GARDENER PROGRAM



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Office of the Assistant Secretary for Civil Rights
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Washington, D.C. 20250-9410; or
fax:
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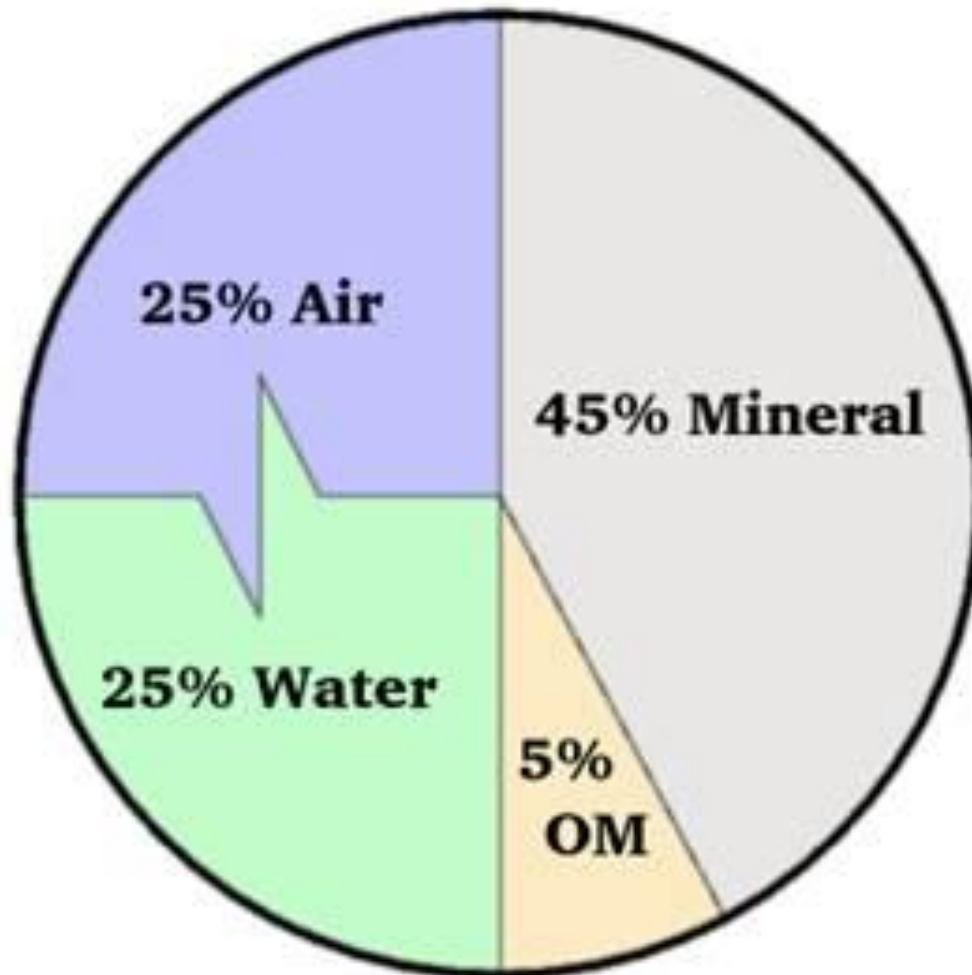
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What is Soil

