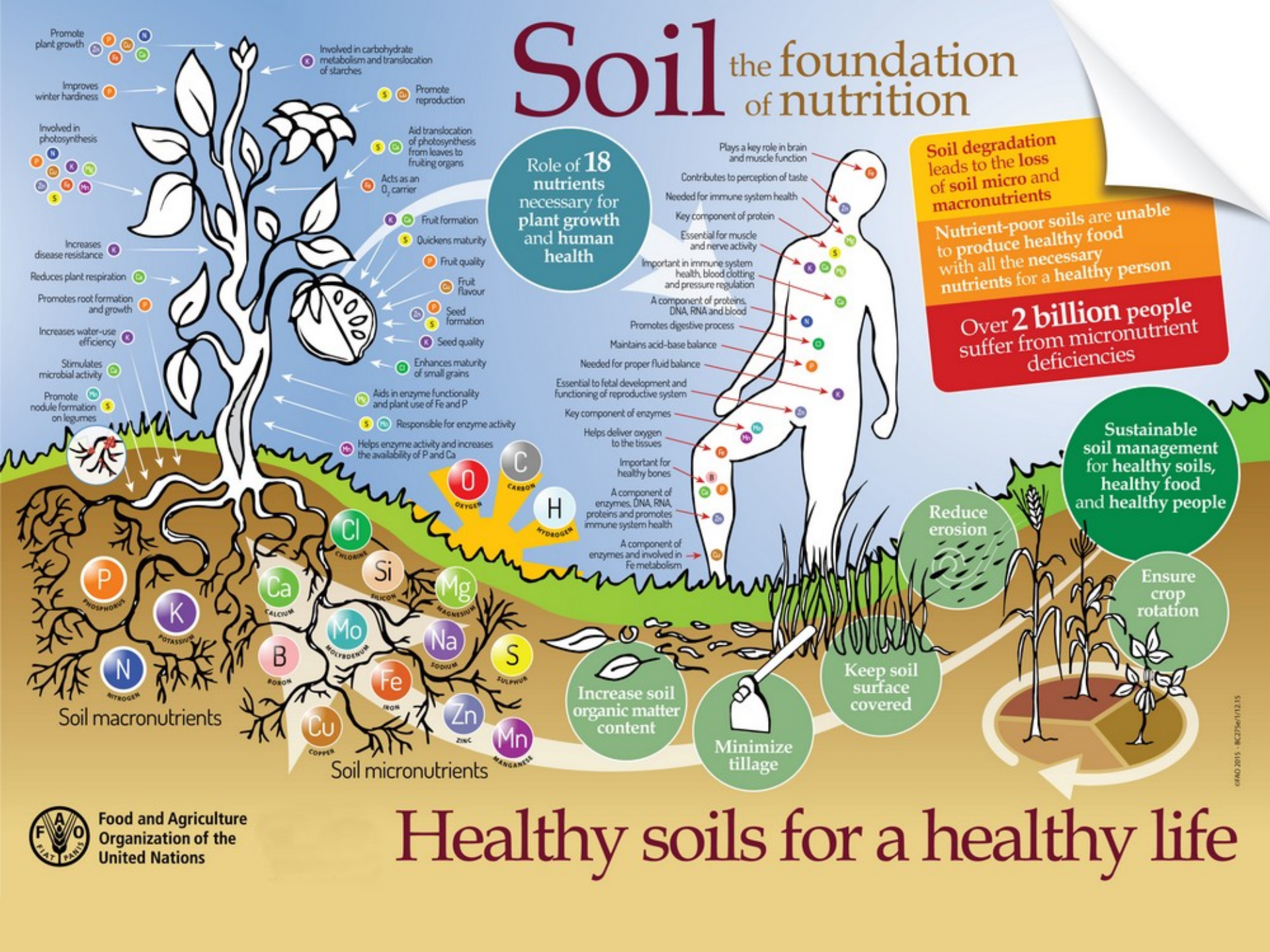
Soil the foundation of nutrition
Role of 18 nutrients necessary for plant growth and human health
Soil degradation leads to the loss of soil micro and macronutrients
Nutrient-poor soils are unable to produce healthy food with all the necessary nutrients for a healthy person
Over 2 billion people suffer from micronutrient deficiencies
Promote plant growth
Improves winter hardiness
Involved in photosynthesis
Increases disease resistance
Reduces plant respiration
Promotes root formation and growth
Increases water-use efficiency
Stimulates microbial activity
Promote nodule formation on legumes
Involved in carbohydrate metabolism and translocation of starches
Promote reproduction
Aid translocation of photosynthesis from leaves to fruiting organs
Acts as an O2 carrier
Fruit formation
Quickens maturity
Fruit quality
Fruit flavour
Seed formation
Seed quality
Enhances maturity of small grains
Aids in enzyme functionality and plant use of Fe and P
Responsible for enzyme activity
Helps enzyme activity and increases the availability of P and Ca
Plays a key role in brain and muscle function
Contributes to perception of taste
Needed for immune system health
Key component of protein
Essential for muscle and nerve activity
Important in immune system health, blood clotting and pressure regulation
A component of proteins, DNA, RNA and blood
Promotes digestive process
Maintains acid-base balance
Needed for proper fluid balance
Essential to fetal development and functioning of reproductive system
Key component of enzymes
Helps deliver oxygen to the tissues
Important for healthy bones
A component of enzymes, DNA, RNA, proteins and promotes immune system health
A component of enzymes and involved in Fe metabolism
O OXYGEN
C CARBON
H HYDROGEN
Soil macronutrients
P PHOSPHORUS
K POTASSIUM
N NITROGEN
Soil micronutrients
Cl CHLORINE
Si SILICON
Ca CALCIUM
Mg MAGNESIUM
Mo MOLYBDENUM
Na SODIUM
B BORON
S SULPHUR
Fe IRON
Zn ZINC
Cu COPPER
Mn MANGANESE
Increase soil organic matter content
Minimize tillage
Keep soil surface covered
Reduce erosion
Ensure crop rotation
Sustainable soil management for healthy soils, healthy food and healthy people
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Food and Agriculture Organization of the United Nations
Healthy soils for a healthy life

