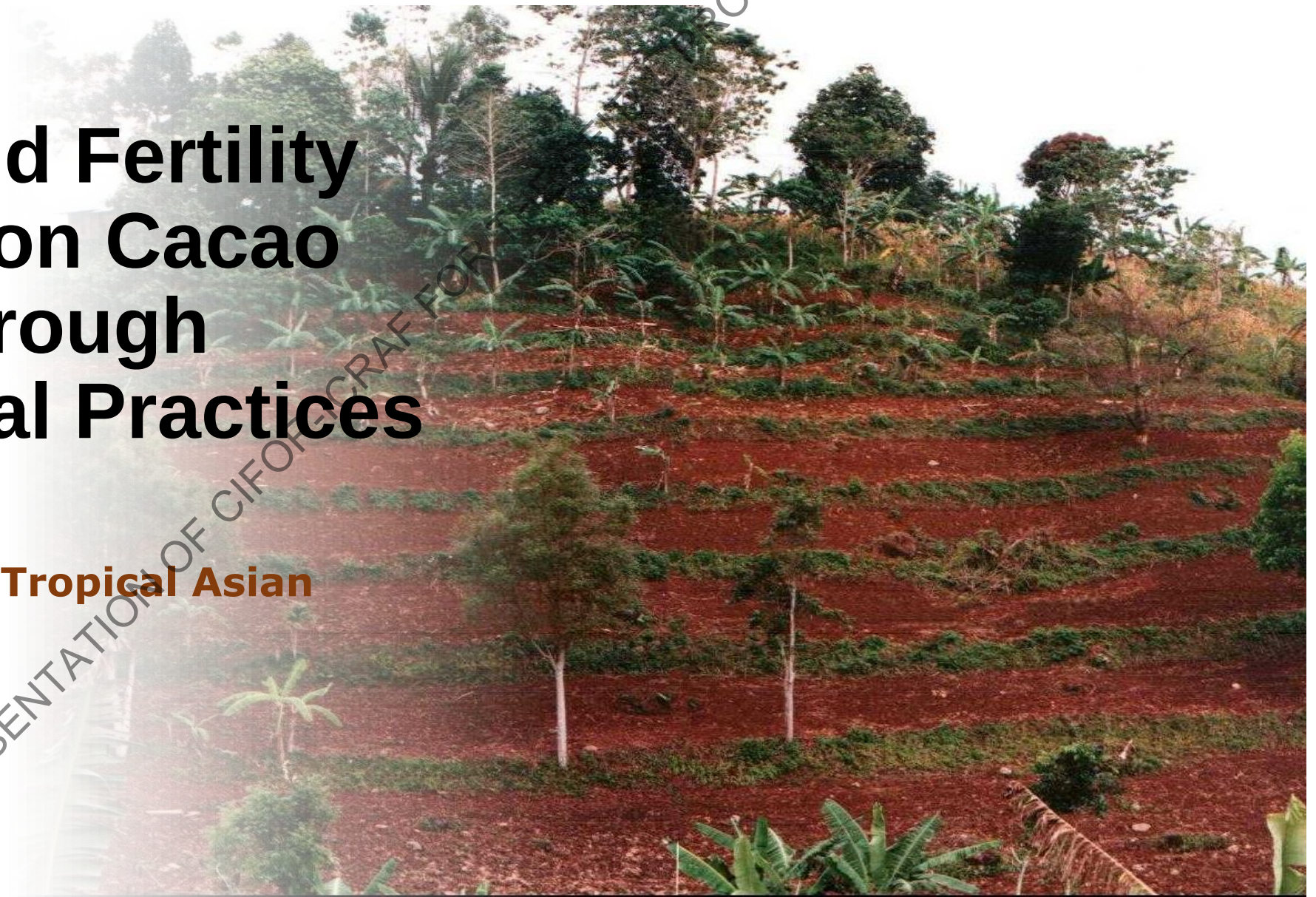
World Agroforestry Centre

Soil Health and Fertility Management on Cacao Cultivation through Agroecological Practices

Sustainable Farming in Tropical Asian Landscapes (SFITAL)



PRESENTATION OF CIFOR-ICRAF FOR ... PROJECT

Understanding Soils

Function of soil

1. A medium for growing plants.
2. Habitat for soil organisms.
3. Filtration of water.
4. Construction materials.
5. Break-down and storage of waste.
6. Carbon sink.

