

Soil air

Features of soil air

Constituents	Volume % in atmosphere	Ratio of soil air to the content in atmosphere
N ₂	78.1	0.96 – 1.15
O ₂	20.9 >>	0.09 – 1.0
Ar	0.93	1.0 – 1.2
CO ₂	0.0345 <<	3 – 30
CH ₄	0.00017 <<<	~30000
N ₂ O	0.00003 <<<	~ 33000
Humidity	30 – 90 % <	100 %

Required air volume % of various crops

extent	Required air volume	Crops
maximum	> 24 %	Cabbage, Green bean
high	> 20 %	Turnip, Cucumber, Wheat, Barley, Common vetch
medium	> 15 %	Oats, Sorghum
low	10 %	Italian Ryegrass, Rice, Onion (initial growth)

Proper soil air composition

- Air phase %: 10 – 15 %
- Oxygen: higher than 10 %
- CO₂ : lower than 8 %

Oxygen concentration in soil air

Volcanic ash soil in Isehara city (Kanagawa)		Non-volcanic ash soil in Taketoyo, Aichi	
Soil depth	Oxygen %	Soil depth	Oxygen %
20 cm	20.2 – 20.8	0 – 10 cm	19.1 – 20.7
50 cm	20.0 – 20.6	10 – 20 cm	19.4 – 20.8
100 cm	19.5 – 20.0	20 – 30 cm	14.2 – 14.8

Concentration of CO₂ in soil air

Volcanic ash soil in Isehara city (Kanagawa)		Non-volcanic ash soil in Taketoyo town, Aichi	
Soil depth	CO ₂ %	Soil depth	CO ₂ %
20 cm	0.14 – 0.25	0 – 10 cm	0.43 – 1.51
50 cm	0.30 – 0.54	10 – 20 cm	0.60 – 1.91
100 cm	0.51 – 0.98	20 – 30 cm	5.89 – 6.20

Soil air moves easily in volcanic
ash soil.

Suitable for the growth of crops.

Effects of plowing on agricultural soils

Items of soil diagnosis standards related to physical properties

Hardness of subsoil 16 - 20

Solid phase % of plowed soil:

25 – 30 (volcanic ash soil)

< 40 (lowland and terrace soils)

Bulk density: 0.70 – 0.90 (volcanic ash soil)

9.0 – 1.10 (lowland and terrace soils)

Coarse pore %: 15 - 25

Easily available water %: 15 - 20

Harrow rate: > 70

Items of soil diagnosis standards related to physical properties (continued)

