What soil profile survey tells you:

- What factor is limiting the plant growth (gravel, volcanic ash, clay, compaction of soil material, acidity, salt accumulation)
- Content and thickness of humus
- Drainage, water retention, dry or wet.
- Different soil layers composing the soil profile → History of soil

Andosoil profile in Obihiro Univ. Agr. & Vmed.

Kuroboku soil

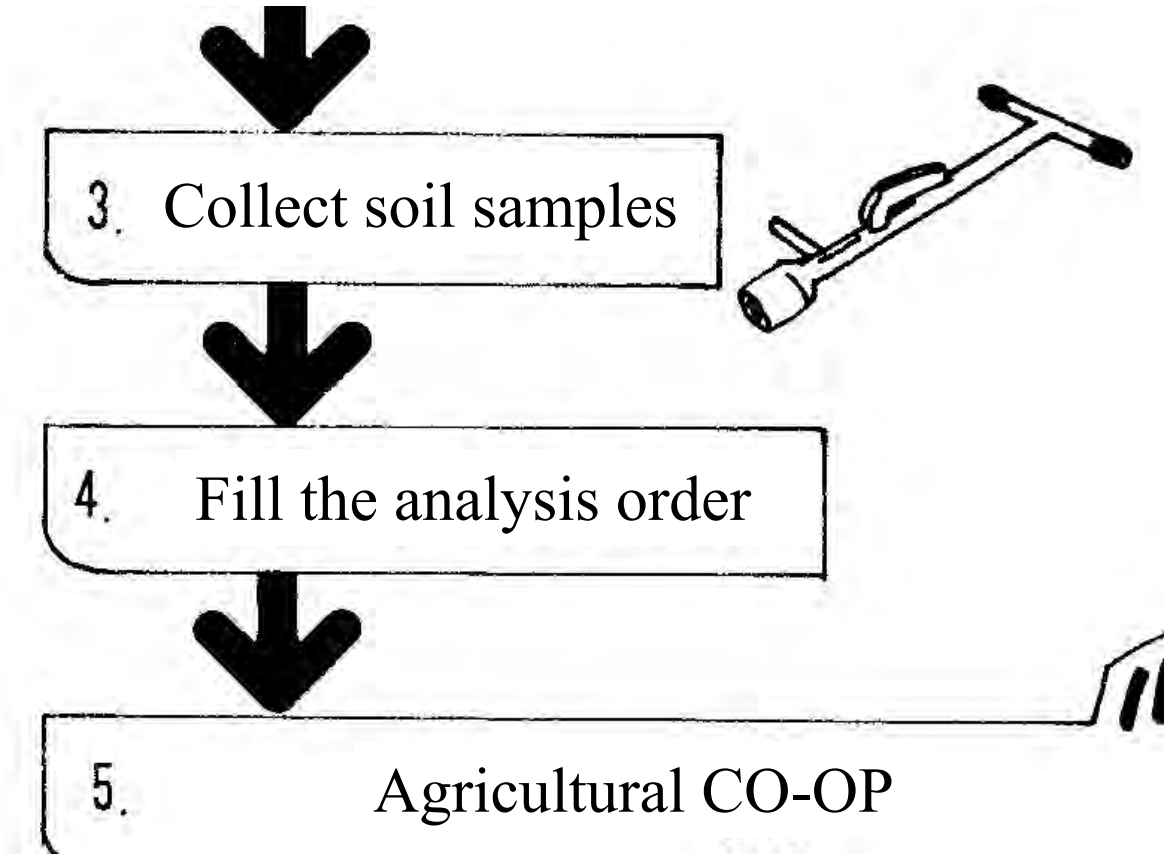
Plowed layer

Tarumae d volcanc ash