our Soils under threat

2015 International Year of Soils

fao.org/soils-2015

#IYS2015

Drivers of soil degradation

- Deforestation
- Population growth
- Urban expansion
- Pollution and waste disposal
- Climate change
- Unsustainable soil management practices

Types of soil degradation

- Biodiversity loss
- Salinization and sodification
- Nutrient imbalance
- Compaction
- Sealing
- Pollution
- Acidification
- Erosion
- Loss of organic carbon

Consequences of soil degradation

- Water scarcity
- Food and nutrition insecurity
- Rapid climate change
- Poverty and social insecurity
- Migration
- Reduction of ecosystem services

Solution: sustainable soil management

- Inclusive soil governance
- Increase investment in sustainable soil management
- Advocacy/ awareness raising
- Establish soil information systems
- Develop capacities and strengthen extension on soils
- Stop soil degradation
- Restore/ rehabilitate degraded soils
- Implement land use planning
- Analyse/ assess soil condition
- Increase soil organic matter content
- Keep soil surface covered
- Use nutrients wisely
- Minimum tillage
- Crop rotation
- Reduce erosion
- Appropriate waste disposal
- Waste water treatment

Food and Agriculture Organization of the United Nations

with the support of Land Development Department of Thailand

Soil & Fertilizers

- **Soil Formation**
- **Chemical Properties**
- **Soil Types**
- **Soil Water**
- **Soil Fertility & Plant Nutrition**
- **Fertilizing Garden Soil**
- **Home Gardening**

Soil & Fertilizers

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how Soil is formed

Food and Agriculture Organization of the United Nations

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Chemical Weathering

- Chemical breakdown of earth materials takes place mostly below the lands surface involving interactions of rock, water, and biological agents.

Water

- Water is a universal solution, and nearly all earth materials can be chemically altered, dissolved, transported, and deposited by it depending on conditions.