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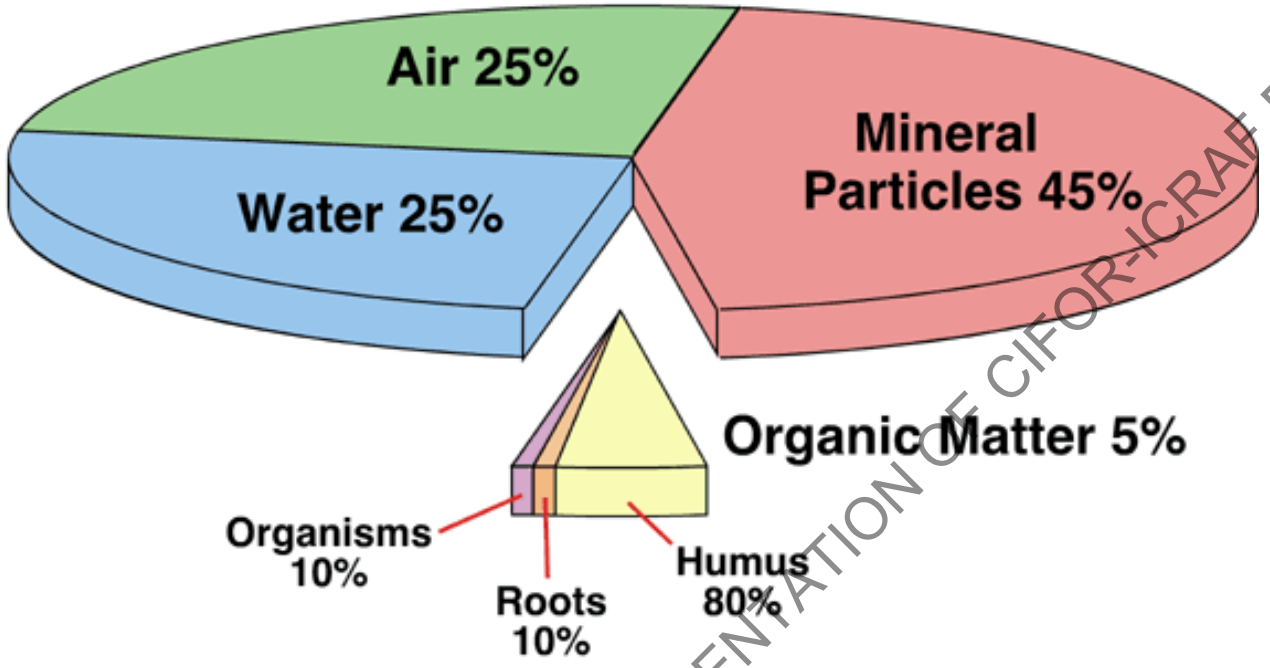
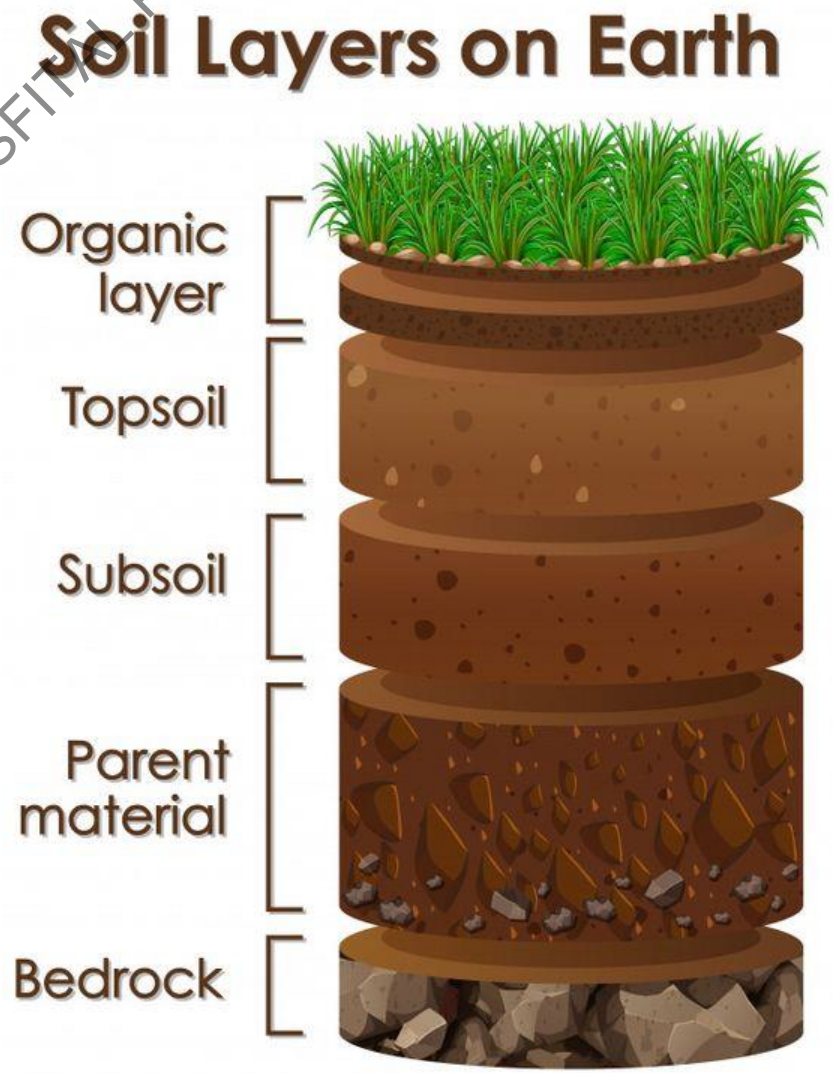
Understanding Soils

What is soil





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Understanding Soils

Composition of good agricultural topsoil

- Air (air spaces)
- Water
- Minerals
- Organic Matter

- Soil contains a network of small ‘macro’ pores between soil particles and smaller ‘micro’ pores.
- Water enters the soil through pore spaces.
- Pore spaces hold air and water needed by plant roots and soil organisms.
- Pore spaces let roots easily search out nutrients and soil organisms move around.