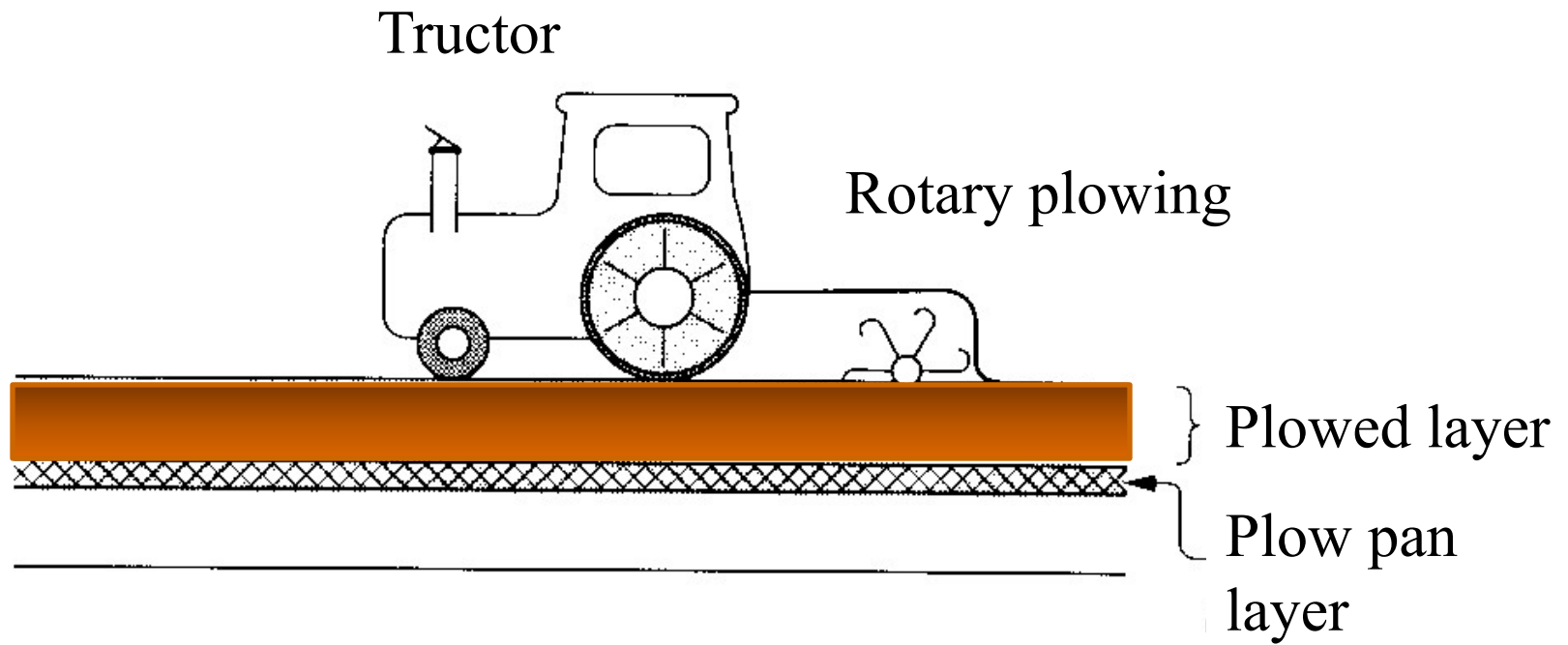
- **Depth of plowed layer: 20 – 30 cm**
- **Effective soil layer: > 50 cm**
- **Saturated hydraulic conductivity: 10^{-3} – 10^{-4} cm/sec**
- **Ground water level: lower than 60 cm**
- **Plow pan layer: >20 by Yamanaka type soil hardness tester, > 1.5MPa by penetration hardness tester.**

Effects of plowing soil

- Make soil soft, and increase the holding capacity of water and air.
- Cut the cycle of weeds and pests.
- Mix the crop residue, compost, and fertilizers.
- Make the uniform distribution of soil nutrients.
- Suitable conditions for germination and initial growth are provided.
- Increase the root area and promote soil microbial activity.

Demerits of plowing soil

- Energy consumption is very large.
- By making the soil bare, soil erosion may be caused.
- Decrease in land supporting capacity. Can not operate agricultural machines after the rain.
- Crust (clay film) is formed after heavy rain.
- Subsoil is mixed with plowed layer soil.
- Plow pan is formed by the operation of heavy machines.
- Decomposition of soil organic matter is enhanced.



Formation of plow pan in the upland field

Subsoil is important for the growth of crops

- Upland crops absorb more than half of nutrients from the subsoil.
- Water absorption from the subsoil is also important.
- Plow pan disturb the penetration of roots to subsoils.
- Ill drainage inhibits the growth of roots in the plowed layer.

No-till

Till farming



Comparison of labor time between till and no-till farming.

method	Labor time (min / 10a)			
	Rotary plow	Seeding	Herbicide application	Total
Till	38	26	11	75
No-till	← 15 →			15

Effect of no-till cultivation

- Decrease the soil loss due to wind and water erosion.
- Retard the soil organic matter decomposition.
- Saving labor and lower the costs.
- Workable under rainy weather.
- Covering the soil surface with crop residues.
Decrease the damage by birds.
- Superior water penetration and water holding capacity.
- Enrich crop residues on the soil surface and maintain soil fertility.

Demerit of no-till cultivation

- Increase in soil hardness, retard crop growth, cause moisture damage.
- Lower the efficiency of fertilizers (due to evaporation and denitrification).
- Decrease soil temperature by crop residue. Cause uneven germination and pest damage.
- Increase the use of herbicides.
- Root crops are difficult to grow.

Deterioration of soil physical properties.

Causes and measures.

Natural factors

Land form

Amend the inclination, make the land flat.

Improve the drainage by under drain and open drain.

Soil types (heavy clay, sandy soil)

Soil improvements, soil dressing,

application of organic matter, growing

green manure, conduct rotational cropping

Deterioration of soil physical properties.

Causes and measures.