Climate

- Tropical
  - Moist with temperatures above 65° periods of heavy moisture
- Dry
  - Evaporation and transpiration exceeds precipitation
- Moist Mid-Latitude
  - Warm and humid summers with mild winters
- Moist Continental Latitude
  - Warm to cool summers and cold winters
- Polar
  - Warmest temperature 50° and below

Soil Minerals

- Gravel - gravel & stones
  - Inert or detrimental to cultivation
- Sand - visible particles
  - Quartz and Calcium Carbonate
- Silt - visible with hand lens
  - Smaller quartz and feldspar
- Clay - electron microscope
  - Finest quartz and metal oxides

Sand

- Sand is the most common mineral resistant to weathering.

Silt

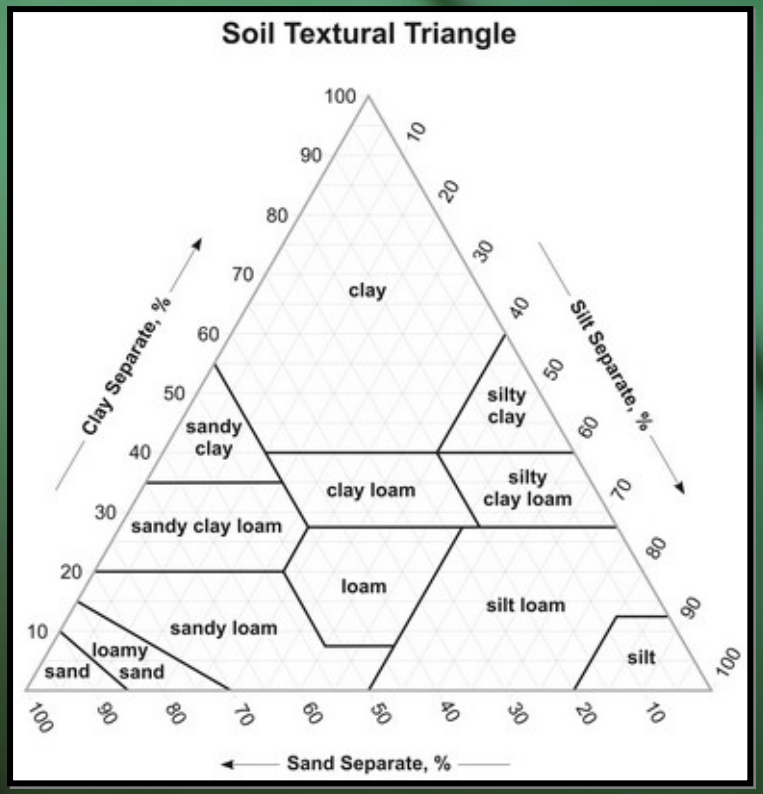
- Silts, which are fine-grained soils that do not include clay minerals, tend to have larger particle sizes than clays

Clay

- Geologic clay deposits are mostly composed of minerals containing variable amounts of water trapped in the mineral structure.

Optimal Type of Soil

- Loam is the optional type of soil
  - 40% Sand
  - 40% Slit
  - 20% Clay



Soil Testing

- Samples are taken from various points in the garden
- Take samples at bottom of 6” holes
- Mix samples together
- Send to lab - make sure you request nutrients available, recommend amounts and types of nutrients, soil toxins…

Soil & Fertilizers

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Soil Water

- It the water between the particles of soil.
- Solvent in which plant mineral nutrients are dissolved in to form the soil solution.
- Plants can on uptake water soluble nutrients

2015
International
Year of Soils

SOILS & BIODIVERSITY

SOILS HOST A QUARTER OF OUR PLANET'S BIODIVERSITY

Soil is one of nature's most complex ecosystems: it contains a myriad of organisms which interact and contribute to the global cycles that make all life possible.

Over **1000 species** of invertebrates may be found in **1 m²** of forest soils.