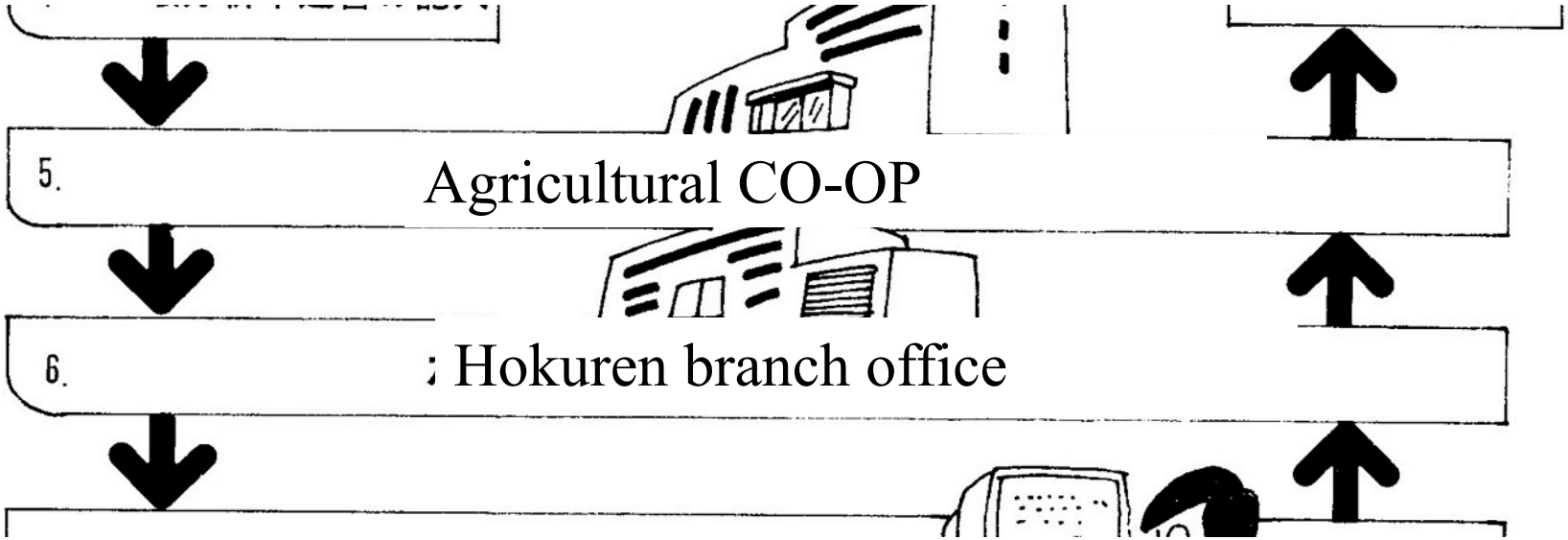
Eniwa loam

Alluvial soil

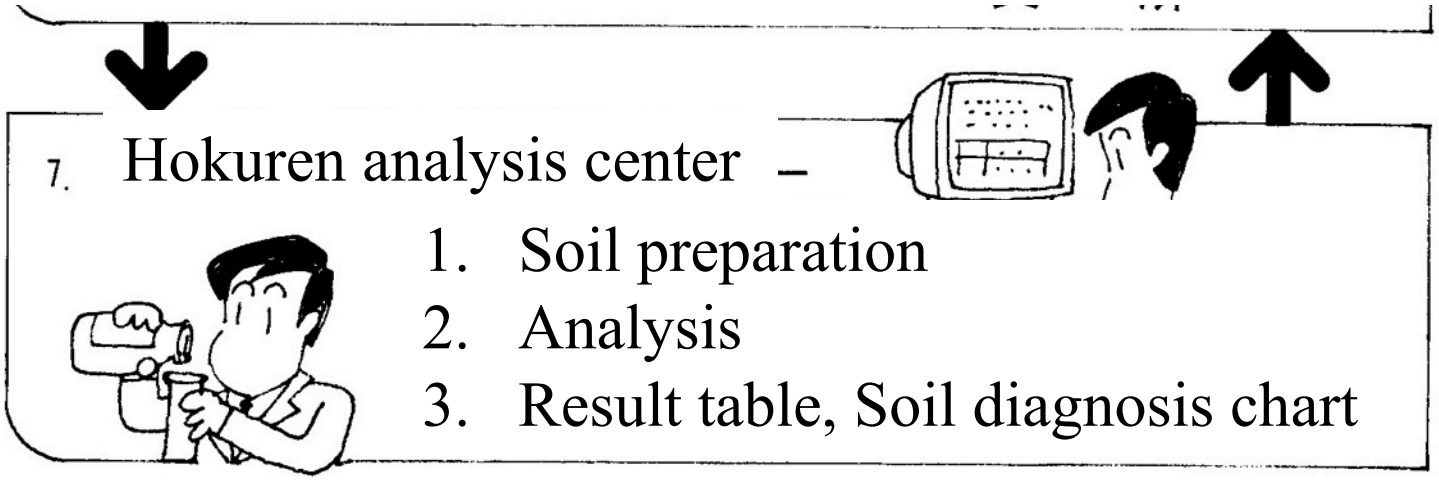
Flow sheet of soil diagnosis 4



Flow sheet of soil diagnosis 5

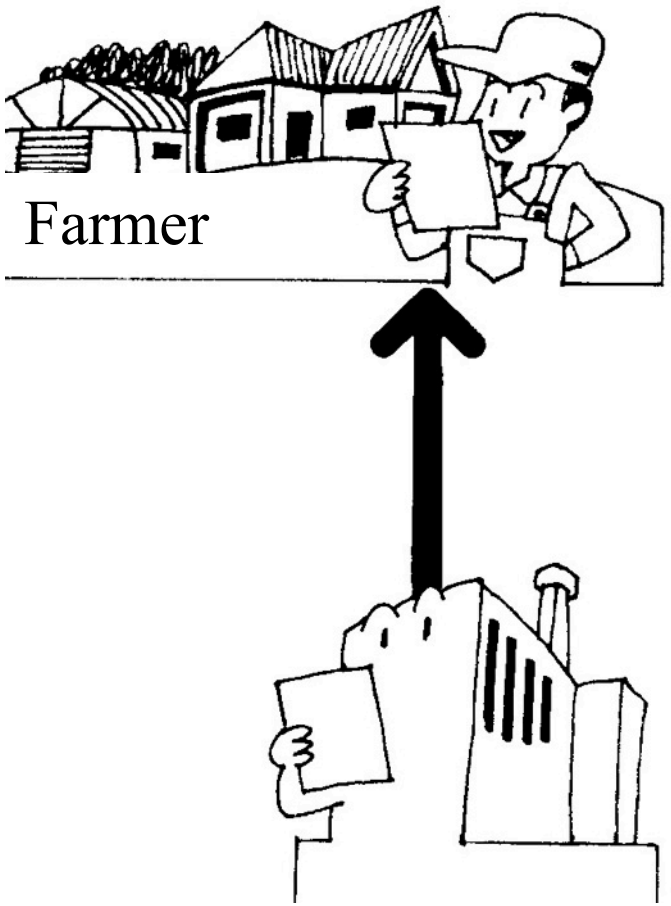


Flow sheet of soil diagnosis 6



Tokachi Federation of Agricultural Cooperative
Soil Analysis Laboratory

Flow sheet of soil diagnosis 7



Guidance and advice to farmers according to soil diagnosis result

Drying soil samples

Sieve soil samples (2mm)