Human factors

- Agricultural machinery

Improving the machines, Change the working process

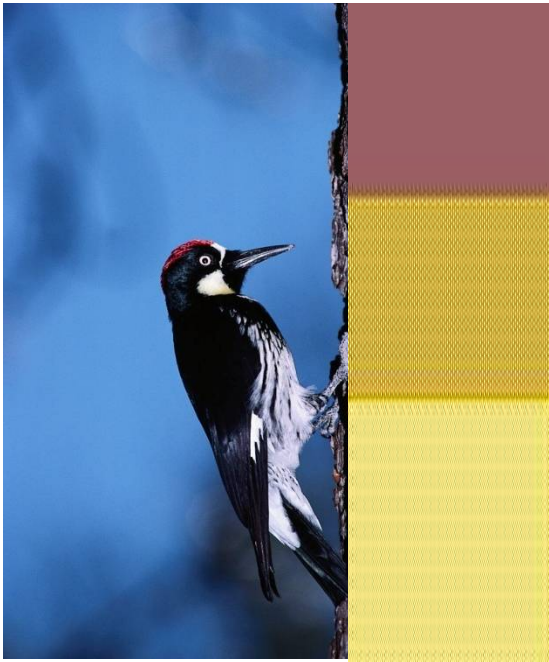
- No-application of organic matter and compost.
- Decomposition of soil organic matter, soil erosion
- Inactivation of soil organisms

Application of compost, growing green manure, rotational cropping, non-till culture

Deterioration of soil physical properties in Japan

- Plowed layer of paddy field became shallower. → Caused the decrease in yield and quality of rice.
- Plowed soil in upland became hard and the drainage became worse. → Caused the decrease in yield and quality of vegetables (especially cabbage).
- Formation of plow pans in upland field
→ Yield and quality of root crops (radish and carrot) decreased.

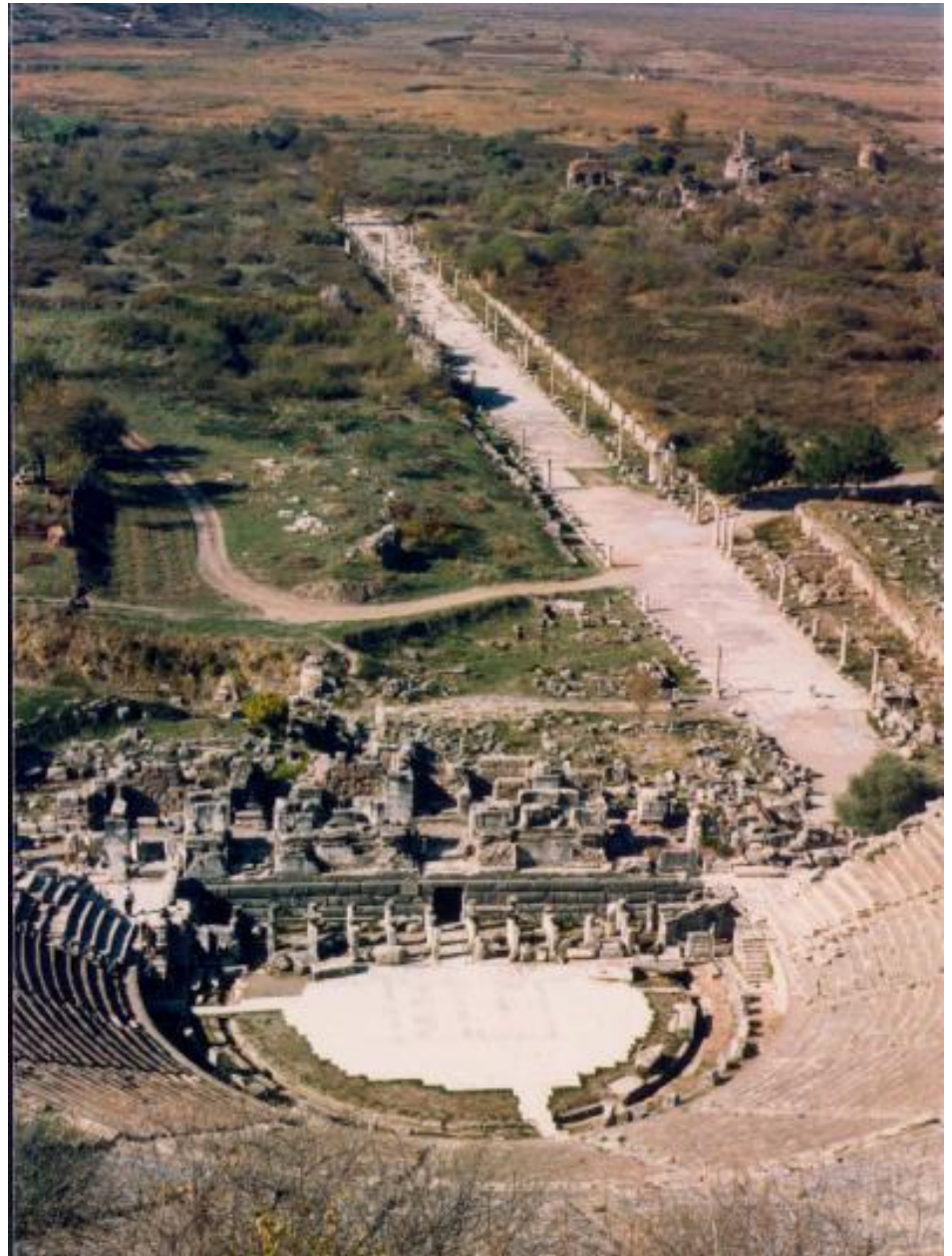
Let's consider toether.