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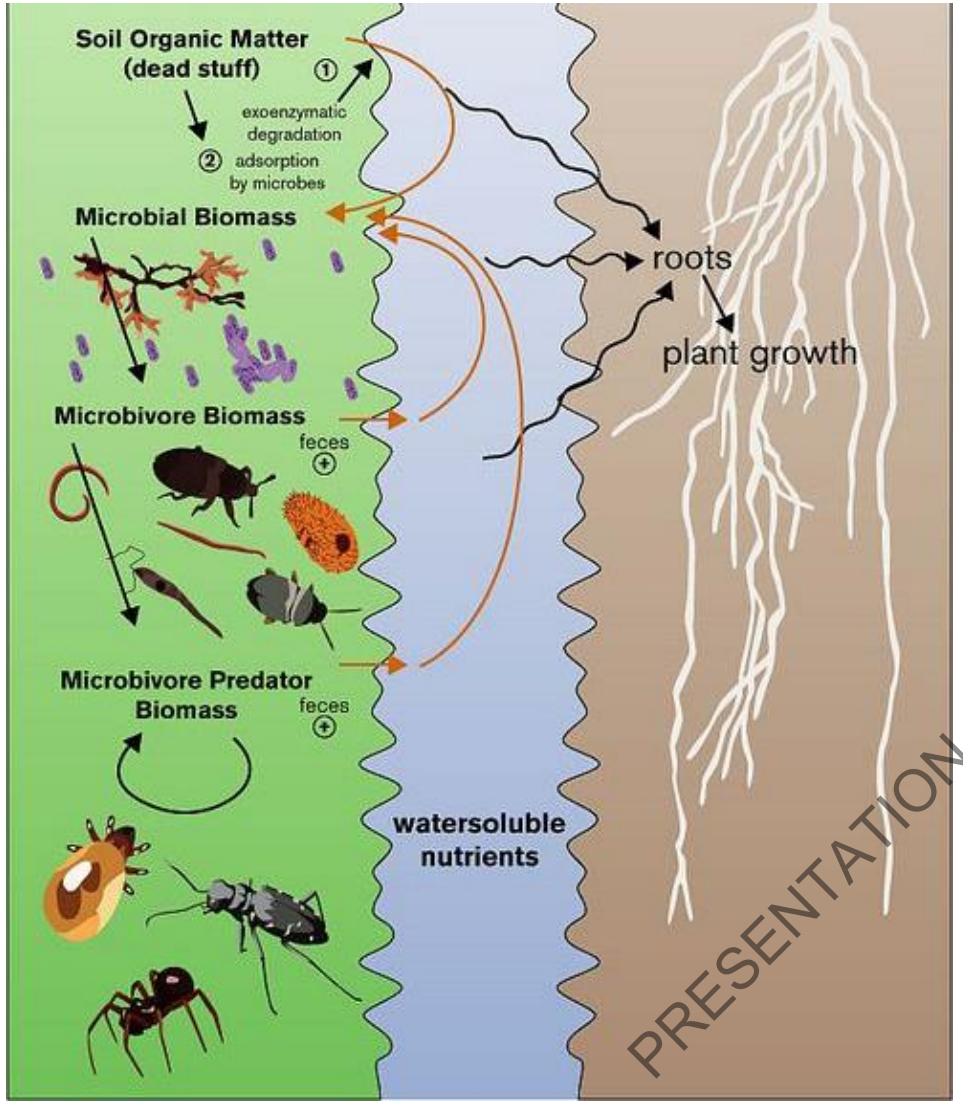
Soil Biota



Soil biota is everything living in the soil (plants roots, invertebrates and microbes).

Vital functions:

- Clearing away and decomposing organic matter – sustains soil fertility.
- Creating spaces in the soil.
- Holding soil particles together.
- Changing nutrients into a form that plants can use.
- Mixing the soil
- Breaking down toxic materials.

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Agroecological key principles relate to soil health and fertility management

1. Recycling of organic materials

- ➢ Promote the use of local renewable resources and try to enhance resource cycles as far as possible.
- ✓ Natural inputs – decomposed/rotten cacao pods, compost
- better utilization of nutrients
- conservation of energy
- reduction of production cost
- reduction of soil pollution
- sustainability of plant growth

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Agroecological key principles relate to soil health and fertility management

2. Input reduction

- ➢ Reduce or eliminate dependency on purchased inputs and increase resource sufficiency.
- ✓ Composting
- ✓ minimize the use of pesticides
- • integrated pest and disease management (IPDM)
- ✓ proper pruning
- ✓ improved sanitation
- ✓ pod sleeving

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Agroecological key principles relate to soil health and fertility management

3. Secure and enhance soil health

- ➢Increasing organic matter inputs
- ➢Enhancing soil biological activity
  - ✓presence of trees in cacao cultivation
    - ❖shade
    - ❖ deep root system - improve soil porosity and infiltration
  - ➢In sloping areas, trees along contour lines
    - ✓help stabilize the slope and reduce soil erosion
    - ✓grass strips along the contour lines
    - ❖ natural terrace formation (“green infrastructure”)
    - ❖retains soils within farm.