A typical healthy soil might contain:

- vertebrate animals
- earth worms
- nematodes
- 20-30 species of **mites**
- 50-100 species of **insects**
- hundreds of species of **fungi**
- thousands of species of **bacteria & actinomycetes**

Biodiversity is essential for **food security and nutrition.**

Soil organisms are responsible for performing vital functions in the soil ecosystem:

Maintenance of **soil structure**

Nutrient cycling

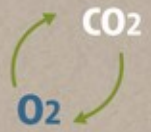
Sources of **food and medicines**

Regulation of soil **hydrological processes**

Soil **detoxification**

Symbiotic and asymbiotic relationships with plants and their roots

Decomposition of organic matter



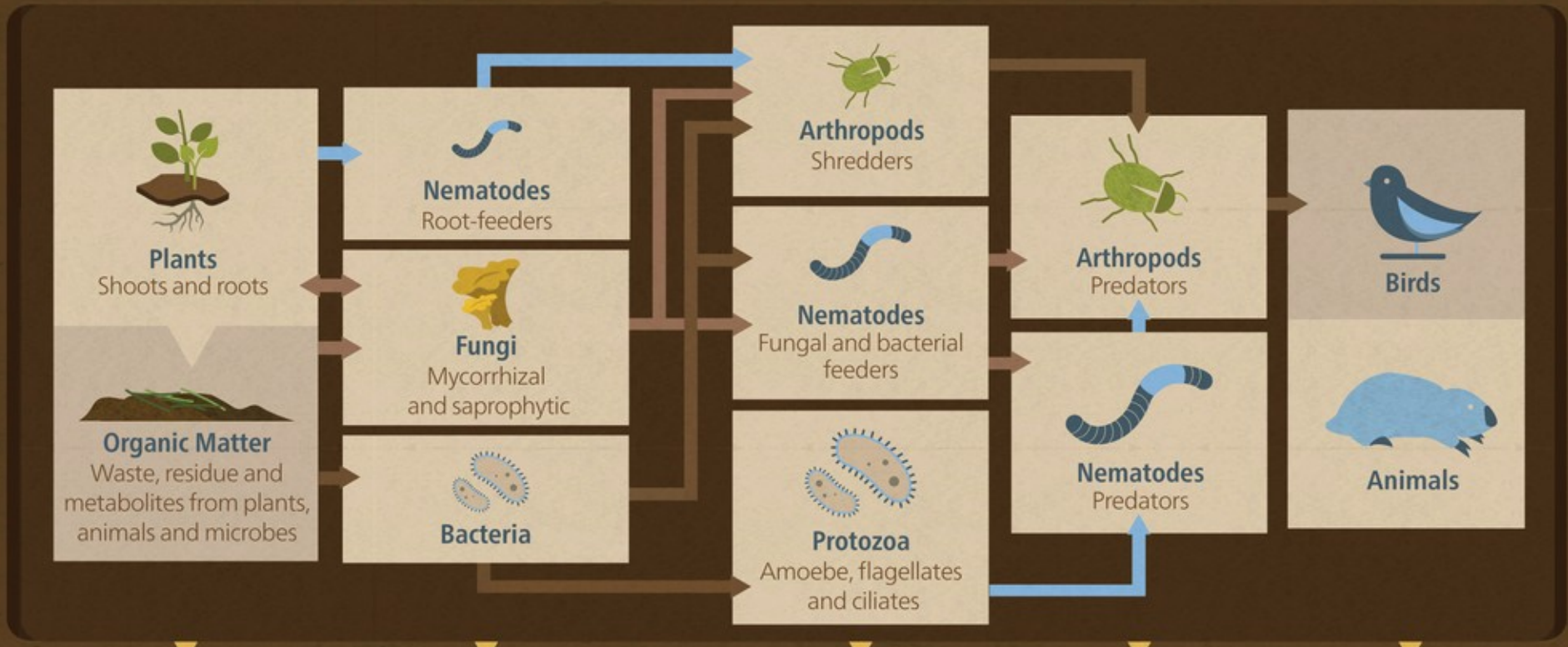
Gas exchanges and carbon sequestration

Suppression of pests, parasites and diseases

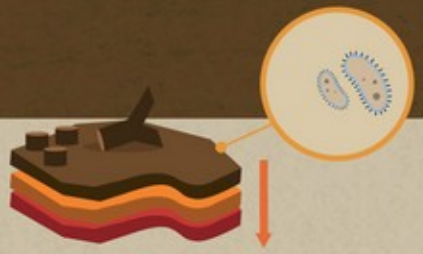
Plant growth control

THE SOIL FOOD WEB

When these diverse soil organisms interact with one another and with the plants and animals in the ecosystem, they form a complex web of ecological activity.