- Soil contains 4 major components



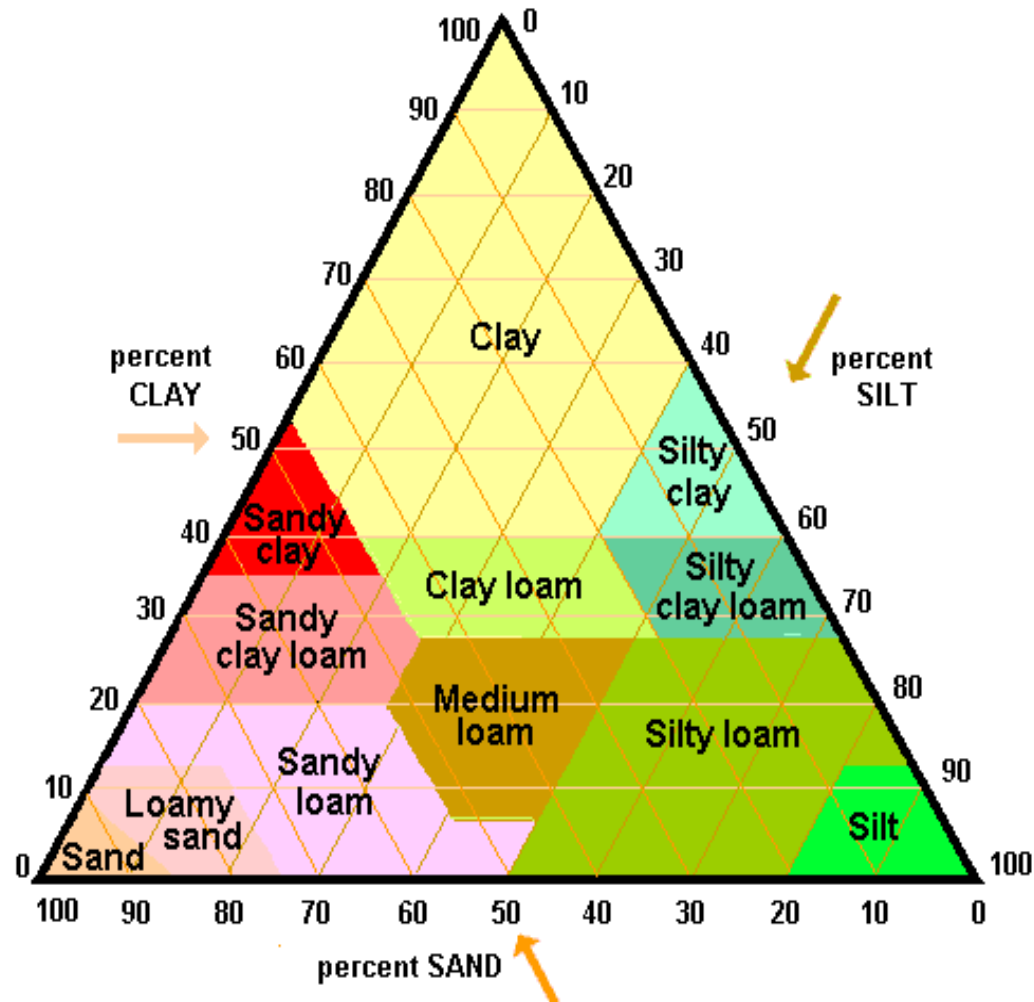


What are the mineral solids in soil

- Mineral solids in soil fall into three classes
 - Sand, which is gritty, size from .05 – 2 mm
 - Silt, feels like flour, size from .002-.05 mm
 - Clay, sticky when wet, size > .002 mm
- Most soils are mixtures of minerals of various sizes.
- Soil texture describes the proportion of sand, silt and clay in soil.
- Soil texture is an unchangeable property and is not altered by soil management.



Soil triangle





Effects of soil properties

- Soils made up of mostly sand(>50%, sand, loamy sand and sandy loam) have low water and nutrient holding capacity but lots of air space
- Soils made up of mostly clay(>60%, clays, sandy clays and silty clays) have high water and nutrient holding capacity and little space for air
- Soils with a mixture of properties have moderate water and nutrient holding capacity and adequate air spaces
- **Since we can't change soil texture, how can we improve our soils?**