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Why does soil fertility decline?

1. Crop Removal of Nutrient

- The total amount of plant nutrients removed from the field in the harvested portion of the crop.

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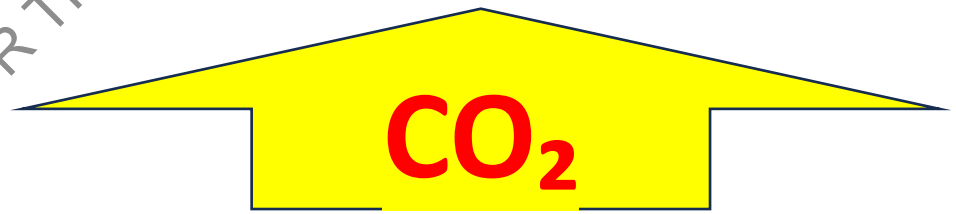
Why does soil fertility decline?

2. Burning

- Causes almost complete N loss, P losses of about 25%, K losses of 20%, and S losses of 5–60%.



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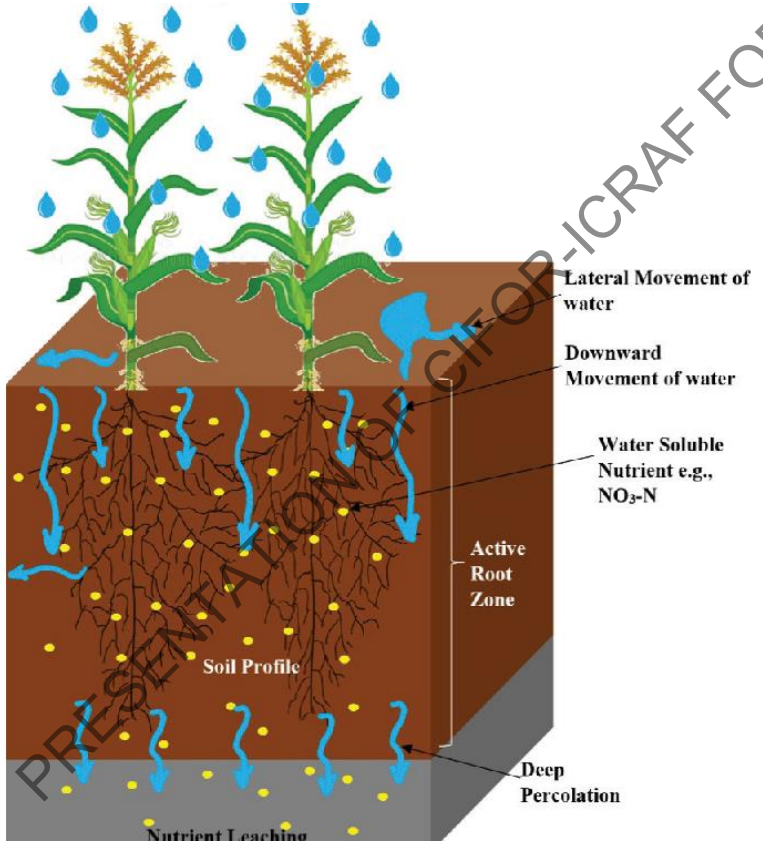
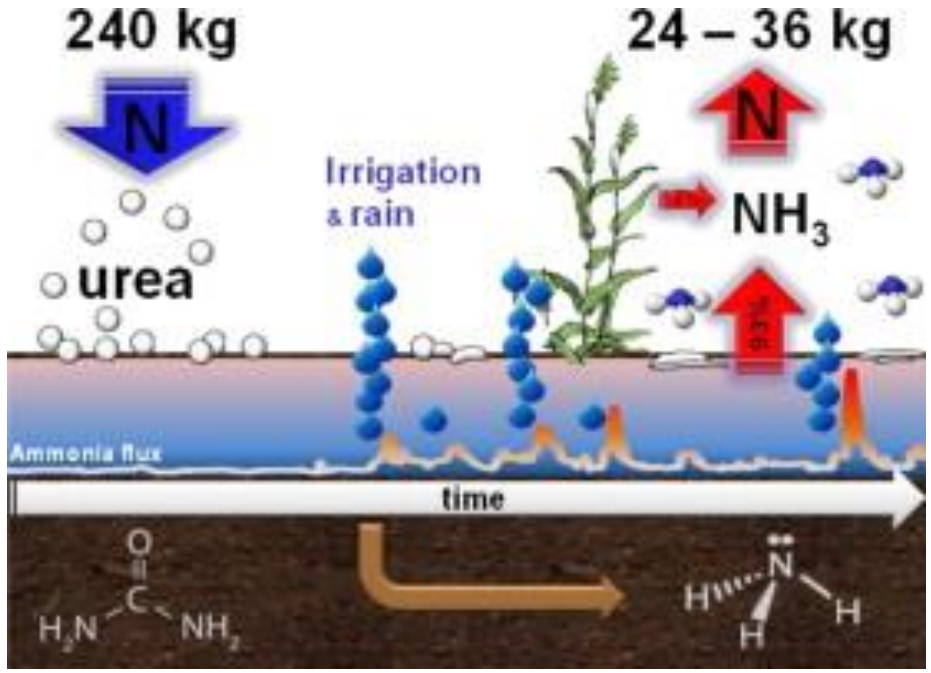
Why does soil fertility decline?