SOIL BIODIVERSITY AND AGRICULTURE



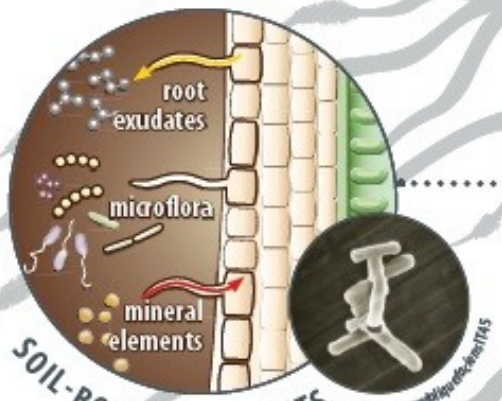
Clearing forested land or grassland for cultivation affects the soil environment and drastically **reduces the number and species of soil organisms.**

The overuse or misuse of agro-chemicals has resulted in environmental degradation, particularly of soil and water resources.

Agricultural systems and agro-ecological practices such as: agroecology, agroforestry, conservation agriculture, organic farming and zero-tillage can sustainably increase farm productivity without degrading the soil and water resources.

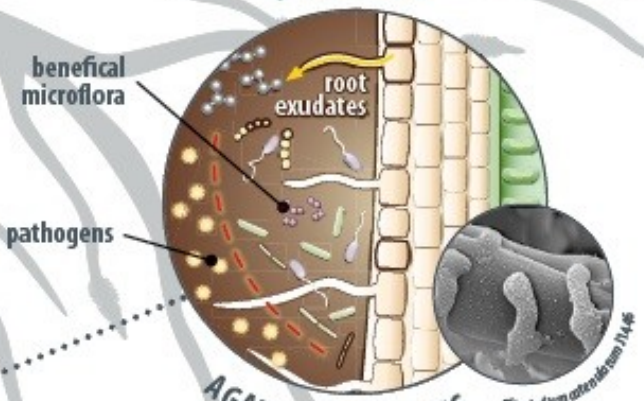
THE CROP PARTNERS

UNLOCK



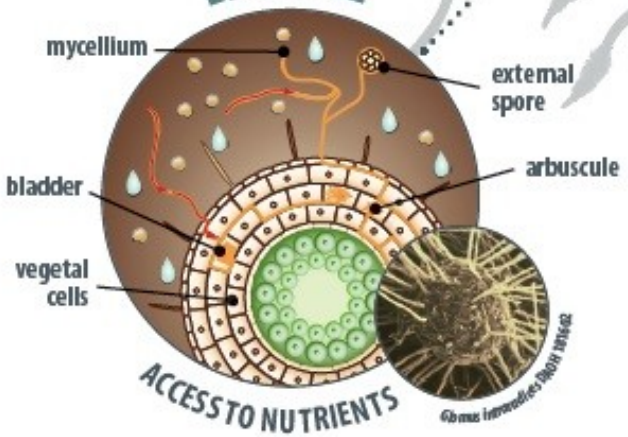
SOIL-BOUND NUTRIENTS

PROTECT



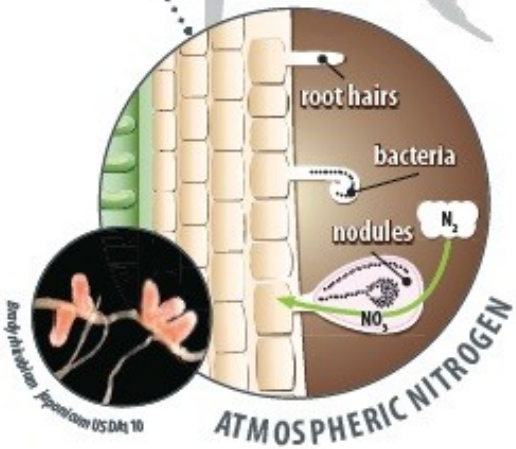
AGAINST PATHOGENS

ENHANCE



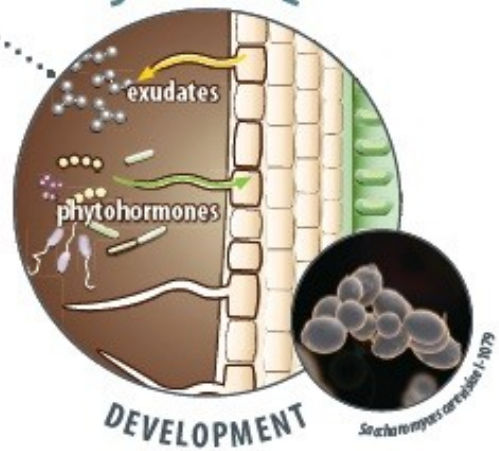
ACCESS TO NUTRIENTS

FIX

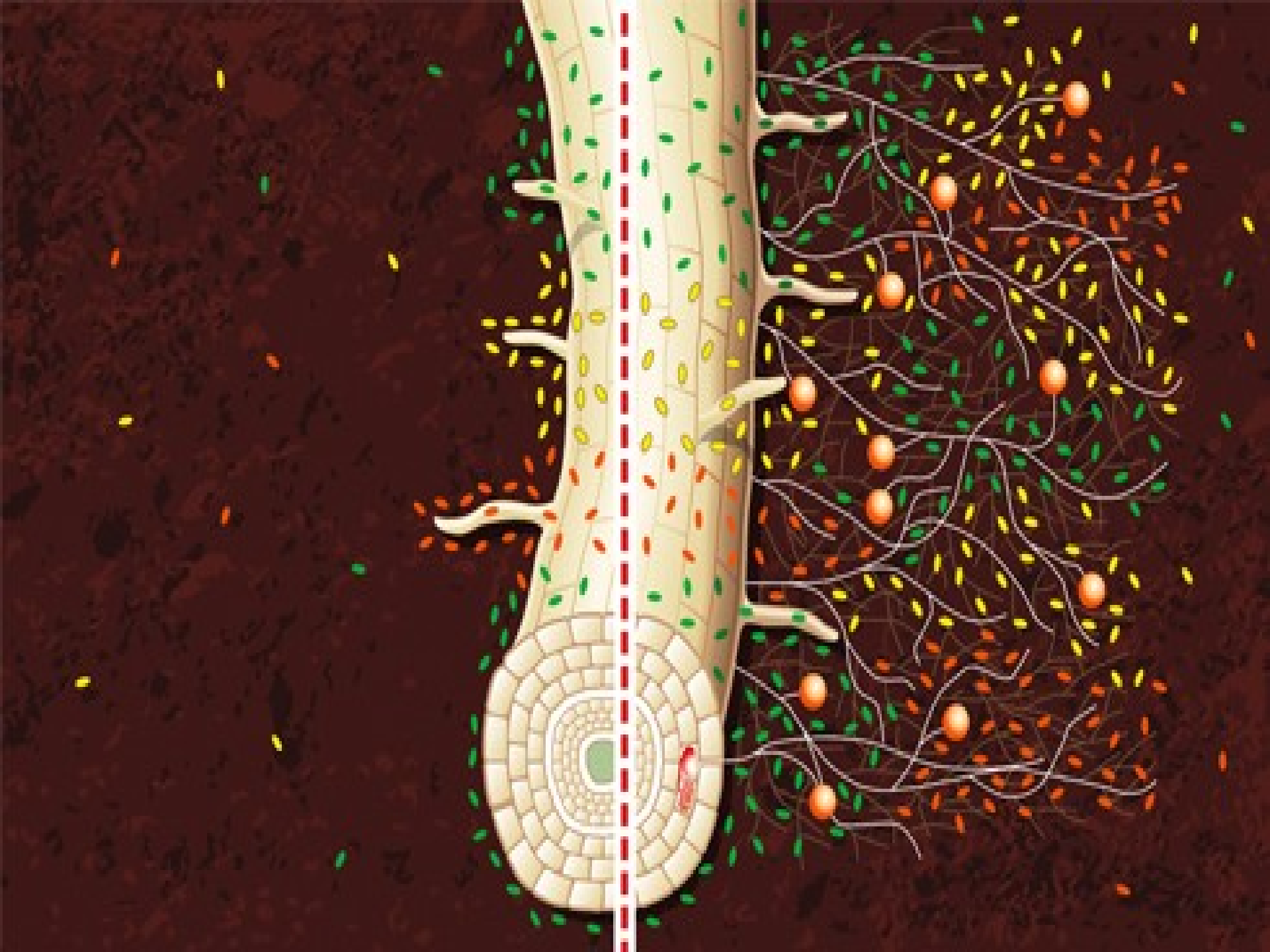


ATMOSPHERIC NITROGEN

STIMULATE



