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Role of Soil Health in Crop Nutrition, Production and Quality under Natural Farming

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Soil health is the foundation of sustainable agriculture, influencing crop nutrition, productivity and quality. Globally, nearly **33% of soils are degraded**, while in India, about **32% of land is degraded** due to erosion, salinity, and nutrient imbalance . Natural farming offers an ecological solution by enhancing soil organic carbon, microbial activity and nutrient cycling. This article explores the scientific basis, numerical impacts and field-level examples of how soil health under natural farming improves crop nutrition, yield and quality.

Keywords: Soil health, Natural farming, Soil organic carbon (SOC), Microbial activity, Nutrient cycling, Soil fertility, Crop nutrition, Crop productivity, Siderophore-producing bacteria (SPB)

Introduction

Soil is a dynamic living system that supports plant growth and ecosystem sustainability. However, modern agriculture has led to severe degradation:

- **147 million hectares of land in India are degraded**
- Around **3 billion tonnes of soil are lost annually due to erosion**
- Nearly **60% of Indian soils are degraded** due to intensive farming

This degradation reduces productivity and threatens food security. Natural farming, which avoids synthetic inputs and promotes biological processes, is emerging as a sustainable alternative.

Concept of Soil Health

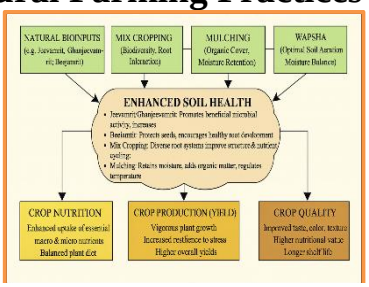
Soil health refers to the **capacity of soil to function as a living ecosystem** that sustains plants, animals and humans.

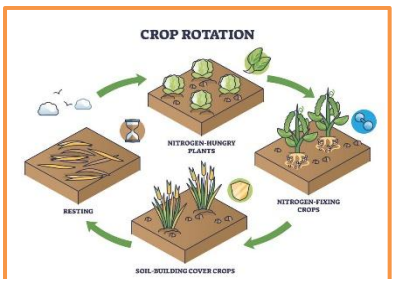
Key Indicators

- Soil Organic Carbon (SOC)
- Microbial Biomass
- Soil Enzyme Activity
- Nutrient Availability
- Water Holding Capacity

In India, average SOC is only **~0.54%**, which is below the ideal level

Natural Farming Practices Enhancing Soil Health





These practices rebuild soil structure and biological activity.

Numerical Improvements in Soil Health

Soil Organic Carbon (SOC)

- Conventional: **0.3–0.5%**
- Natural farming: **0.6–1.0%**
- Increase: **20–40%**

Example: A farmer increased SOC from **0.5% to 2.5%** through natural farming practices in Tamil Nadu

Nutrient Deficiency Status in India

- Nitrogen deficiency: **58% soils**
- Phosphorus deficiency: **49%**
- Potassium deficiency: **48%**

Natural farming improves nutrient cycling and availability.

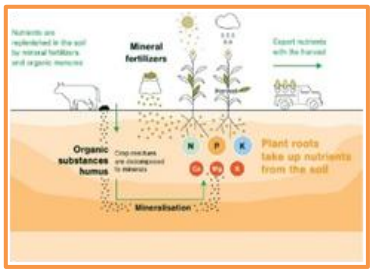
Microbial Activity

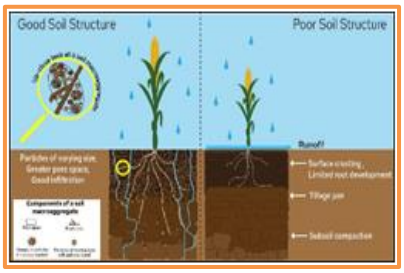
- Increase: **30–50%**
- Enhanced beneficial microbes like *Rhizobium* and *Azotobacter*

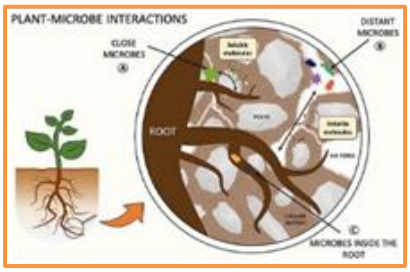
Water Holding Capacity

- Improvement: **10–15%**
- Organic matter enhances moisture retention

Soil Health and Crop Nutrition







Healthy soil improves:

Macronutrients

- Nitrogen fixation
- Phosphorus solubilization
- Potassium mobilization

Micronutrients

- Iron (Fe), Zinc (Zn), Boron (B) availability

Benefits:

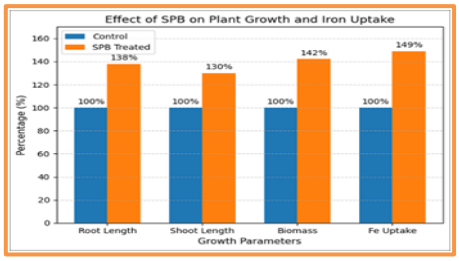
- Iron uptake increases by **20–40%**
- Zinc content improves by **10–20%**

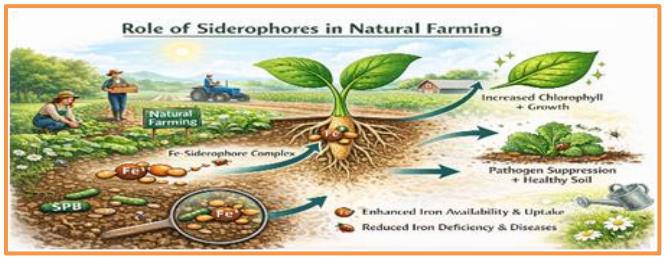
Role of Siderophore Producing Bacteria (SPB)

SPB are beneficial microbes that improve iron availability in soil.

Functions

- Convert Fe^{3+} into plant-available form
- Enhance chlorophyll formation
- Suppress pathogens





Examples
- *Pseudomonas*
- *Bacillus*
- *Azotobacter*

Impact:
- Iron uptake increased by **20–40%**
- Plant growth increased by **15–25%**

Impact on Crop Production

Yield Changes
- Initial years: slight reduction (**5–10%**)
- After stabilization: increase of **10–20%**

Example:
- Wheat yield: **3.2 → 3.8 t/ha**
- Groundnut yield: increase of **15%**

Cost Reduction
- Reduction in input cost: **30–50%**

Impact on Crop Quality

Nutritional Quality
- Protein increase: **10–15%**
- Micronutrients increase significantly

Food Safety
- Reduction in chemical residues: **80–100%**

Shelf Life
- Increase: **20–30%**

Example:
- Tomatoes last **7–10 days longer**

Environmental Benefits
- Carbon sequestration: **0.3–1.0 t/ha/year**
- Reduced greenhouse gases
- Improved drought resistance

Crops can survive **10–15 days longer during drought**

Discussion
Natural farming improves soil health through:
- Enhanced microbial activity
- Increased organic matter
- Better soil structure
- Improved nutrient cycling

These processes lead to:
- Better plant metabolism
- Higher nutrient uptake
- Improved crop quality

Conclusion
Natural farming is a sustainable agricultural approach that restores soil health and improves crop nutrition, production and quality. Given the alarming levels of soil degradation in India and globally, adopting natural farming practices is essential for ensuring food security, environmental sustainability and farmer profitability.

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