3. Leaching and Volatilization/Gaseous Losses of Nutrient

- Leaching - is the loss of water-soluble plant nutrients from the soil.
- Volatilization - is the conversion of a liquid chemical into a vapour, which escapes into the atmosph





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Why does soil fertility decline?

4. Soil Erosion

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Soil Fertility Management

- The efficient use of nutrient sources in the soil system.

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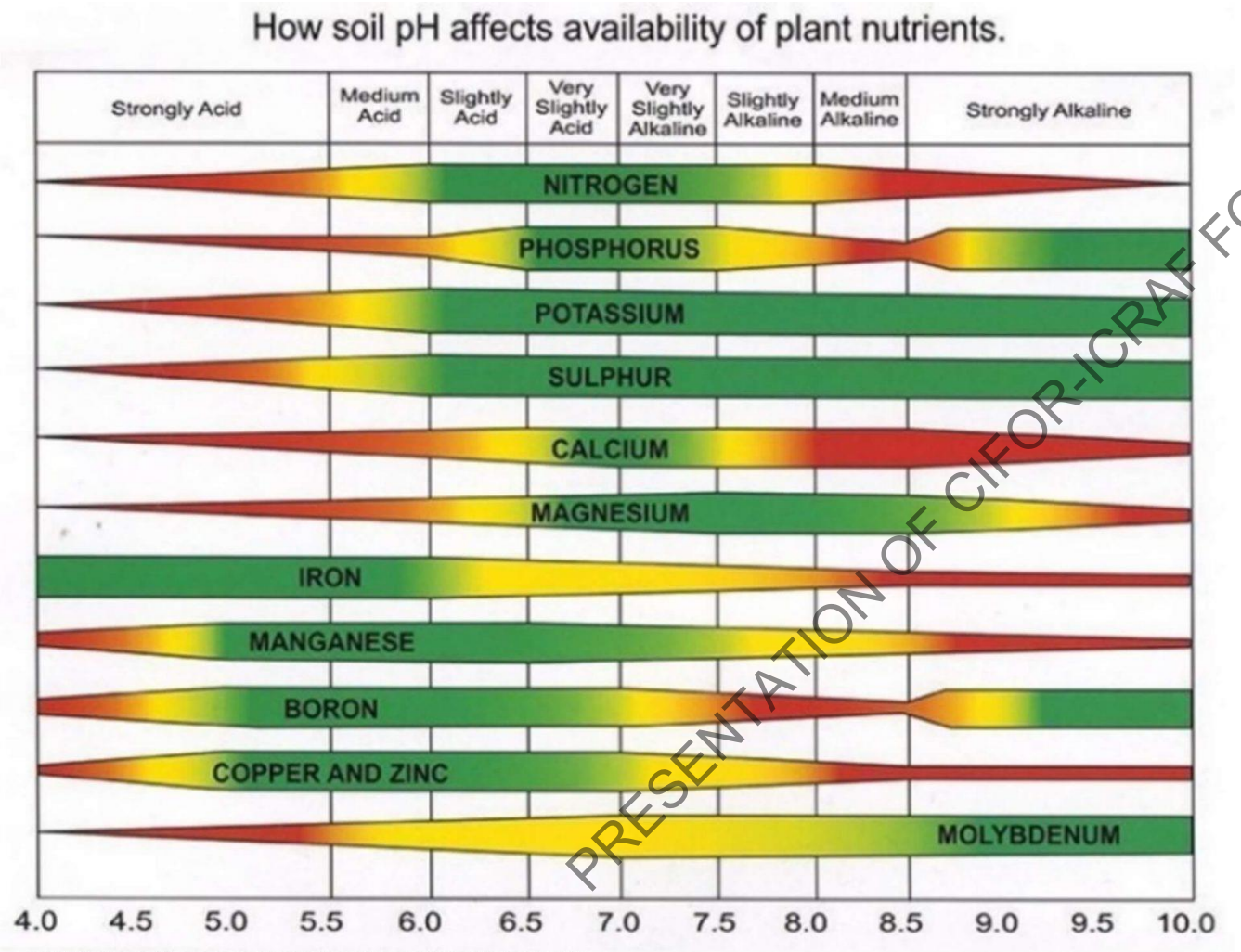
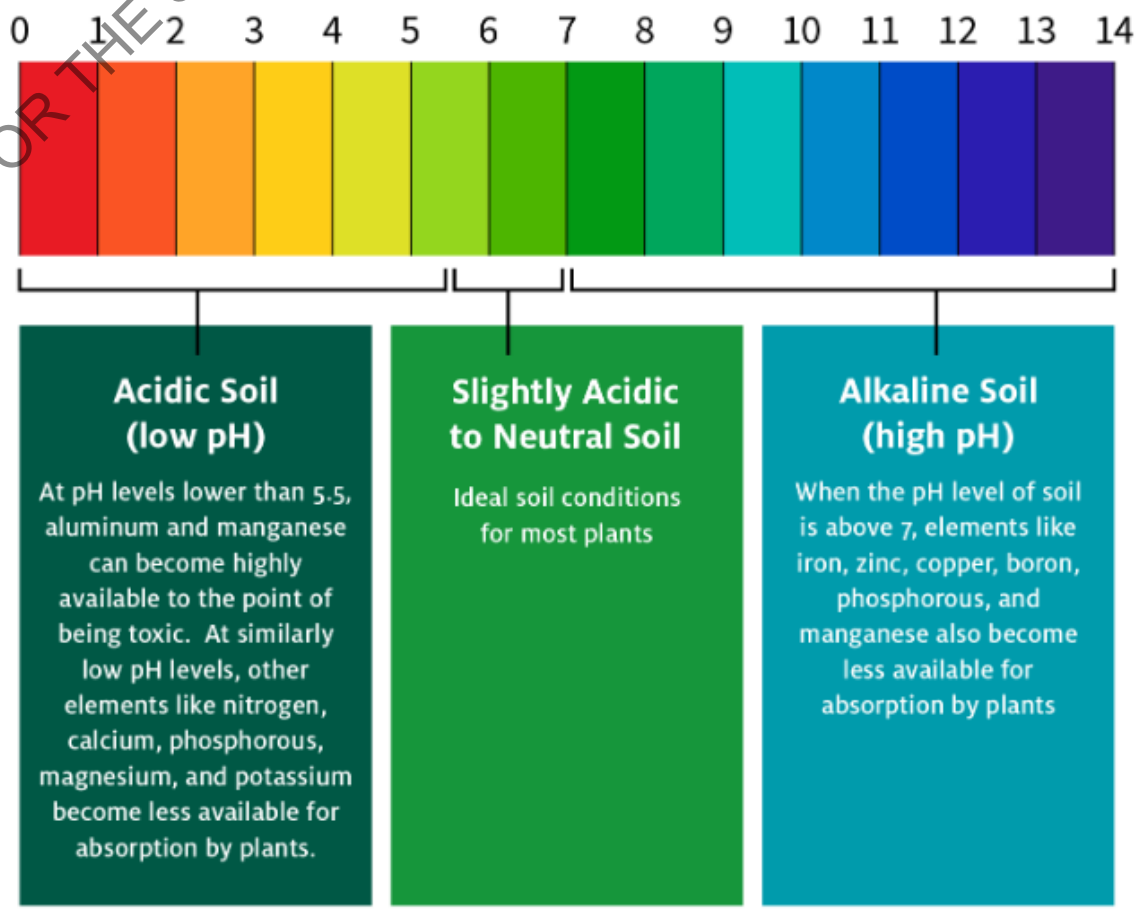
What pH level do cacao trees like?