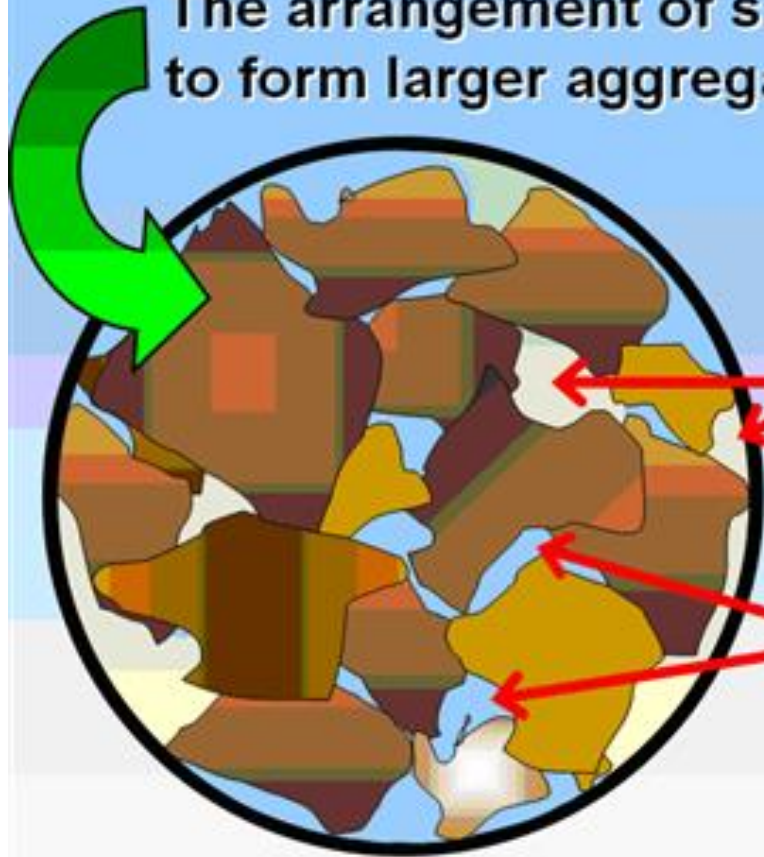
Soil structure

- The productivity of soil can be change by changing a soil's structure
- Soil structure is the arrangement of soil particles into clumps or aggregates
- Organic matter plays a “pivotal” role in cementing soil particles together
- A granular or crumb structure is desirable in topsoil



Soil aggregate

The arrangement of sand, silt, and clay particles to form larger aggregates.



- Organic matter is the glue that holds the aggregates together

Large pores (spaces) between aggregates are filled with air in a moist soil.

Small pores are filled with water in a moist soil. Even smaller pores inside the aggregates (not shown) are also filled with water.

0.5-25 cm



Components of organic matter

- Humus makes up about 75% of OM
 - It is a stable product of decomposition and increase a soils ability to hold water and nutrients
 - By cementing soil particles together, it impacts the number and size of the pores in the soil
 - Macro (large) pores drain water and aid in the flow of gases (O_2 & CO_2) into the soil
 - Micro (small) pores retain water after drainage and store it for plant use
 - Increasing OM improves soil structure insuring plants have adequate water and oxygen in the root zone



Humus (cont.)

- Micro pores hold the soil solution which is made up of water and other materials
- Soil solution is the source of nutrients for plants
 - Fertilization increases nutrients in solution
 - Plant uptake decreases nutrients in solution
 - Breakdown of plant residues and organic nutrient sources increase nutrient levels
- Plant growth is optimized by maintaining adequate water and nutrients in soil solution



Biomass

- Biomass is the living component of soil
 - Worms, bacteria, fungi, etc.
- Function of biomass
 - Nutrient cycling – digest residues, use what they need and leave waste in plant-available form – mineralization
 - Creation of bio pores – larger organisms improve soil structure as they move through the soil
 - E.g. Worms create channels for water flow



Residues and by-products

- Residues and by-products include crop residues, dead roots, bodies of biomass and materials that roots and creatures release into the soil
 - Residues provide nutrients and energy for soil biomass
 - Residues with $C/N > 25$ use N from soil solution
- The sticky, gummy by-products of decomposition hold soil particles together in clumps or aggregates



Take away

- OM improves soil structure
 - Humus holds soil solution (water and nutrients)
 - Provides residue for soil organisms
 - Soil organisms cause mineralization
 - Mineralization is changing organic materials containing NPK into an ion forms plants can use
 - Sticky, gummy by-products glue particles together creating aggregates
 - Aggregates and other soil particles create spaces of different sizes which permit soil to hold soil solution (water and nutrients) and gases



Take away (cont.)

