Recommendations for Soil Building through Mineral-Based Farming

For People, For Earth

SOKENSHA International JAPAN LLC.

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Healthy crops start with healthy soil.
Let's strengthen the soil and grow healthier crops.

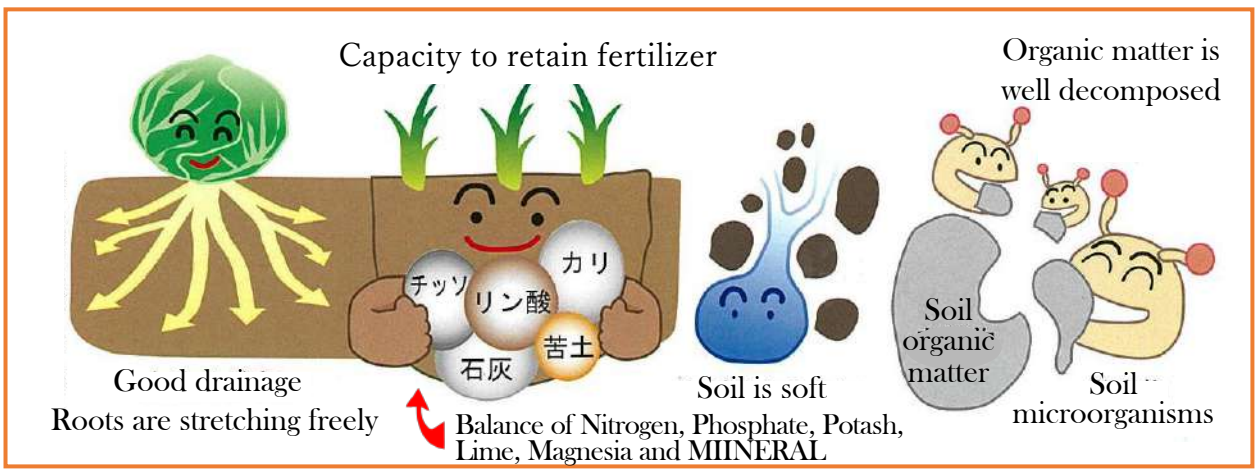
Soil preparation consists of stably supplying the water, air, and fertilizer components necessary for crops, and enhancing "Soil Fertility"—the power of the soil that prevents the increase of soil pathogens through the activity of microorganisms in the soil.
In a good soil environment, roots extend well, absorption of nutrients and water is smooth, and crops grow soundly. Healthy crop growth leads to improved yield and quality of agricultural products and the formation of crop bodies that are less prone to pests and diseases.
It is believed that now is the time to return to the basics and reaffirm the importance of soil preparation.

Objectives of Soil Preparation

- Enhance drainage and water retention
- Enhance air permeability
- Enhance softness/swelling (make the soil fluffy)
- Enhance fertilizer retention capacity
- Keep pH weakly acidic (generally 5.5–6.5 is desirable)
- Increase organic matter and activate soil microbial activity

Soil preparation requires different improvement items depending on soil properties and uses, such as paddy fields or upland fields. For example, generally, in sandy soil, drainage and air permeability are high, but water retention and fertilizer retention are low, and humus tends to be consumed quickly. Clay soil has high water retention and fertilizer retention, but drainage and air permeability are inferior.

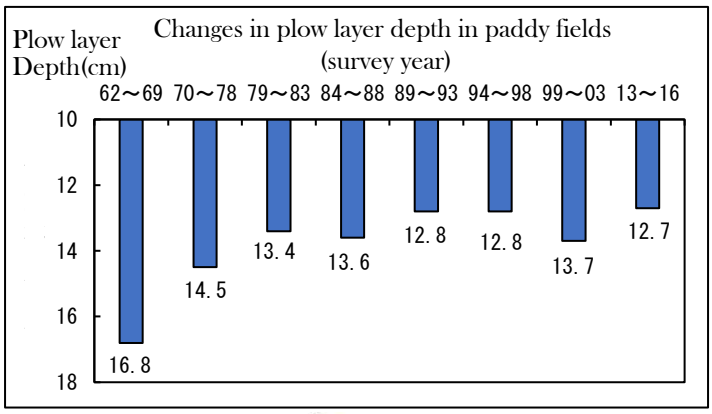
What is well-balanced soil?