- **6.5-7.0**



SOURCE: https://www.emporiumhydroponics.com/what-is-ph-1-to-14



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Key nutrients for Cacao

- **Good flowering:**
  - **N, P, Ca, B, Zn**
- **Healthy Fruit**
  - **K, Ca, B**
- **Green leaves**
  - **N, P, K, Mg, S, Fe, Mn Zn**
- **Healthy roots**
  - **P, Ca, B, Zn**

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Role of Nutrients in Cacao

1. Nitrogen (N)

- Essential for yield and quality.
- Responsible for the formation of proteins, chlorophyll, and nucleic acid
- Nitrogen will;

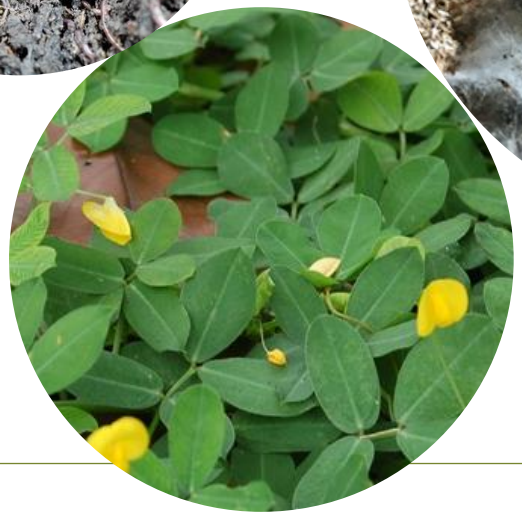
✓Increase fruit weight

✓Increase fruit number

✓Increase fruit sugars

✓Increase ascorbic acids

Natural source of Nitrogen



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Role of Nutrients in Cacao

2. Phosphorous (P)

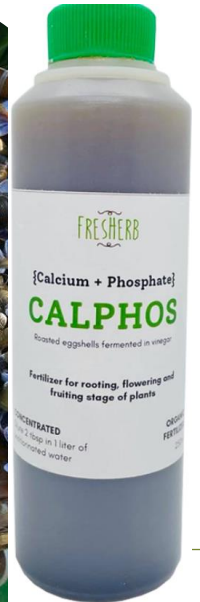
- Responsible for energy storage and transfer, cell division and enlargement