- U of MD recommends 6" of compost for new gardens, 2 to 4 inches if OM levels are low < 4 and 1" for existing gardens
- Object is to raise OM content in soil and create a reservoir of residues for biomass to mineralize
- Objective is to add OM to improve soil structure



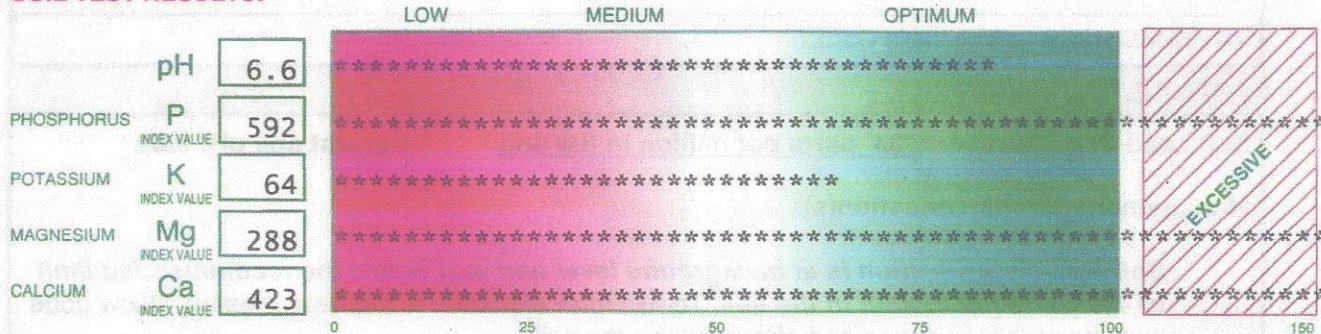
Healthy soil

- First rule get a soil test
 - Send a soil sample to a soil testing lab
 - Test for lead and OM
 - Cost about \$17
 - Follow lab recommendations for amending soil
 - Understanding your soil test report
 - Nutrients
 - pH level
 - % Organic Matter
 - Cation Exchange Capacity (CEC) >10
- Ask Extension



Soil Test

SOIL TEST RESULTS:



5.1	42.1	82.0	30.1	12.0+		7.62	100.0	27.6	89.0	1,13
B	Mn LBS/ACRE	Zn	SO ₄ -S	% ORGANIC MATTER	SOL. SALTS MMHOS/CM	BUFFER pH	% Phosphorus Saturation	CEC meq/100gm	% Base Saturation	ENCLOSURES

SUGGESTED FERTILIZER PROGRAM:

CROP: FLOWER BEDS

*****SEE BELOW*****						
T/A	TYPE	N	P ₂ O ₅	K ₂ O	S	B
	LIME	LBS/A	LBS/A	LBS/	LBS/A	LBS/A

YIELD GOAL: N/A

1. Apply 1 lb of N per 1000 square feet of garden area. This can be supplied by 3 lbs ammonium nitrate (34-0-0) or 2.5 lbs of urea (46-0-0). If these two fertilizers are not available, select an alternate source that is low in P as soil levels of P and K are already in the "Optimum" or "Excessive" range.

Apply recommended fertilizer to the soil surface and rake in just before planting.