Soil samples after preparation

Various Analysis Items and their significance

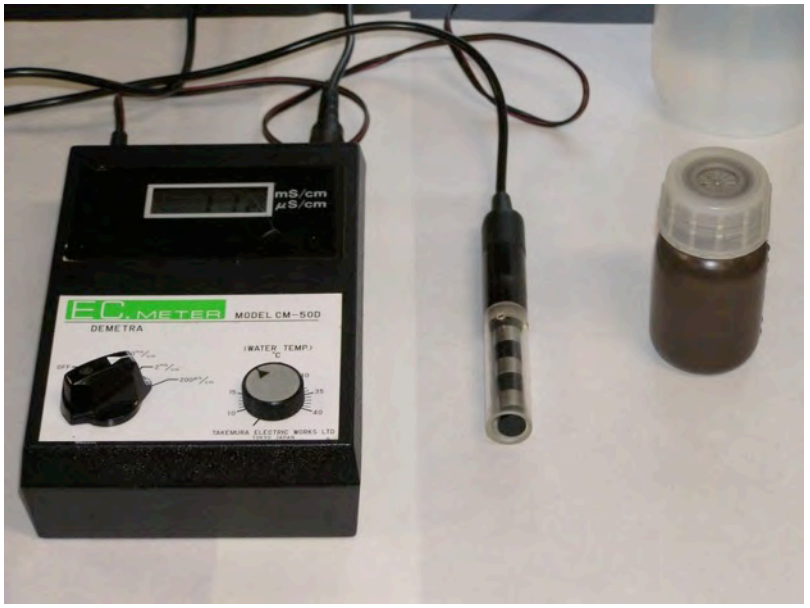
pH(H_2O)

- Concentration of free form H^+ in soil solution
- pH = $-$ log (H^+)
- Add 25 ml of water to 10g of soil.
- Shake 30 minutes.
- Measure the pH of turbid suspension using pH meter.

Factors affecting soil pH(H_2O)

- Fertilizer application
- Nutrient absorption by crops
- Seasonal change in climate, precipitation
- Partial pressure of CO2
- Activity of soil microbes
- Decomposition of soil organic matter
- Saturation degree of soil bases
- Leaching of soil bases
- Nitrification (NH_4^+ , NO_3^-)

pH meter & EC meter



pH(KCl)

- Reflect the concentration of H^+ and Al^{3+} adsorbed electrostatically to clay and humus.
- pH(KCl) decreases when degree of saturation by basic cations is low.
- Add 25 ml of 1 M KCl to 10g of soil.
- Shake 30 minutes.
- Measure the pH of turbid suspension using pH meter.

Meaning of soil pH(KCl)

- Highly correlated with Al saturation degree of soil.
- pH(KCl) lower than 5.2 means

  → occurrence of exchangeable Al^{3+}

  → Inhibition of plant growth by Al^{3+}
- $Al^{3+} + H_2O \rightarrow Al(OH)^{2+} + H^+$
- $Al(OH)^{2+} + H_2O \rightarrow Al(OH)_2^{+} + H^+$

pH(0.01M $CaCl_2$)