DEVELOPMENT



Soil & Fertilizers

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Plant Nutrition

- Fertile soil contains nutrient elements in amounts favorable for optimal plant growth
- Plants absorb soluble nutrients
- Loam optimal soil

Nutrient Elements

- Macronutrients (primary)
  - Nitrogen
  - Phosphorus
  - Potassium
- Macronutrients (secondary)
  - Sulfur
  - Calcium
  - Magnesium

- Micro-nutrients
  - Iron
  - Molybdenum
  - Boron
  - Copper
  - Manganese
  - Sodium
  - Zinc
  - Nickel
  - Chlorine
  - Cobalt
  - Aluminum
  - Silicon
  - Vanadium
  - Selenium

Insoluble Nutrients

- All the listed elements are insoluble.
- To become soluble and plant useable the elements need to be change.
- Man Made Nutrients
- Organic Nutrients

Man Made Nutrients

- Man made inorganic compounds (fertilizers) are usually derived from by-products of the petroleum industry. Examples are Ammonium Nitrate, Ammonium Phosphate, Superphosphate, and Potassium Sulfate.

- Plants cannot distinguish between an organic or synthetic fertilizer – the nutrients are processed in exactly the same way. However, the similarity stops there.

Organic Nutrients

- Alfalfa
- Ash
- Blood meal
- Bone meal
- Compost
- Kelp
- Fish emulsion
- Fish meal
- Humic Acid
- Aged Manure
- Rock phosphate
- Raw Langbeinite
- Rockdust
- Unprocessed potassium sulfate
- Wood chips/sawdust
- Phosphate rich organic manure

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Fertilizing Garden Soil

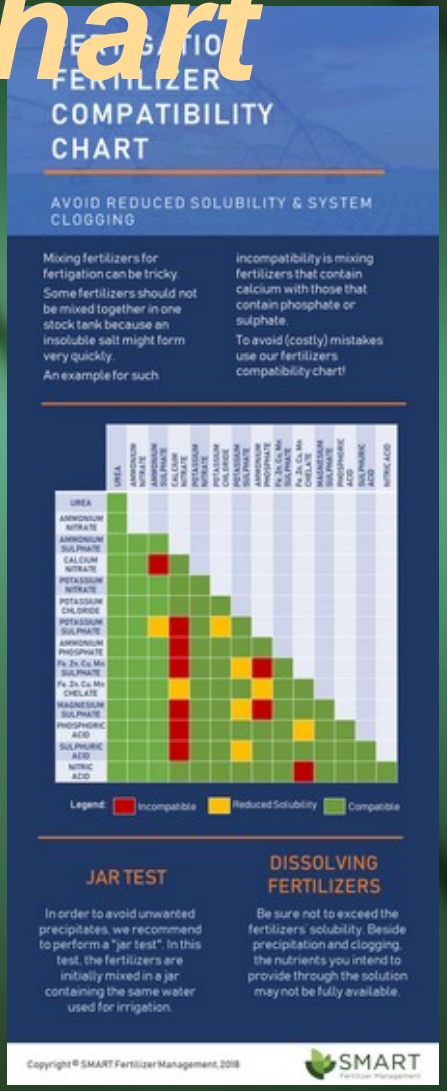
- Man Made - Chemical Fertilizers
- Organic Fertilizers
- What the Numbers Mean
- Soil Test

Man Made Nutrients

- Chemical fertilizers add nutrients to the soil, but they don't add anything else.
- Synthetic fertilizers do not support microbiological life in the soil.
- Application of a synthetic fertilizer actually kills a significant percentage of beneficial microorganisms.