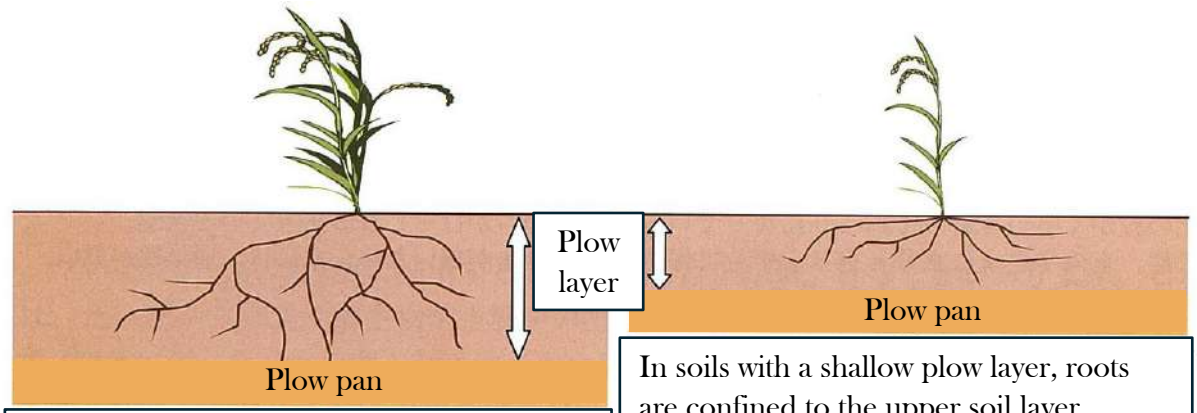
The condition of agricultural soils.

Soil preparation is performed according to soil conditions such as land category and soil texture. Surveys such as soil function monitoring surveys conducted so far have revealed the following points. Referencing the trends of the soil function monitoring survey (within Chiba Prefecture), check the condition of your fields and perform appropriate soil preparation.

◆ In paddy field soil, the plow layer is becoming shallower.



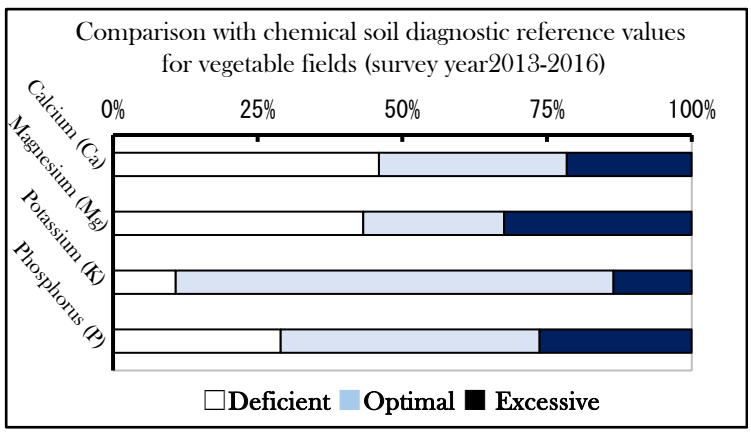
Recently, paddy soils in Chiba Prefecture have tended to develop shallower plow layers, which restrict root growth and reduce nutrient uptake. Countermeasures include deep tillage combined with the application of compost and trace-element-rich materials."



In soils with a deep plow layer, roots develop well and nutrient uptake is enhanced.

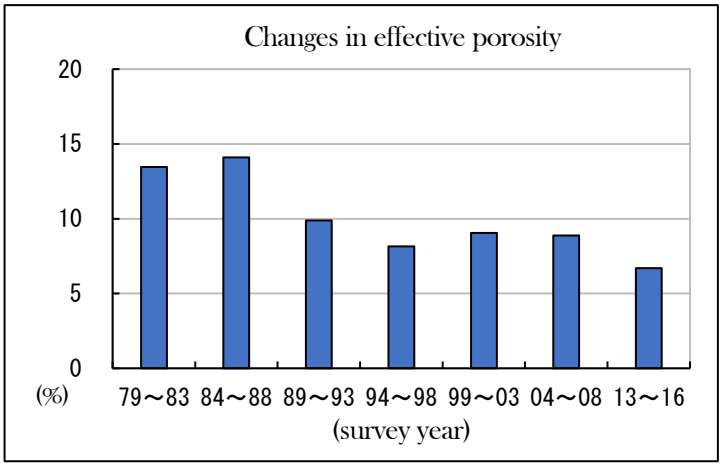
In soils with a shallow plow layer, roots are confined to the upper soil layer, resulting in poor nutrient uptake and increased vulnerability to weather conditions such as drought.