✓Increases duration of flowering

✓Increases fruit set

✓Increases yield per branch

✓Decreases fruit drop



Natural source of Phosphorous (P)

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Role of Nutrients in Cacao

3. Potassium (K)

- Responsible in enzyme actions and sugar translocation.
- Adequate supplies of K will improve:

✓Increases plant resistance to disease

✓Fruit firmness

✓ Potassium helps flowers and fruit to form

Natural source of Potassium (K)

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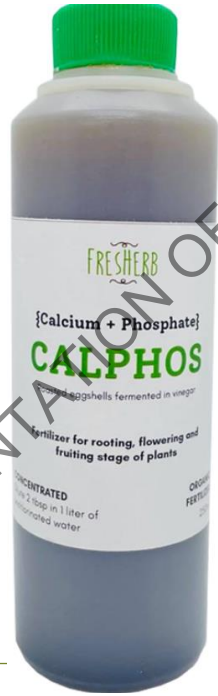
Role of Nutrients in Cacao

4. Calcium (Ca)

- A structural nutrient (an essential part of cell walls and membranes and is a requirement in the formation of new cells)
- Reduces pod drop and enhances tolerance to diseases and environmental stress

Natural source of Calcium (Ca)



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Role of Nutrients in Cacao

5. Boron (B)

- Fruiting crops have a high demand for boron in the early fruiting stage
- Boron works with calcium to give the cell wall flexibility
- The combination of calcium and boron improves the plant's strength and tolerance

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Natural source of Boron (B)

Nutritional deficiency symptoms in Cacao


Zinc deficiency


Zinc deficiency


Sulfur deficiency


Sulfur deficiency


Sulfur deficiency


Potassium deficiency


Potassium deficiency


Potassium deficiency


Potassium deficiency


Potassium deficiency


Phosphorus deficiency


Phosphorus deficiency


Nitrogen deficiency


Nitrogen deficiency


Nitrogen deficiency


Magnesium deficiency


Magnesium deficiency


Magnesium deficiency

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Nutritional deficiency symptoms in Cacao


Magnesium deficiency


Magnesium deficiency


Iron deficiency


Iron deficiency


Iron deficiency


Copper deficiency


Copper deficiency


Calcium deficiency


Calcium deficiency


Calcium deficiency


Calcium deficiency


Boron deficiency


Boron deficiency


Boron deficiency


Boron deficiency


Manganese deficiency

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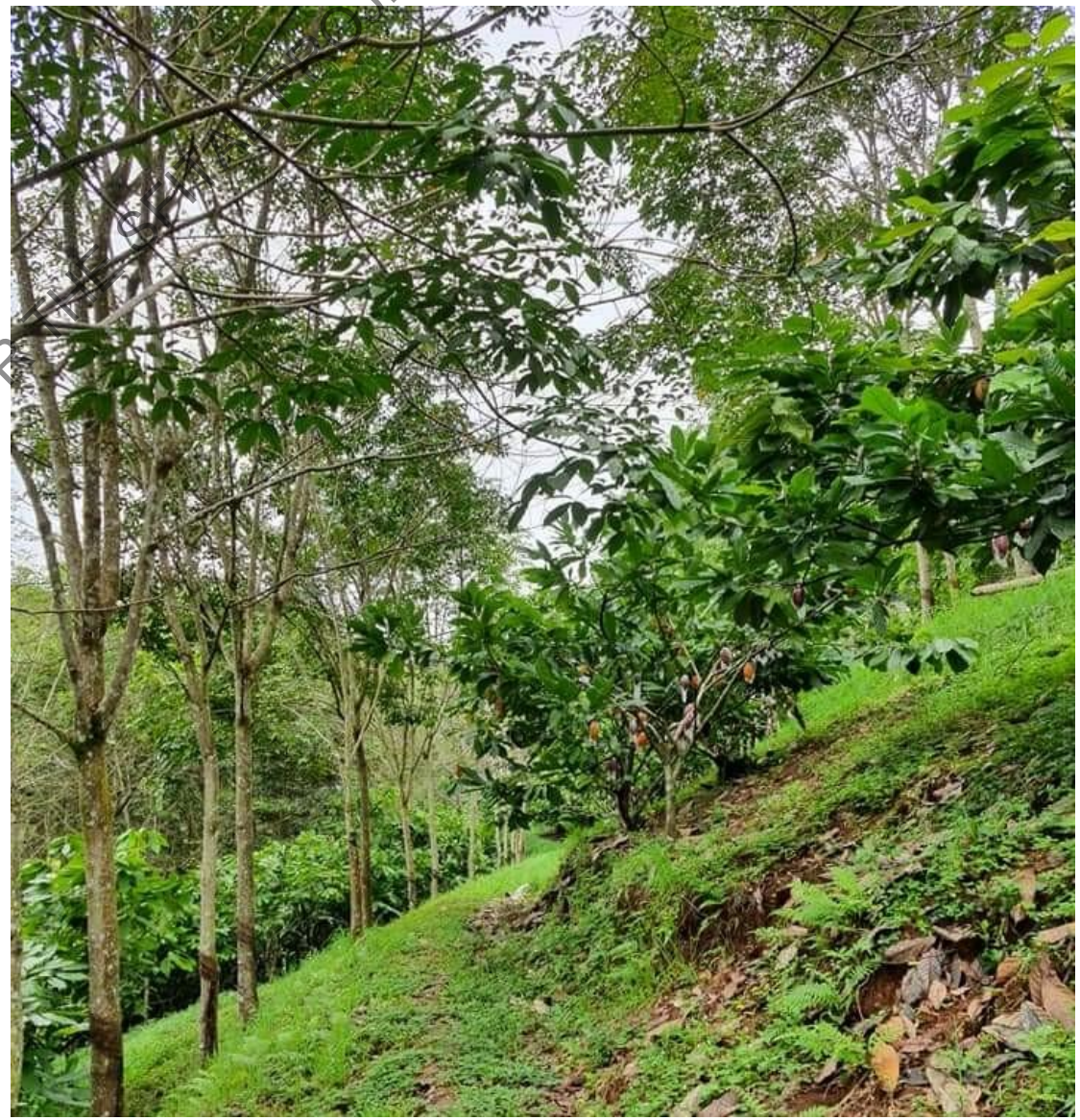
Soil Improvers