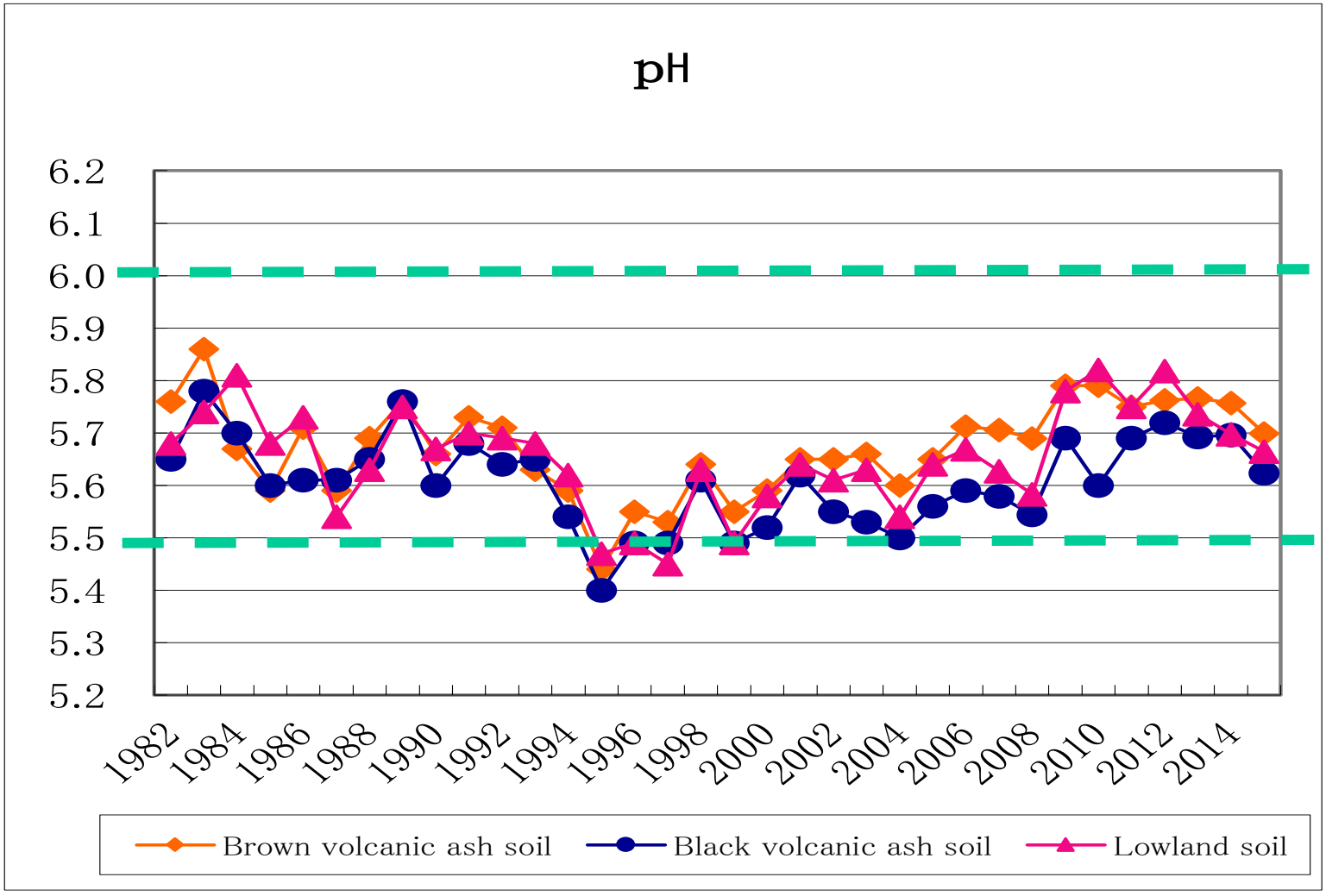
- Masking the effect of seasonal change and farm management
- To reflect the actual root zone environment more accurately, soil pH under dilute electrolyte concentration is more appropriate.

Meaning of soil pH

< 5.0	Very acidic
5.0 – 5.5	Acidic
5.5 – 6.0	Weakly acidic
6.0 – 6.5	Slightly acidic
6.5 – 7.0	Neutral
7.0 – 7.5	Slightly alkaline
7.5 – 8.0	Weakly alkaline
8.0 – 8.5	Alkaline
8.5 <	Very alkaline

Change in soil pH in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Effect of pH on plant growth

- H^+ ion inhibits the function of root (pH < 4)
- Increase in Al^{3+} ion (Inhibit growth at >1 ppm level）
- Inhibit absorption of N, P, K, Ca, Mg, B, Mo and symptom of deficiency（in acidic range）
- Excess in Cu, Zn, Mn, Fe（in acidic range）
- Deficiency in Cu, Zn, Mn, Fe（in alkaline range）

Exchangeable Acidity

- Weigh 10 g of air dried soil in to a flask or bottle.
- Add 25 mL of 1N KCl.
- Shake for 1 hour.
- Filter through a filter paper (Advantec No.6).
- Take 10 mL of the filtrate into a flask and titrate with 0.1 N NaOH.
- Consumed mL is multiplied by 12.5.
- Obtained value is Y_1.