◆ In paddy field soil, the plow layer is becoming shallower.



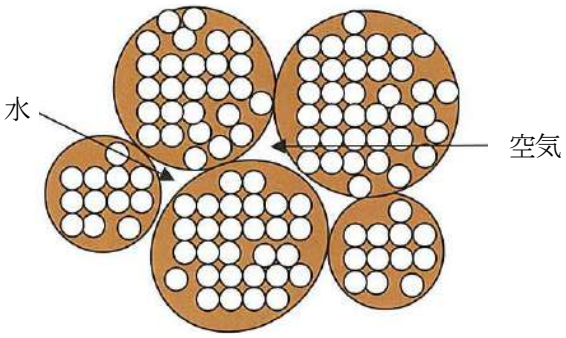
In many vegetable fields in Chiba Prefecture, recent years have seen increases in calcium and magnesium contents, along with excessive levels of phosphorus and potassium. When applying chemical fertilizers or compost, it is necessary to conduct soil testing and apply appropriate amounts based on the results.

◆ In upland field soils, water-holding capacity has been declining.



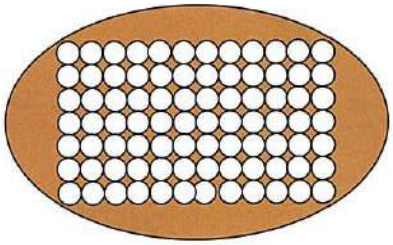
In recent years, soils in Chiba Prefecture have shown a decrease in effective pore space (water-holding capacity) within the plow layer. As a result, soil drainage, water-holding capacity, and aeration have deteriorated.
To improve these conditions, the formation of stable soil aggregates is essential, and the application of well-matured organic matter such as compost, as well as mineral solutions extracted from natural rocks, is effective.

Soil aggregate structure



A condition in which soil particles bind together to form aggregates. This structure allows the soil pores to retain sufficient water and air, resulting in a soft, well-aerated soil with good drainage.

Single-grain soil structure



A condition in which soil particles are tightly packed with little pore space. As a result, drainage and aeration are poor.

As measures to improve these conditions, it is recommended to conduct soil testing prior to soil management in order to assess soil conditions, and to improve the soil's physical, chemical, and biological properties through the application of high-quality compost (organic matter) and mineral solutions extracted from natural rocks.

Assessment of soil hardness, drainage conditions, and plow layer depth.

Assessment of soil pH and identification of nutrient deficiencies.

Assessment of nutrients showing excessive accumulation.

Assessment of CEC (Cation Exchange Capacity), an indicator of nutrient-holding capacity.

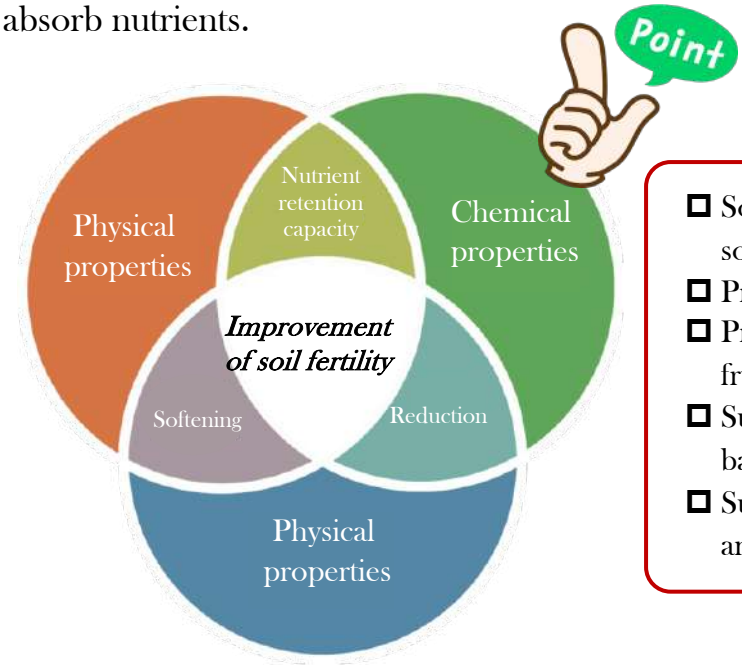
1. Soil management focused on mineral-based farming

The inorganic nutrients (minerals) required by crops are present in soil and compost. For crops to grow normally, it is essential that the soil contains a well-balanced supply of inorganic nutrients without deficiency or excess, and that a favorable soil environment is maintained in which roots can develop healthily and absorb nutrients efficiently.

