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The Phosphorus Problem:
Critical Shortage of Phosphorus

Why in News?

- The global phosphorus problem is gaining attention.
- With limited phosphorus reserves, contamination issues,
- and disruptions in the fertilizer market,
- Phosphorus scarcity poses a growing challenge to global agriculture, with critical implications for food production and environmental sustainability.

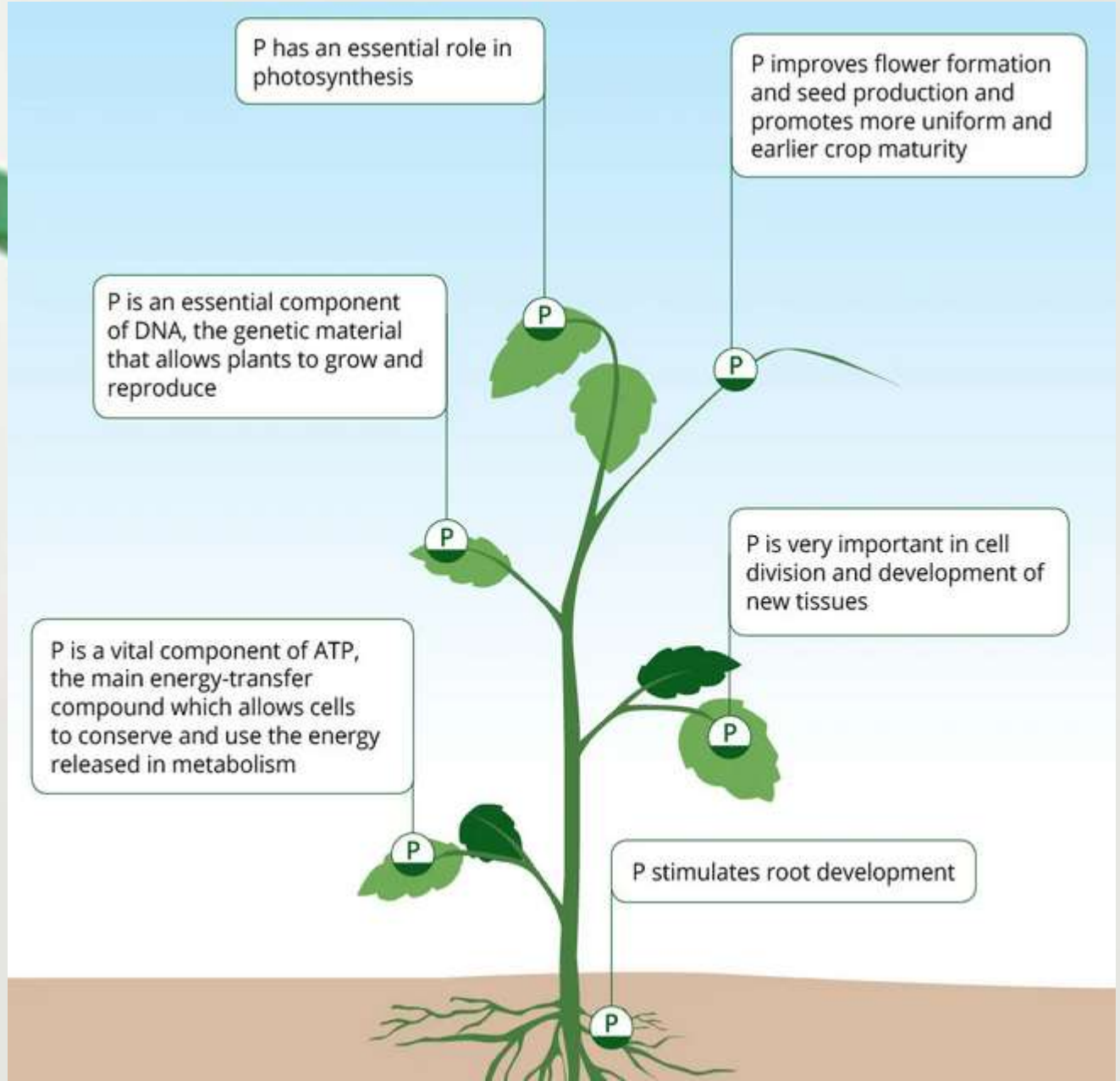
Natural Occurrence of phosphorus:

- Phosphorus is commonly found in the Earth's crust in the form of various phosphate minerals, such as Apatite.
- The term phosphate rock (or phosphorite) is used to denote any rock with high phosphorus content.
- Virtually all common fertilizers have an "N-P-K" rating. Phosphorus is the "P" in fertilizers.

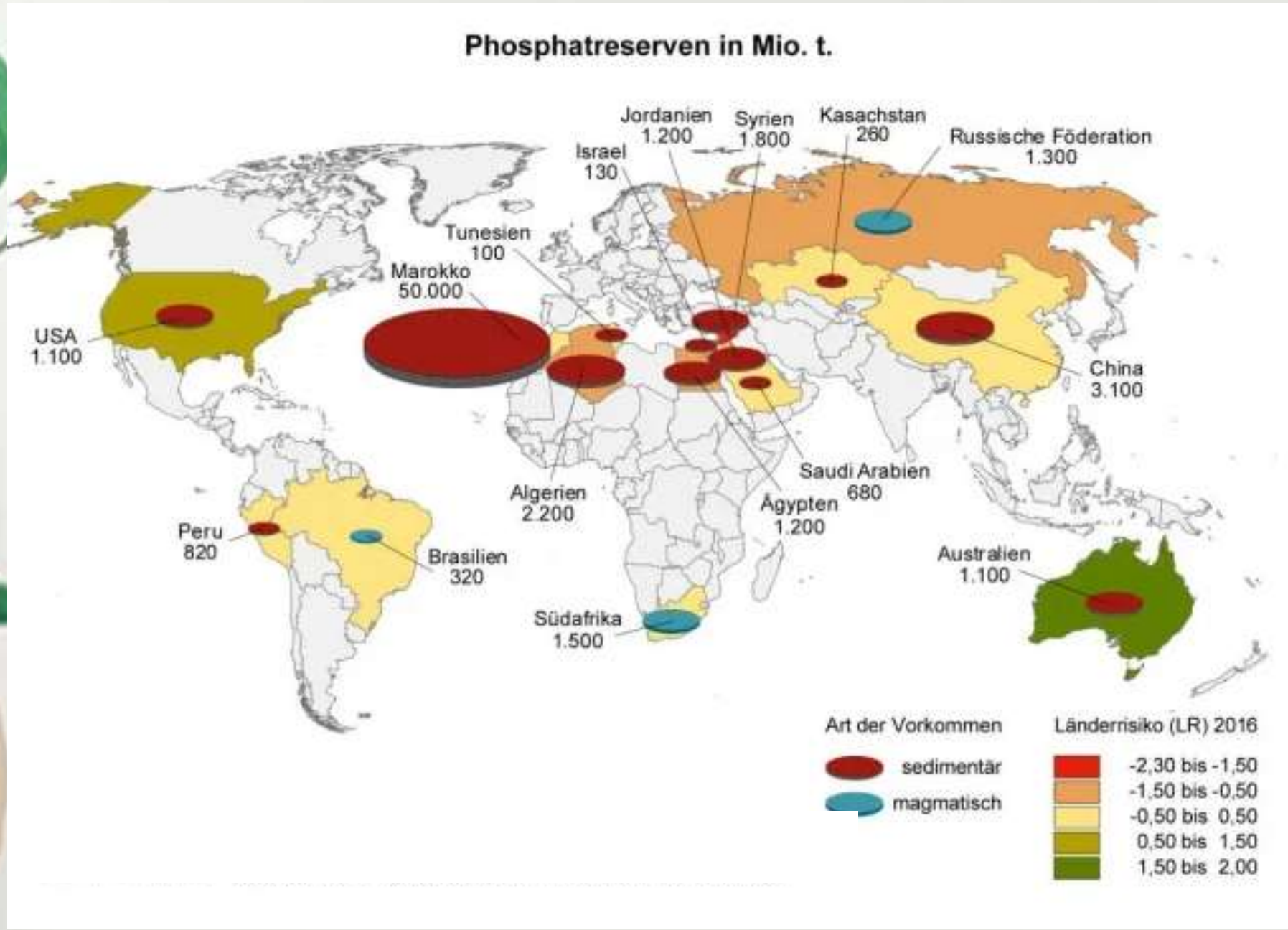
Industrial Uses of phosphorus:

- It is also used in detergents,
- Phosphates are common additives in detergents to soften the hard water where phosphate compounds help break down and remove stains.
- Phosphorus is utilized in the production of steel and other metallurgical processes

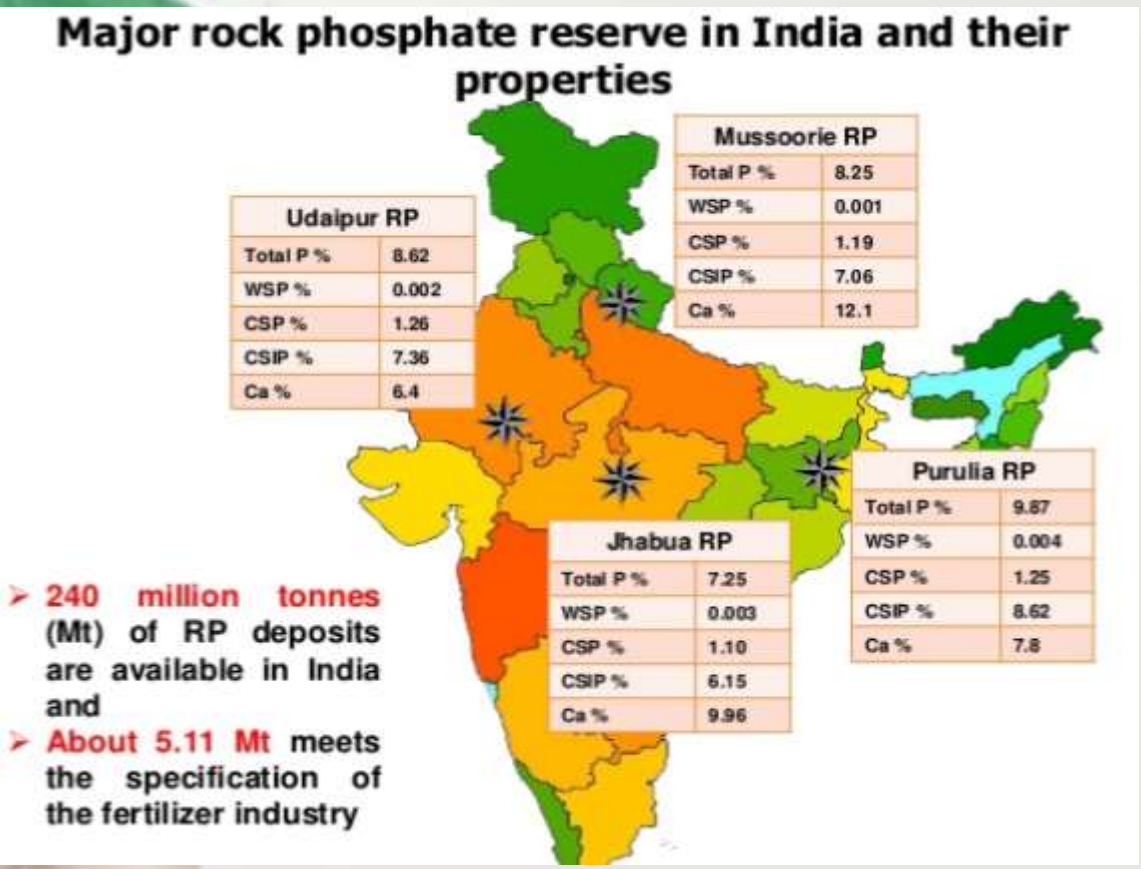
Phosphorus for plant growth



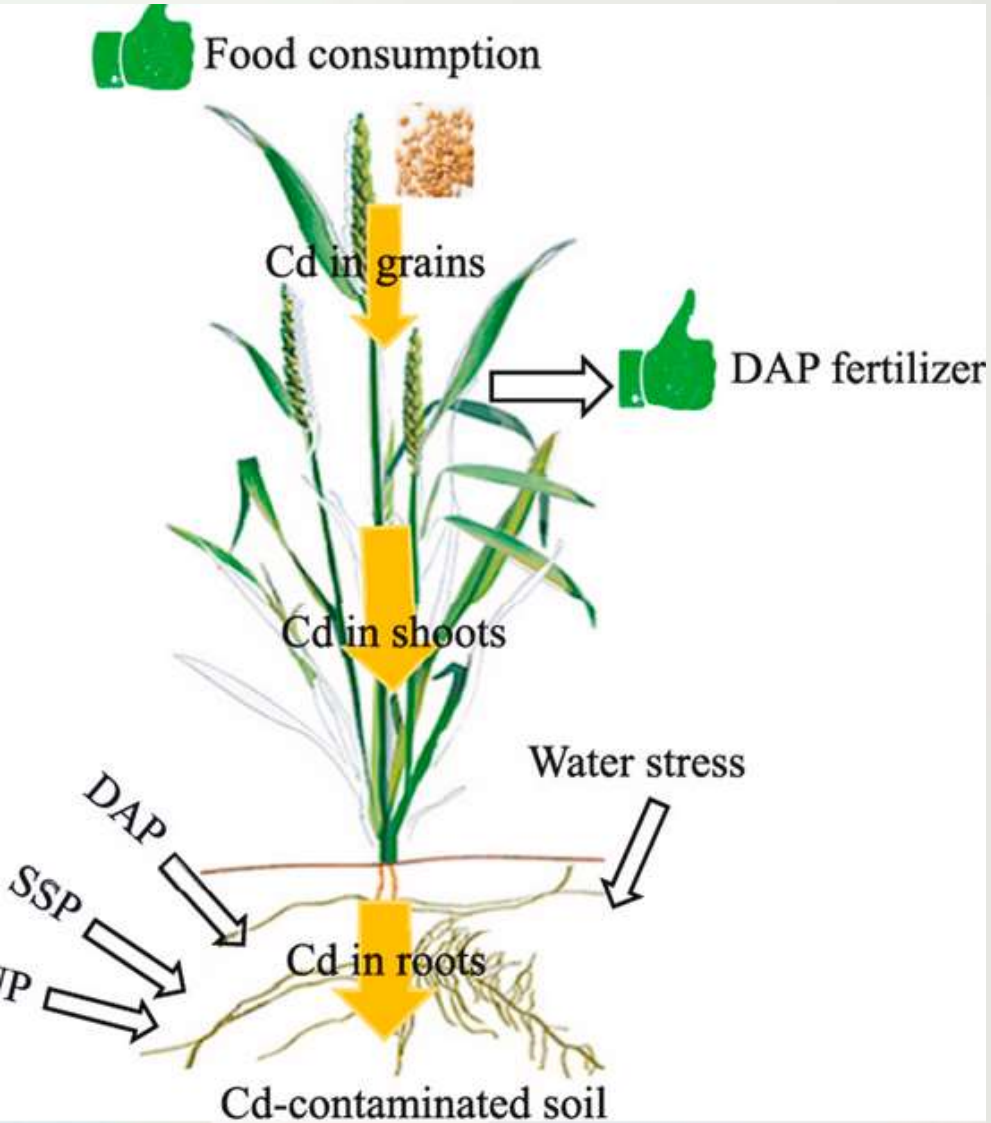
Phosphorus in world map



Phosphorus in India:

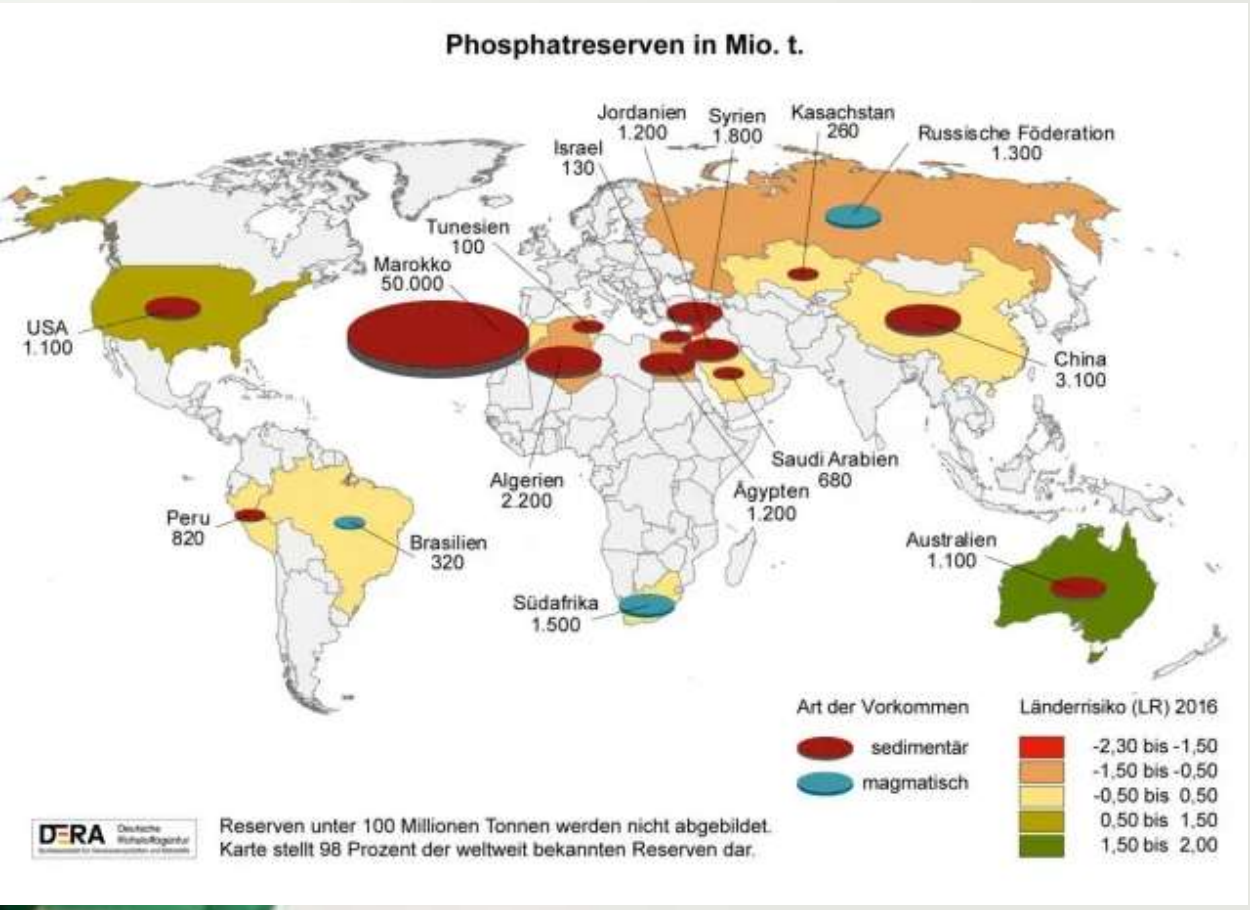


- India is deficient in Apatite (group of phosphate minerals) & Rock Phosphate availability.
- According to Indian Minerals Yearbook 2018, in case of apatite, the country is fully dependent upon imports,
- while the Rock Phosphate production is only from two states namely, Rajasthan and Madhya Pradesh.