Electric conductivity（EC）

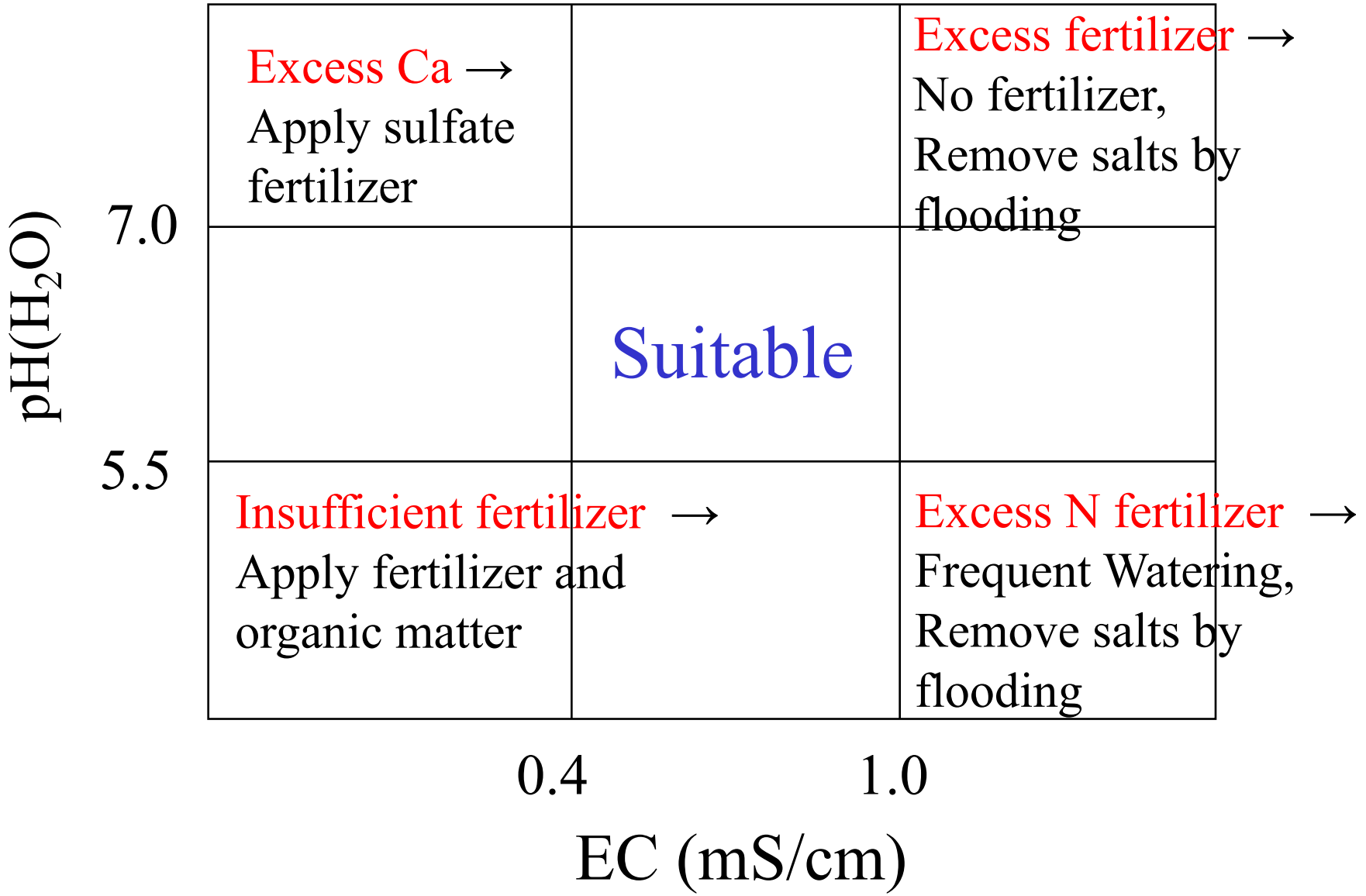
- Reflect total concentration of water soluble ions in soil solution
- Add 50 ml of deionized water to 10g of soil, shake 30 min. Measure EC of turbid suspension using EC meter.
- Unit is S/m, mS/cm or μS/cm, S: Siemens

  （1S/m=10 mS/cm = 10^4 μS/cm ）

Meaning of soil EC

- High correlation with nitrate NO_3^- content
- Malnutrition under low EC(< 0.1 mS cm^{-1})
- Growth damage at high EC (> 1 mS cm^{-1})
- Adjust fertilizer application rate according to EC

Greenhouse soil diagnosis according to pH and EC



Application rate of basal fertilizer (N, K) according to soil EC（dS m^{-1}） in upland field

Soil Type	< 0.3	0.4-0.7	0.8-1.2	1.3-1.5	1.6 <
Humic andosoil	Standard rate	2/3	1/2	1/3	No fertilizer
Sandy・Fine textured	Standard rate	2/3	1/3	No fertilizer	No fertilizer
Sand dune/ immature	Standard rate	1/2	1/4	No fertilizer	No fertilizer