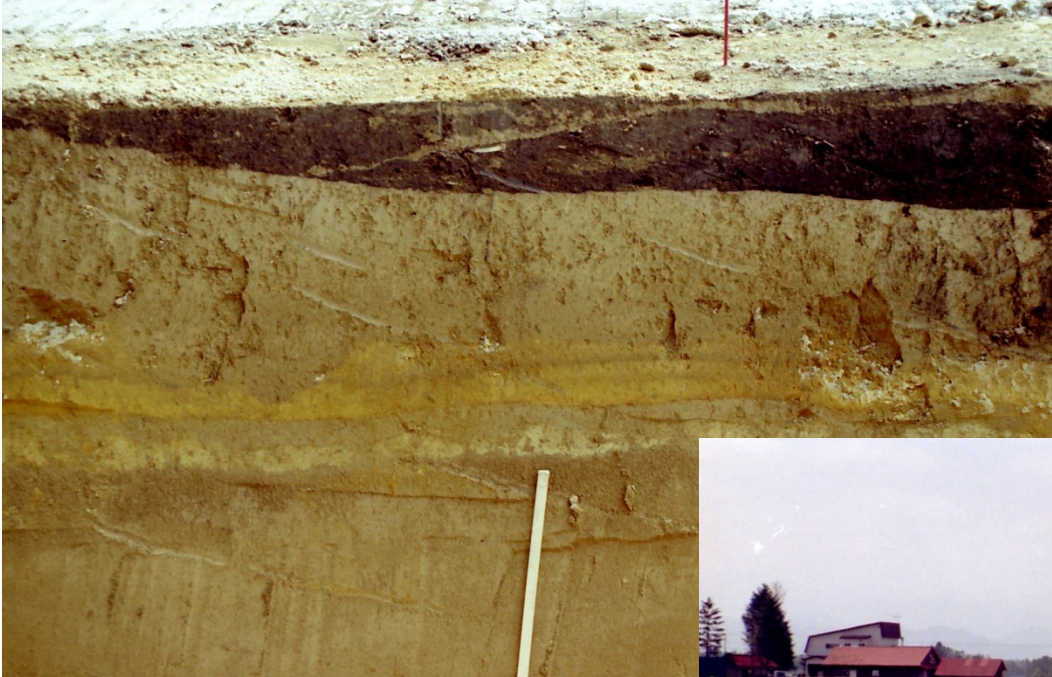
How can we protect our
soil and agriculture?

The remains of ancient Roman city Ephesus in Turkey

"The Nation
that destroys
its soil
destroys
itself" --
Franklin D.
Roosevelt



Volcanic ash soil with thin plowed layer in Memuro, Hokkaido



Thanks to soil

- Life is born from soil

All the life on the land comes are born from the soil. Fertile soils support the agriculture.

- Soil is protecting the environment.

Decompose the biological remains and feces.

Keeps the composition of atmosphere, and moisture.

Buffer the environmental change.

Soil records the history

Fall of volcanic ashes, floods and Tsunami,
remains of ancient human lives.

Soil is burying and keeping the past history.

Tradition handed down by the American native people, Hopi.

Though our land is inherited from our **ancestors**, it is also borrowed from our **descendants**. Therefore, we have to return it in unchanged state to our **descendants**.