The agricultural mineral solution recommended by SOKENSHA is produced by extracting mineral components from a combination of representative rocks that form continental crusts.
By promoting 'soil softening' and enhancing 'enzyme activity,' this mineral solution is expected to improve the soil's physical, biological, and chemical properties.

Furthermore, when the mineral solution is used in combination with high-quality compost (such as fermented compost, bamboo powder, and green manure), the interaction between lactic acid bacteria contained in the compost and minerals enhances enzyme activity. This process suppresses harmful microorganisms in the soil and improves its biological condition.

In addition, based on the principles of compost mulching, slow decomposition proceeds under conditions of appropriate moisture and oxygen availability. As a result, earthworms and other beneficial organisms increase, the soil gradually becomes softer, and a soil environment is created in which crops can more easily absorb nutrients.



- ☐ Soil improvement and management of soil microbial balance.
- ☐ Promotion of root crop growth.
- ☐ Promotion of growth in leafy vegetables, fruit vegetables, and fruit trees.
- ☐ Support for improved sugar and acid balance.
- ☐ Support for enhanced root vitality, among other benefits.

Mineral-based farming is an approach that draws out the soil's inherent fertility and enhances the six effects shown in the table.
Rather than replacing fertilizers or pesticides, it is designed to 'optimize soil functions.' This approach does not conflict with either conventional or organic farming and enables steady improvements in quality, yield, and production stability without placing excessive burden on cultivation practices.

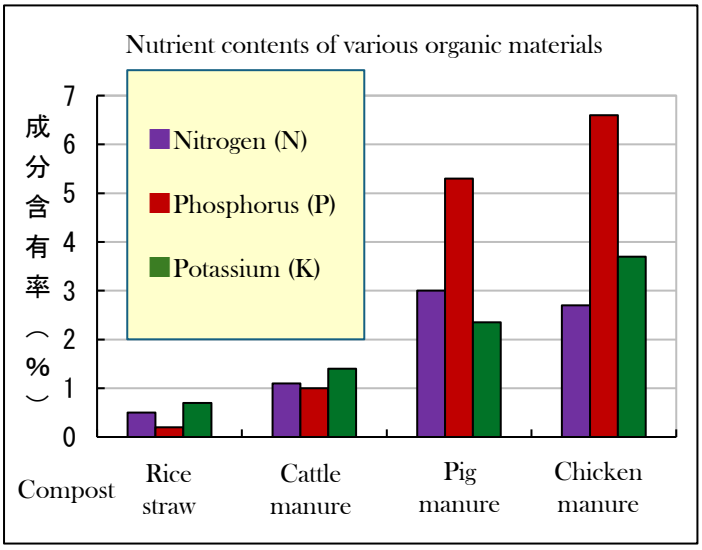
2. Compost and Mineral Amendments for Improved Soil Biology

The application of compost is an effective means of soil improvement.
By applying well-matured, high-quality compost together with mineral amendments at appropriate rates, the effects of improving soil water-holding capacity and aeration can be enhanced.
When applying compost and mineral materials, attention should be paid to the following points.

- Understand the nutrient composition of compost and apply it while taking its fertilizer value into account.
  Some livestock manure composts have high fertilizer effectiveness. Care should be taken to prevent environmental impacts caused by nitrogen leaching into groundwater, as well as excessive accumulation of potassium.

- When the objective is soil improvement, compost with a nitrogen content of 1% or less should be applied.
  It is important to continuously apply high-quality organic matter.
  Applying materials with a nitrogen content of 1% or less and a carbon-to-nitrogen ratio (C/N ratio) of 30–50 enhances the effectiveness of soil improvement.

- Pay close attention to the timing of compost application.
  Applying compost immediately before planting may cause nitrogen immobilization, leading to suppressed crop growth.
  Incorporate well-matured compost during soil preparation prior to transplanting and allow it to fully integrate into the soil before applying mineral amendments.
  This practice helps regulate the soil microbial community before sowing or transplanting.