Humus

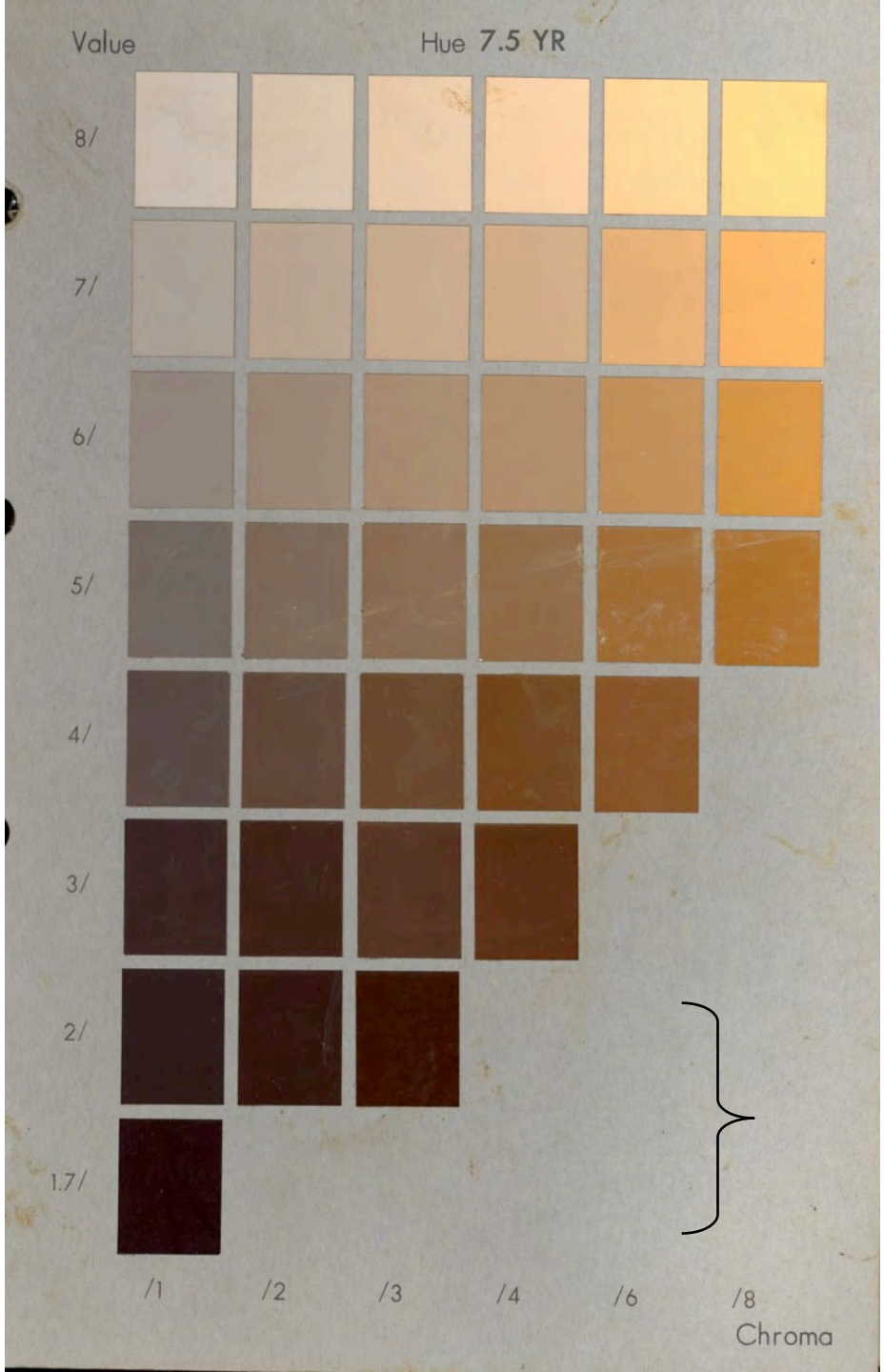
- Humus = Soil organic matter

Method of determination

- Rapid estimation by soil color
- Tyurin method（Potassium dichromate oxidation/ Titration）
- Dry combustion method（Instrumental analysis）