2. Next growing season - follow the maintenance fertilizer programs for flowers in Soil Test Note 13 (enclosed).



Reading The Soil Test

- Results
 - Fertilizer recommendations
 - 2.5# of 46-0-0 or 3# of 34-0-0 per 1000 sqft
 - Per 100 sqft. .25# or 4 ounces of 46-0-0 or .3# or 4.8 ounces of 34-0-0
 - For 4 x 8 bed, 32/100 times amount
 - .32 times either 4oz. = 1.28 oz or 4.8oz. = 1.53 oz
 - For 12 ft x 15 ft garden, 180/100
 - 1.8 times 4 oz = 7.2 oz or 4.8oz. = 8.6 oz
- Use a kitchen scale to weigh out amounts



Tons to teaspoons

- Don't have a kitchen scale, reference information on UMD's [soil test](#) webpage.
- [UCONN](#) 1C of urea = $\frac{1}{3}$ lb. or 5.3oz.
 - 1C = 16 Tbs. or 5.3oz
 - $1.28\text{oz.} \div 5.3\text{oz.} \times 16 \text{ Tbs} = 3.8\text{Tbs}$ or $\approx \frac{1}{4}\text{C}$
 - $7.2\text{oz.} \div 5.3\text{oz.} \times 16 \text{ Tbs} = 21.6\text{Tbs}$ or $\approx 1\frac{1}{3}\text{C}$
- Search “tons to teaspoons of fertilizer calculator”