- India is the world's largest importer of phosphorus, primarily sourcing it from West African deposits contaminated with cadmium.
- Paddy, is particularly prone to cadmium uptake, and Indian farmers extensively use fertilizers on paddy fields.
- Cadmium is a harmful heavy metal that can accumulate in the kidneys of animals and humans when consumed.

Challenges Associated with Phosphorus



Limited Reserves and Cadmium Contamination

Phosphorus is scarce and primarily found in specific geological formations only .

Morocco and the Western Sahara region possess the world's largest phosphorus reserves , but these reserves contain cadmium,

The extraction and removal of cadmium from phosphorus resources are costly processes.

- **Cadmium-laden fertilizers can contaminate crops, leading to potential health risks, such as heart disease**

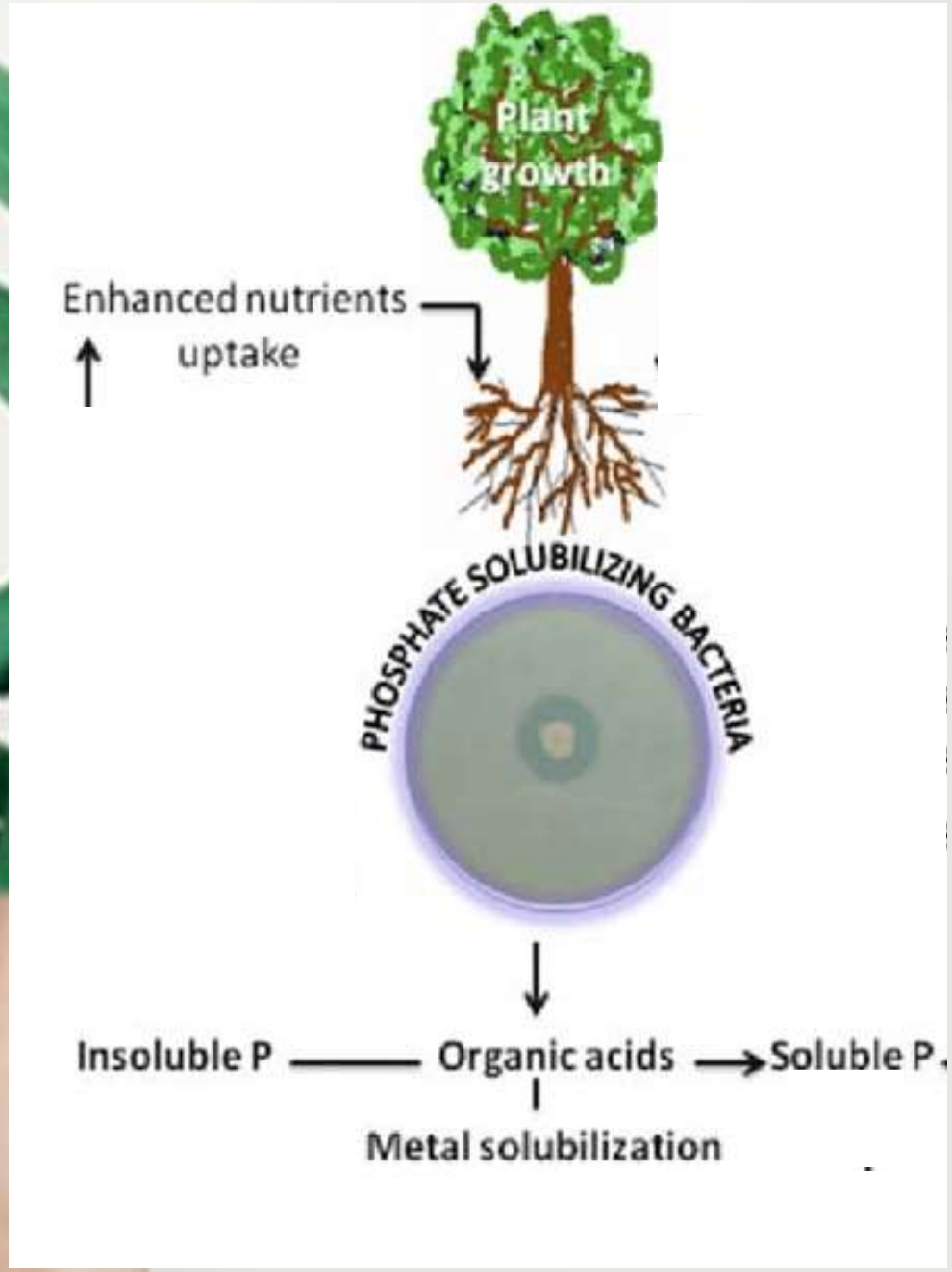
Phosphorus Overuse: Eutrophication

- Enrichment of an aquatic system by addition of nutrients, primarily phosphates & nitrates
- accelerates the growth of algae known as algae bloom.
- Algae bloom restricts the penetration of sunlight>>restricts photosynthesis among underwater plants >>depletion of oxygen >>> Death of aquatic organisms
- Depletion of oxygen also occurs due to decomposition of dead algae

Potential Strategies for Managing Phosphorus Usage

Smart Agriculture and Precision Fertilization:

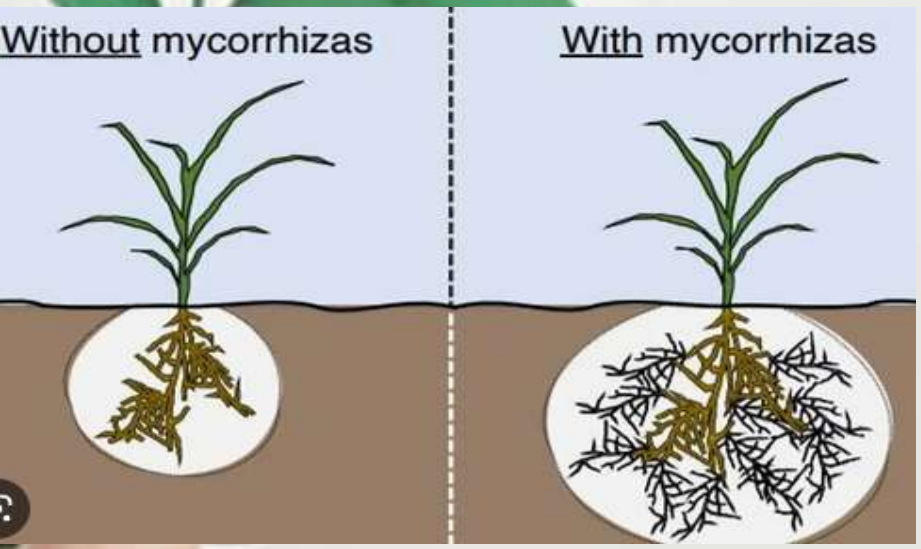
- **This ensures that crops receive the exact amount of phosphorus they need, reducing excess runoff into water bodies.**
- **Implement precision agriculture techniques that utilize sensor networks, AI, and data analytics to optimize phosphorus use on farms.**