Standard Soil Color Chart Hue 7.5YR

Relationship between soil color and organic matter content

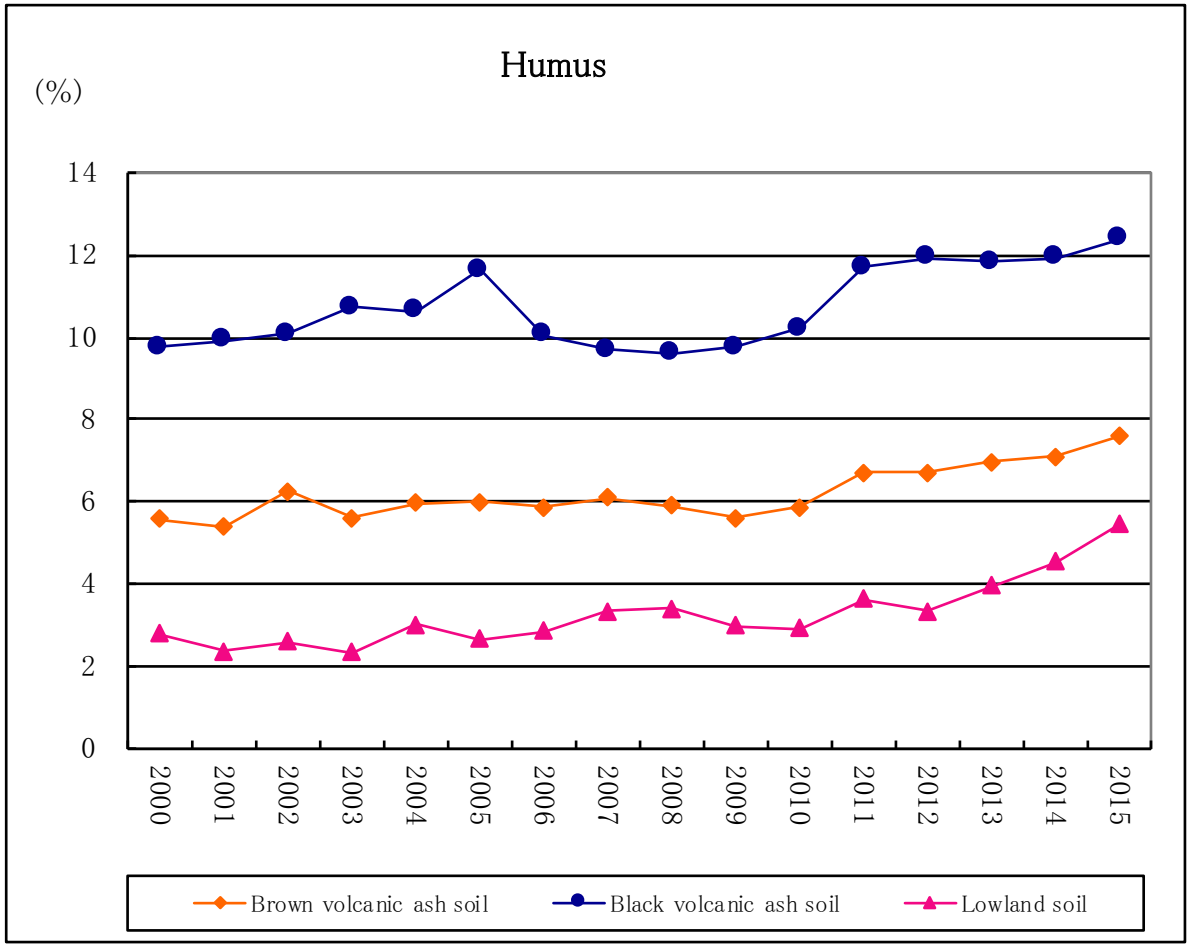


Importance of humus

- Soils with high humus content are generally fertile and easily manageable.
- Exception → Andosoil (Kuroboku in Japan)
- Supply nutrients (especially N)
- Hold soil moisture
- Hold nutrients（Cation Exchange Capacity）
- Formation of Soil Aggregate Structure

Change in soil humus in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Nitrogen Analysis

- Nitrogen is the most important constituent of fertilizer.

Inorganic nitrogen

- Ammonium nitrogen

  Extracted by 1N KCl, 2N KCl
- Nitrate nitrogen

  Extracted by Water, 1N KCl, 2N KCl
- Determine by steam distillation/ titration or colorimetry
- Rapidly available to crops

Available nitrogen

- Potential amount of inorganic nitrogen formation
- After incubating 4 weeks at 30 °C, total amount of formed inorganic nitrogen is determined.
- Incubation under upland or paddy condition.
- Problem: Time consuming method

Phosphate buffer (pH7) extraction method (Rapid estimation method for available nitrogen)

- Extracted nitrogen content or absorbance at 420 nm of the extracted solution showed high correlation with available nitrogen estimated by incubation method.

Hot water extractable nitrogen

- Another measure of available nitrogen
- Soil + water (1:10)
- Autoclaved (105 ℃/modified to 121 ℃, 1 hour)
- Filtered
- Extracted solution is digested by Kjeldahl method
- Nitrogen is determined by colorimetry

Adjustment of N application rate according to hot water extractable nitrogen

Hot water N (mg / 100 g)	N application rate (kg / 10 a)
1, 2	24
3, 4	20
5, 6	16
7, 8	12
9, 10	8
Higher than 11	8

Change in hot water extractable N in Tokachi

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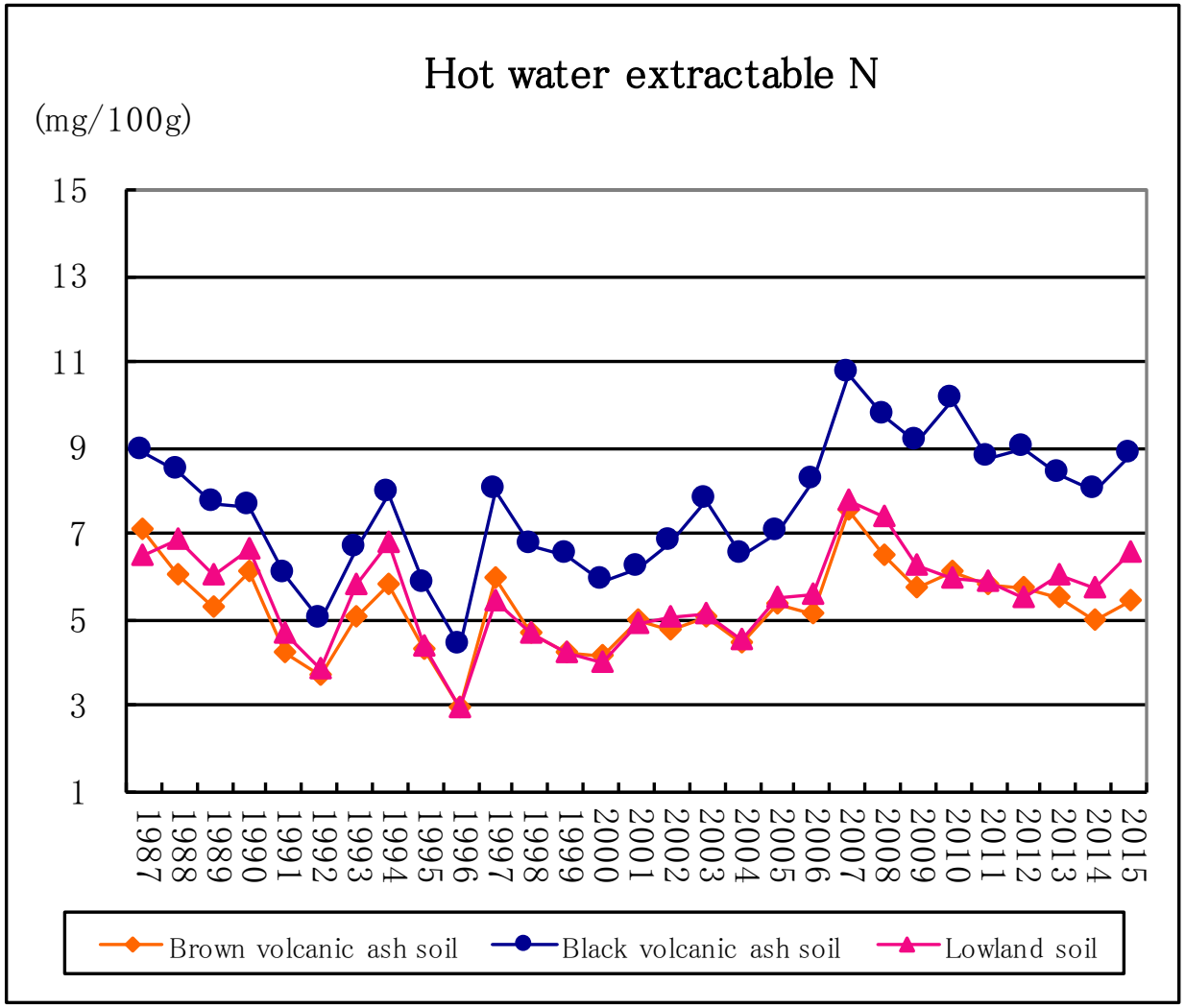