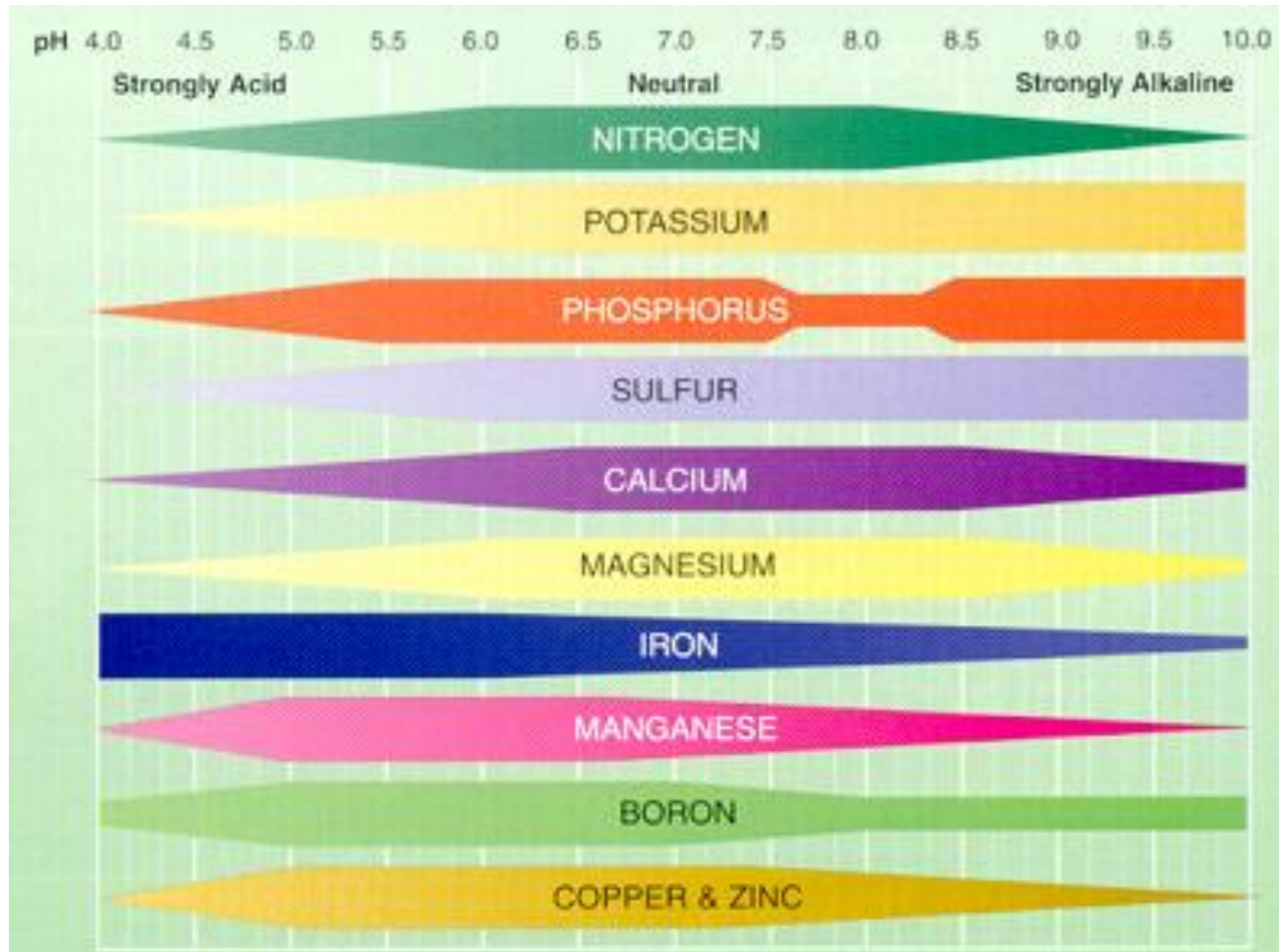


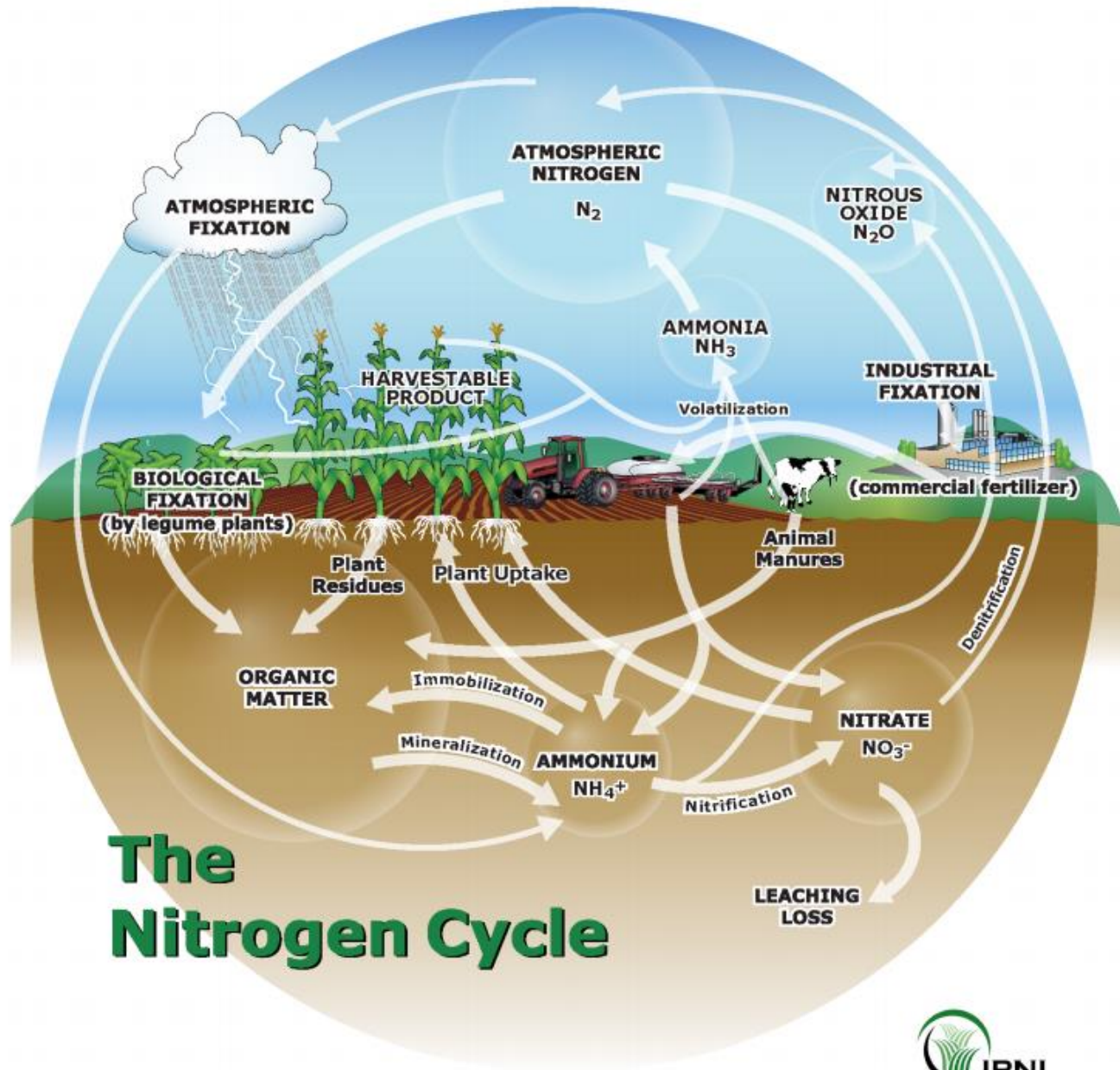
Healthy soil

- pH (potential hydrogen)
 - Vegetables - $6.2 < \text{pH} < 6.8$ is optimal
 - Soils in this pH range allow the optimum uptake of macro and micro nutrients
 - Lime raises pH
 - Ferrous sulfate or sulfur lowers pH
- Soil lab will tell you what and how much to apply
- Questions about soil tests can be sent to Extension at [Ask Extension](#)



pH and nutrient uptake





The Nitrogen Cycle



Nitrogen cycle

- Plants only take up mineralized N
 - Ammonium ion
 - Nitrate ion
- These forms of N come from two main sources
 - Fertilizers
 - Inorganic - readily available to plants
 - Organic forms - must be mineralized by the biomass to create ammonium and nitrate ions
 - Organic residues containing N
 - must be mineralized by the biomass to create ammonium and nitrate ions



Mineralization

- Soil biomass is temperature sensitive
 - Slow in cold and cool weather
 - Rapid in hot weather
 - For each 1% OM .067 lbs of N released per 100 sqft.
- In spring and fall organic gardeners should use
 - Fish emulsion NPK 5-0-0 90% immediately available
 - Blood meal NPK 12-0-0 50% immediately available
- In summer, soybean meal, cotton seed, etc.
- See [Fertilizer Basics](#)
- See [Fertilizing Vegetables](#)



Side Dressing

Broccoli

- **Fertilizing** – Broccoli is a heavy feeder. Mix compost into the soil and fertilize at transplanting; side-dress three weeks later and when central head has been cut ($\frac{1}{4}$ lb. of 10-10-10 per 10 ft. row). This will help produce later but smaller heads from side shoots.

Peppers

- **Fertilizer needs:** Light-medium feeder. Use starter fertilizer for transplants; side-dress with $\frac{1}{4}$ lb. of 10-10-10 or equivalent per 10 ft. of row after first fruits set.

Brussels Sprouts

- **Fertilizing** – Heavy feeder. Side-dress with a balanced fertilizer 2 to 4 weeks after planting or when plants are 12 inches high.