Fertilizer Compatibility Chart

- Prior to implementing a fertilizing regiment
  - Combine the fertilizers in a glass container, add water and shake
  - If the fertilizers start clumping don't use that combination of fertilizers
    - Combination may inhibit the fertilizers from working correctly



Organic Nutrients

- 300 million years microorganisms break down organic matter into a stable amendment for improving soil quality and fertility.

- Organic matter improves soil structure, resulting in a crumb-like structure.

Organic Nutrients

- Organic matter improves water retention and enhances soil fertility.
- Microorganisms can break down contaminants in the soil and water to components that pose less of an environmental hazard.

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Composting

- Backyard Composting
  - Hot
  - Cold
- Vermicomposting
- Bokashi composing

Backyard Composting

- Hot
  - Produces compost in a much shorter time. It has the benefits of killing weed seeds and pathogens (diseases), and breaking down the material into very fine compost. Heats up to temperatures of 120 to 170 degrees. 1/3 Green 2/3 Carbon (browns)
- Cold
  - Involves placing a variety of organic materials in a compost bin, enclosure, or even just in a large heap, and leaving it there until it breaks down several months later. Careful of weed seeds, diseases.

Vermiculture

- Aerobic bacteria breakdown organic material. Worms consume the bacteria concentrating the nutrients. Worm Castings

Bokashi Composting

- Anaerobic composting
- Food scrapes including meat…
- Technique that involves fermenting food waste in a closed container for a few weeks.
- Completely sealed container
- If you can smell it you are not doing it correctly.

Soil & Fertilizers

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Home Gardening

- Modify existing garden according to soil test recommendations
  - Make take years for all recommendations to be fruitful
- Start fresh
  - Create a new growing environment raised beds

Home Gardening

- Modifying Existing Growing Medium
- Soil Test Results
  - Too much Clay
    - Add organic materials, bacteria, fungi
  - Missing Nutrients
    - Add organic nutrients in recommended quantities
    - Add bacteria and fungi to unlock sequestered nutrients

Improving Clay Soil

Starting Fresh

- Raised Beds
  - Location - opportunity to find ideal location
  - Cost - construction of bed, building materials
  - Growing medium - what kind and amounts
    - Material Data Sheet - What is in it
  - Microorganisms - finding and costs
    - Vermiculture bacteria and fungi
    - Online sources

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Soil & Fertilizers

- Carbon

Carbon

- To Date all life forms contains Carbon
- Plants upwards of 48-50%
- Human upwards of 23%

Carbon

- Inorganic Carbon
  - Consists of mineral forms of C, from weathering of parent material, or from reaction of soil minerals with atmospheric CO_2.
- Organic Carbon
  - Available C as fresh plant remains
  - Relatively inert C in materials derived from plant remains: humus and charcoal

Carbon

- Soil Carbon
  - Home for bacteria, fungi, nutrients, water
  - Fungi construct nutrient and water transport tube

Carbon

- Terra Petra
  - Amazonian
  - 6 feet deep
  - Composed
    - Animal waste
    - Charcoal
    - Bacteria
    - Fungi

Carbon

- Make your own Terra Petra
  - Carbon
    - Biochar, Activated Charcoal
  - Compost
    - Hot composted materials
  - Pottery chards - optional
  - Fish and Animal bone
    - Bone, Blood, & Fish Meal
  - Manure
    - Cured cow, horse, chicken…
  - Microorganisms
    - Bacterial, Fungi, Insects

Terra Petra My Experience

Terra Petra My Experience

Worm Tea