Options of tree species to help fertilize soils

- ‘Fertilizer trees’ is commonly used to refer to the utilisation of Nitrogen-fixing leguminous trees in crop production systems to improve Nitrogen availability to crops.
- Fertilizer trees enhance soil health by taking nitrogen from the air and transferring it to the soil through their roots and leaf litter.
- Can bring nutrients from deep within the soil to its surface for crops with shallow roots like cacao.



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Soil Improvers

Options of cover crops to help fertilize soils

- Cover crops can improve soil tilth and structure, which in turn improves water infiltration and reduces compaction.
- Cover crops can also help control erosion, suppress weeds, maintain soil organic matter, and provide pollen and nectar for beneficial insects.
- Leguminous cover crops are planted as living mulch and provide large amounts of organic material, nitrogen, and available phosphorus to the soil reducing fertilizer costs.

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Soil Improvers

Options of cover crops to help fertilize soils

- The most recommended nitrogen-fixing cover crop that is suitable for cacao is the Mani-mani (*Arachis pintoi*)
- It is widely known for being capable of controlling weeds and fixing large amounts of nitrogen.
- Maintaining a good soil cover will increase soil organic matter which is an essential component of healthy soils.

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Soil Improvers

Improve nutrient cycling and organic inputs

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Soil Improvers

Improve nutrient cycling and organic inputs

- Use of pruned branches of cacao or shade trees.
- can be used and arranged as contour-aligned barriers, especially in sloping land in every two rows of cacao to control soil run-off as well as to promote water infiltration.
- can also serve as a habitat for cacao pollinators (midges) and help increase soil organic matter that reduces farmers' dependency on synthetic fertilizers in the long run, thereby reducing greenhouse gas (GHG) emissions.

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Soil Improvers

Mulching to thicken soil organic matters

- Mulching using farm leftovers (e.g., decomposed cacao pods, banana trunks, decomposed rice hulls and coconut husks) into the cacao trees to maintain soil moisture and suppress weeds.
- Mulch will become a natural fertilizer when decomposed adding nutrients and organic matter to the soil, improving water retention, and nurturing the soil fauna that promotes fertility, replenishes soil nutrient loss, and helps increase cacao farm productivity.

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Soil Improvers

Mulching to thicken soil organic matters

- It is recommended to practice mulching to cacao trees in the home landscape.
- Mulch with a 2- to 6-inch (5- to 15-cm) layer of decomposed roughage or similar mulch material.
- Keep mulch 8 to 12 inches (20–30 cm) from cacao trunk.

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Soil Improvers

Composting to increase organic inputs

- Composting is a great way to recycle waste and return nutrients to the soil –dried and decomposed cacao pods provide the soil with nutrients like phosphate, nitrogen, and potash.
- making it great topsoil to use as-is or when combined with other decomposed crop residue materials and applied around the cacao trees.

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Soil Improvers

Vermiculture for improved soil aeration and nutrient status

- The output of vermiculture is called vermicompost and is formed by the process in which earthworms consume the farmyard manure and roughage in addition to the wastes from farms thereby producing it.
- The vermicompost is rich in terms of nutrients and other plant growth-promoting substances, which can supply necessary mineral nutrients to help and sustain plants' growth.
- Vermicomposting can play an important role in the remediation of soil.

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SUSTAINABLE FARMING IN TROPICAL ASIAN LANDSCAPES (SFITAL)

Salamat ka'ayo!

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