Recommended application rates of livestock manure compost by crop type, considering nitrogen fertilizer effectiveness (kg/10 a)

Corp	Cattle Manure Compost (Manure-based)	Cattle Manure Compost (with Bulking Materials)	Pig & Chicken Manure Compost (Manure-based)	Pig & Chicken Manure Compost (with Bulking Materials)	Basal nitrogen application rate (kg/10 a)
Paddy rice	200~300	300~400	200~300	60~80	3
Field crops	500~1,000	1,000~1,500	500~1,000	200~300	10
Field crops	500~1,000	1,000~1,500	500~1,000	200~300	10
Fruit trees (Japanese pear, mandarin orange, loquat etc)	1,000~1,500	2,000~2,500	800~1,000	400~600	20~30 (12)

- Based on an application rate in which 30% of the basal nitrogen is substituted with nitrogen derived from compost.
- Japan's Standard Fertilization Guidelines for Major Crops (March 2019).

without MIINERAL

with MIINERAL
(1000×)

- High-quality compost dominated by actinomycetes, together with the enzyme-activating effects of minerals, improves the biological properties of the soil.
- This leads to a reduction in the proportion of filamentous fungi, which account for approximately 80% of soil-borne plant pathogens.

3. Soil Aggregate Formation (Improvement of Physical Properties)

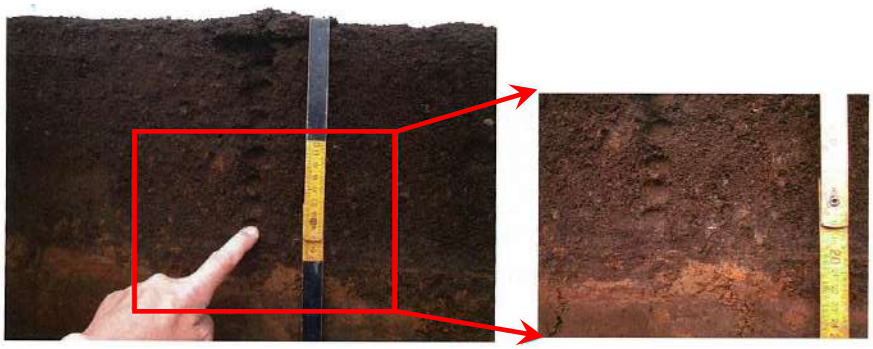
Due to the increasing size and weight of agricultural machinery such as tractors, there is a tendency for the plow layer to become shallower and for the soil beneath the plow layer to become compacted and hardened, restricting root development. As a countermeasure, deep tillage using rotary tillers, plows, or subsoilers can be carried out to break up the plow pan formed beneath the plow layer, thereby improving soil conditions.

Function of minerals — Minerals with an average particle size of 2 mm have approximately 80% of their atoms exposed on the surface, resulting in very high reactivity.
When these minerals come into contact with soil, the soil becomes ionized, and electrostatic repulsion is expected to create a loose, well-aggregated soil structure.

Furthermore, when soil-borne pests and diseases are present, relying solely on physical deep tillage carries the risk of spreading these organisms.
In such cases, promoting soil aggregate formation and regulating the soil microbial community through mineral-based farming is a more efficient and effective approach.

Tillage guidelines using the index finger method

High risk of drought	The index finger enters easily without resistance
Optimal	With moderate pressure, the index finger can be inserted fully
Slightly hard, but roots can grow	With strong pressure, the index finger can be inserted halfway or fully, depending on the degree of soil hardness.
Roots can penetrate slightly, but growth is poor	Even with pressure, the index finger does not enter, but the soil surface dents.
Roots have difficulty penetrating; risk of excess moisture damage	Even with pressure, the index finger does not enter.



In a strawberry field in Tochigi Prefecture, mineral-based soil management removed the plow pan, resulting in root growth reaching a depth of 1.4 m.