Total Nitrogen

- Kjeldahl digestion（conc H_2SO_4＋K_2SO_4＋Catalyst(Cu, Hg, Se)）

  Organic N $\rightarrow$ NH_4^+
- Instrumental（Dry combustion method）
- C/N is calculated
- C/N is related to the pattern and rate of nitrogen mineralization

Kjeldahl digestion apparatus

Release of N from organic matter applied to soil every year

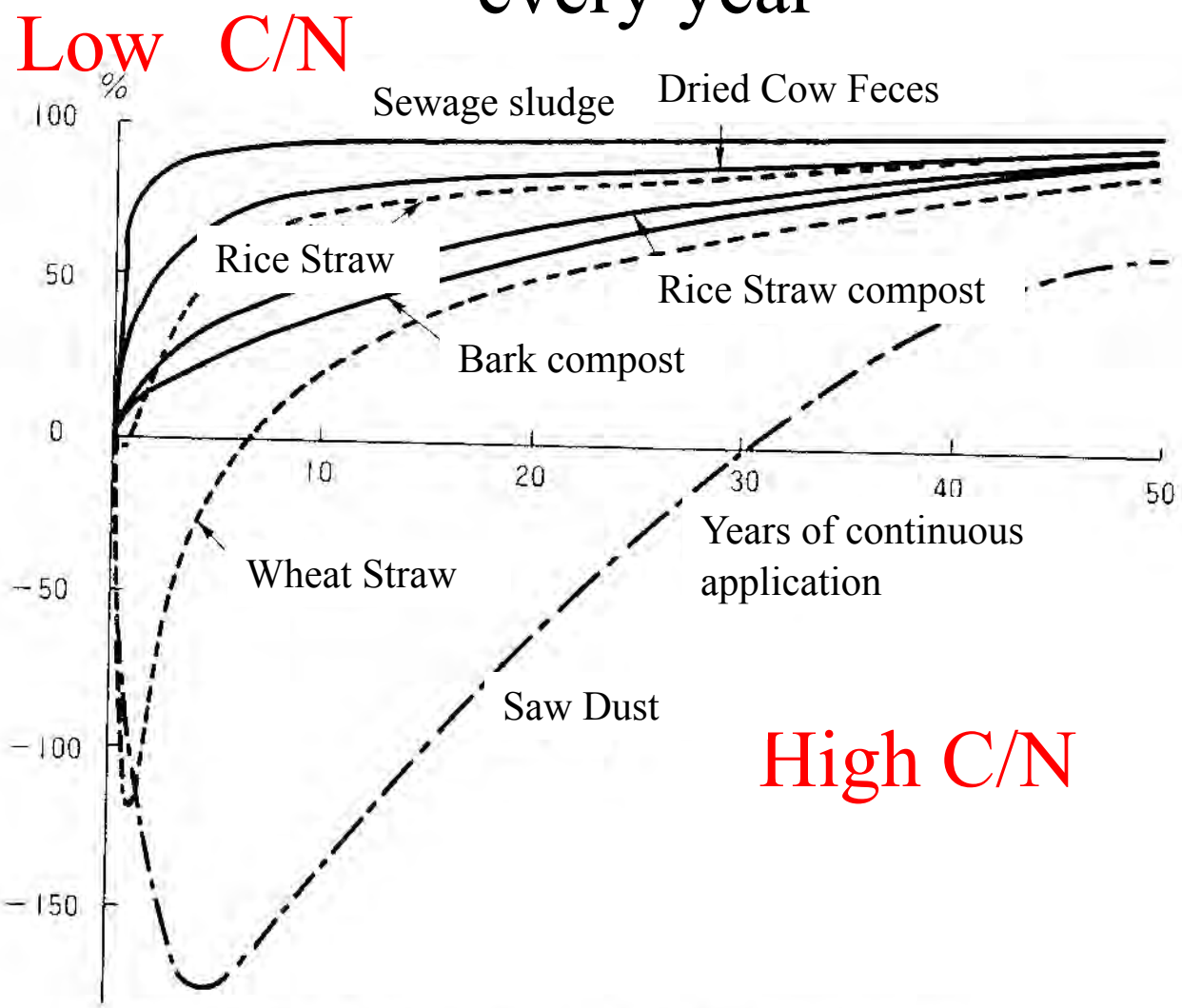

図 10　有機物連用の場合の炭素の集積率，毎年の窒素の放出率の予測値
1 年間に添加する量を100とした場合（志賀ら，1985）