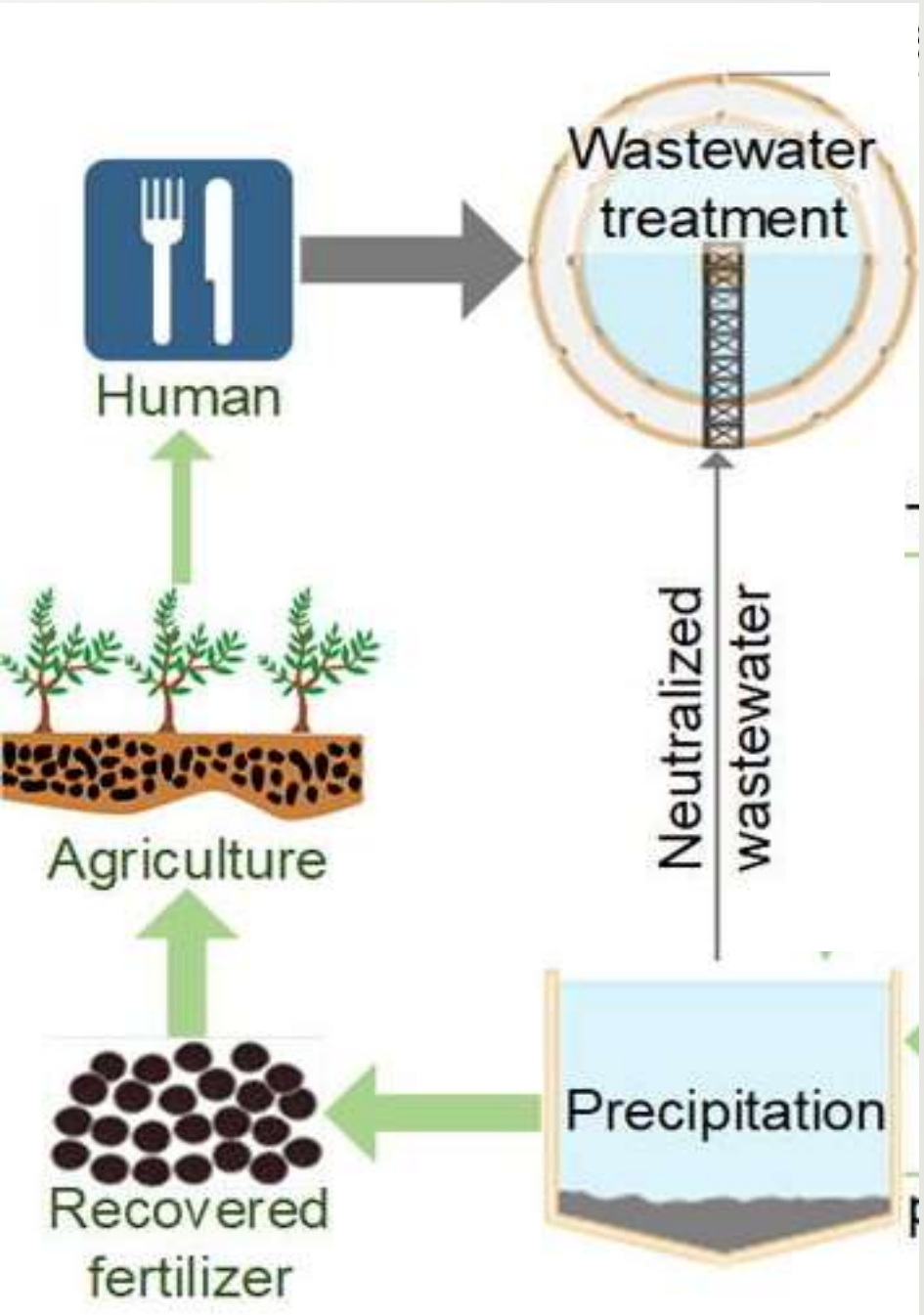
Phosphorus solubilizing biofertilizer

- Some microorganisms are capable of solubilizing immobilized phosphorus making it available to plants for absorption. Eg Pseudomonas, Bacillus

Mycorrhizal fungi biofertilizer for phosphorus



- Mycorrhizal fungi occur naturally on roots of forest trees and crop plants.
- Mycorrhizal fungi resist disease in plants. Increase drought and salinity resistance. Plants can tolerate adverse soil, pH, high temperature and heavy metal toxicity.
- The fungus has the ability to dissolve phosphorus
- Increase absorption of nutrients by plants infected with Mycorrhiza.



Phosphorus Recovery from Sewage and Waste

- There is a need to develop advanced technologies for efficient phosphorus recovery from sewage and various waste streams.
- This could include using innovative filtration, precipitation, and ion-exchange processes to extract and recycle phosphorus for use in fertilizers or other applications.

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