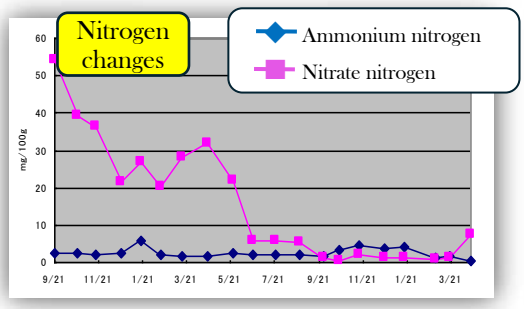
4. Soil Aggregate Formation (Improvement of Physical Properties)

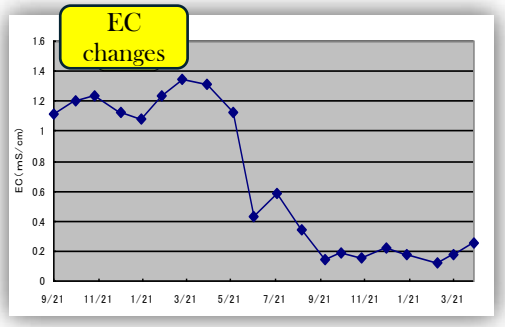
Through the application of mineral amendments, the soil maintains a soft, well-aggregated structure, while pH and salinity (EC) are optimized, creating an environment in which microorganisms can actively thrive.
As a result, soil enzyme activity is enhanced and the microbial community is regulated toward a desirable balance.
Furthermore, improvements in physical properties (elimination of plow pan and enhanced aeration and drainage) and biological properties (enhanced activity of nitrate reductase) progress simultaneously, allowing nitrate nitrogen (NO_3^-) and EC values to stabilize within optimal ranges in a short period of time.

[Five Reductions]

- Reduction in fertilizer use：Improved nutrient-holding capacity and enhanced rhizosphere activity optimize required application rates and reduce the frequency of topdressing.
- Reduction in pesticide use:Suppression of initial outbreaks and reduced disease and pest pressure allow a reassessment of spraying frequency.
- Reduction in irrigation:Improved soil aggregation increases water-holding capacity, preventing excessive irrigation.
- Reduction in losses:Decreased growth variability and reduced off-grade produce caused by salt stress and root damage.
- Reduction in GHG emissions:A healthy rhizosphere environment suppresses emissions of CH_4 and N_2O.

［Changes observed after mineral application］





All verifications are based on the results provided by Professor Mr.Kikuchi of Muroran Institute of Technology.

5. Mineral-Based Farming and Other Inputs / Soil Fertility-Enhancing Crops

● Compatibility with soil improvement materials

A list will be provided to illustrate the compatibility between soil improvement materials defined under Japan's Soil Fertility Enhancement Act and mineral amendments.

Objectives of land improvement	Types of soil conditioners	Compatibility with minerals	
Soil mellowing	Peat	◎	pH buffering and improvement of nutrient-holding capacity
	Peat compost	◎	Promotion of microbial activation
Improvement of nutrient-holding capacity	Humic acid materials	◎	Natural chelation support
	Zeolite	◎	Enhancement of cation exchange capacity
Improvement of water-holding capacity	Peat	◎	Improved water-holding capacity through maintenance of soil aggregates
	Perlite	○	Enhanced improvement of soil physical properties
Improvement of water permeability	Charcoal	○	Improvement of water-holding capacity
	Calcined diatomaceous earth granules	○	Improvement of soil aeration and drainage
	Vermiculite	◎	Synergistic effects through high CEC (nutrient-holding capacity)
Promotion of soil aggregate formation	Polyethyleneimine-based	×	Not suitable due to metal ion binding
	Polyvinyl alcohol–based	○	Supports the maintenance of soil aggregates
Prevention of water leakage in paddy fields	Bentonite	○	Diffusion is suppressed due to swelling

● Compatibility with soil fertility–enhancing crops (green manure)

By cultivating soil fertility–enhancing crops as green manure and incorporating them into the soil, the following effects can be expected:

- Improvement of soil physical properties, including enhanced water-holding capacity, aeration, and promotion of soil aggregation;
- Reduction of soil erosion and wind erosion during winter;

- Function as a cleaning crop;
- Prevention of continuous cropping disorders;
- Suppression of nematode damage; and
- Weed suppression.

Green manure activates the ‘organic engine,’ while minerals act as the ‘metabolic ignition,’ increasing the system’s efficiency.
When minerals are applied to soil where decomposition has begun, microbial and enzymatic activities work in synergy, driving soil aggregation, CEC (nutrient-holding capacity), and nitrogen cycling, while stabilizing pH and EC.

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