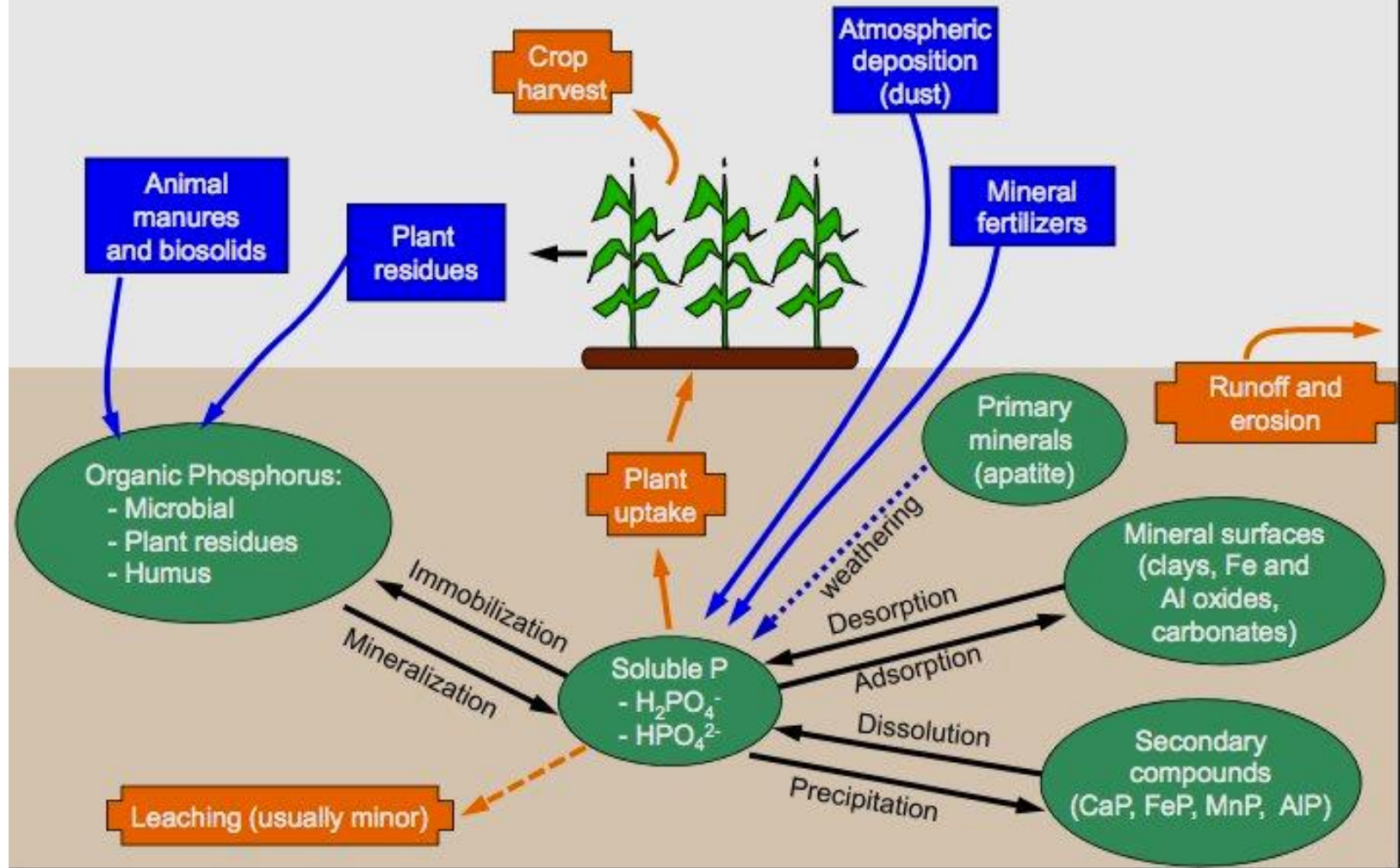


The Phosphorus cycle

Component

Input to soil

Loss from soil





Phosphorous Cycle

- Maryland soils generally contain sufficient P
 - Only add P if called for by soil test
- Plants can only uptake P in ion form
 - Inorganic fertilizers
 - Mineralization by biomass
- Phosphorous movement
 - Leaching is minor except in sandy soils
 - Runoff can be a major problem in fertile soils.



- Online references at www.extension.umd.edu/hgic
 - [Soil Test](#)
 - [Understanding your soil test report](#)
 - [Soil, Fertilizer, Mulch and Compost](#)
 - [Fertilizer Basics](#)
 - [Fertilizing vegetables](#)
 - [Vegetable facts](#)
 - [Cover crops](#)
- Questions [Ask Extension](#)



Cover Crops

- Legume plants
 - Fix nitrogen in the soil
 - Stabilize soil during the winter
- Cereal cover crops
 - Mine nutrients with extensive root systems
 - Stabilize soil
 - Oats are winter killed
- Forage radish
 - Breaks up clay soil
 - Winter killed



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