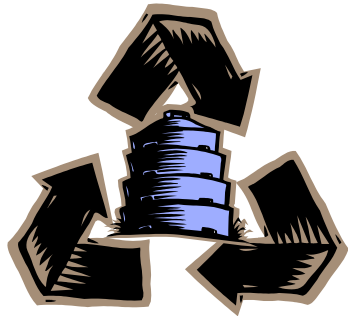
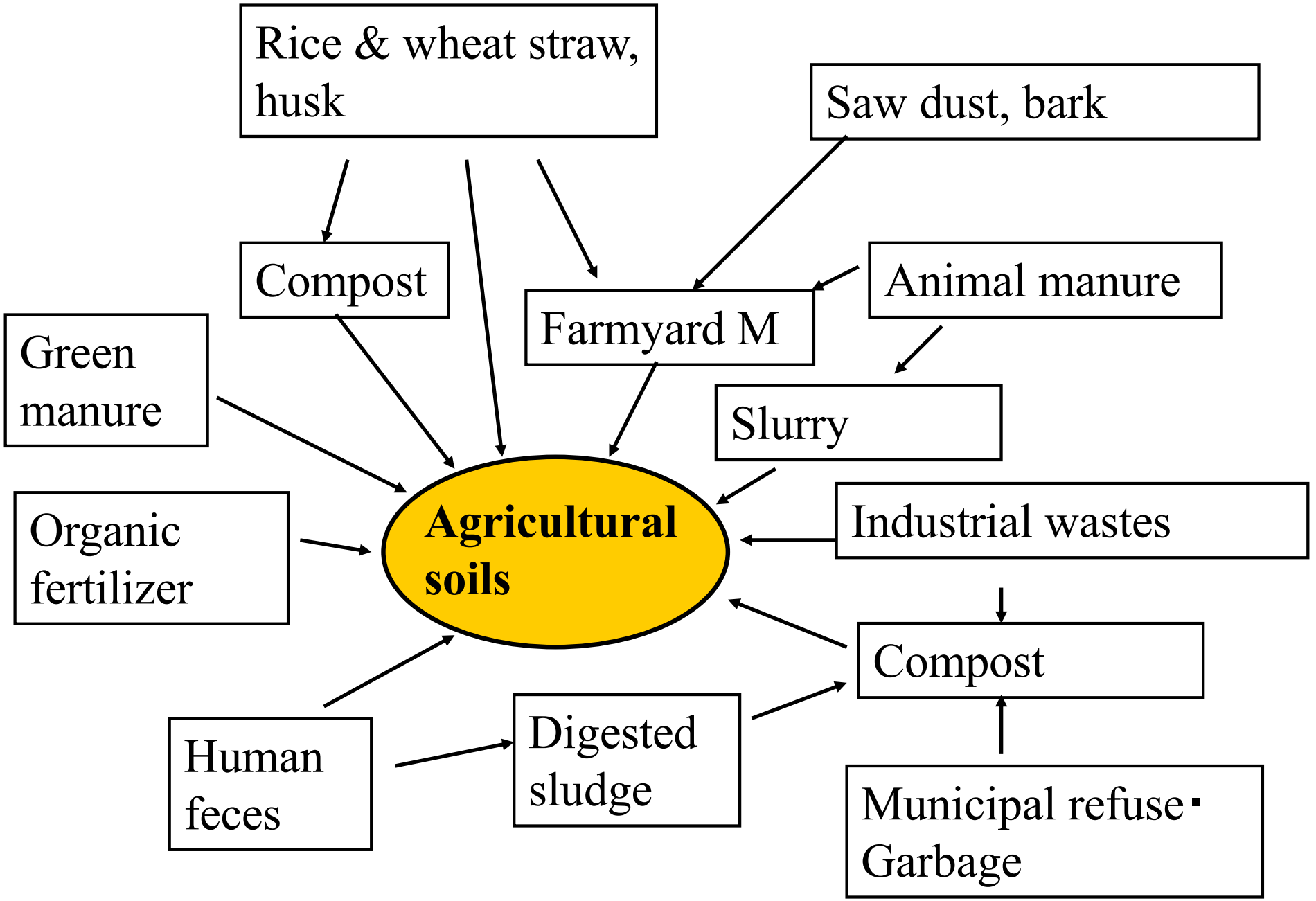
Compost and Farmyard Manure

Preparation methods, Characteristics, Effects

Kiyoshi Tsutsuki
http://timetraveler.html.xdomain.jp





Organic matter Input in Agriculture

Purpose of composting… 1

1 To make manure easy for handling and transporting, by reducing dirty feeling, malodor, and stickiness.

2. To prevent soil reduction and emission of harmful gasses and the resulting inhibition in crop growth which is assumed to occur when raw material is applied to soil.

Purpose of composting...2

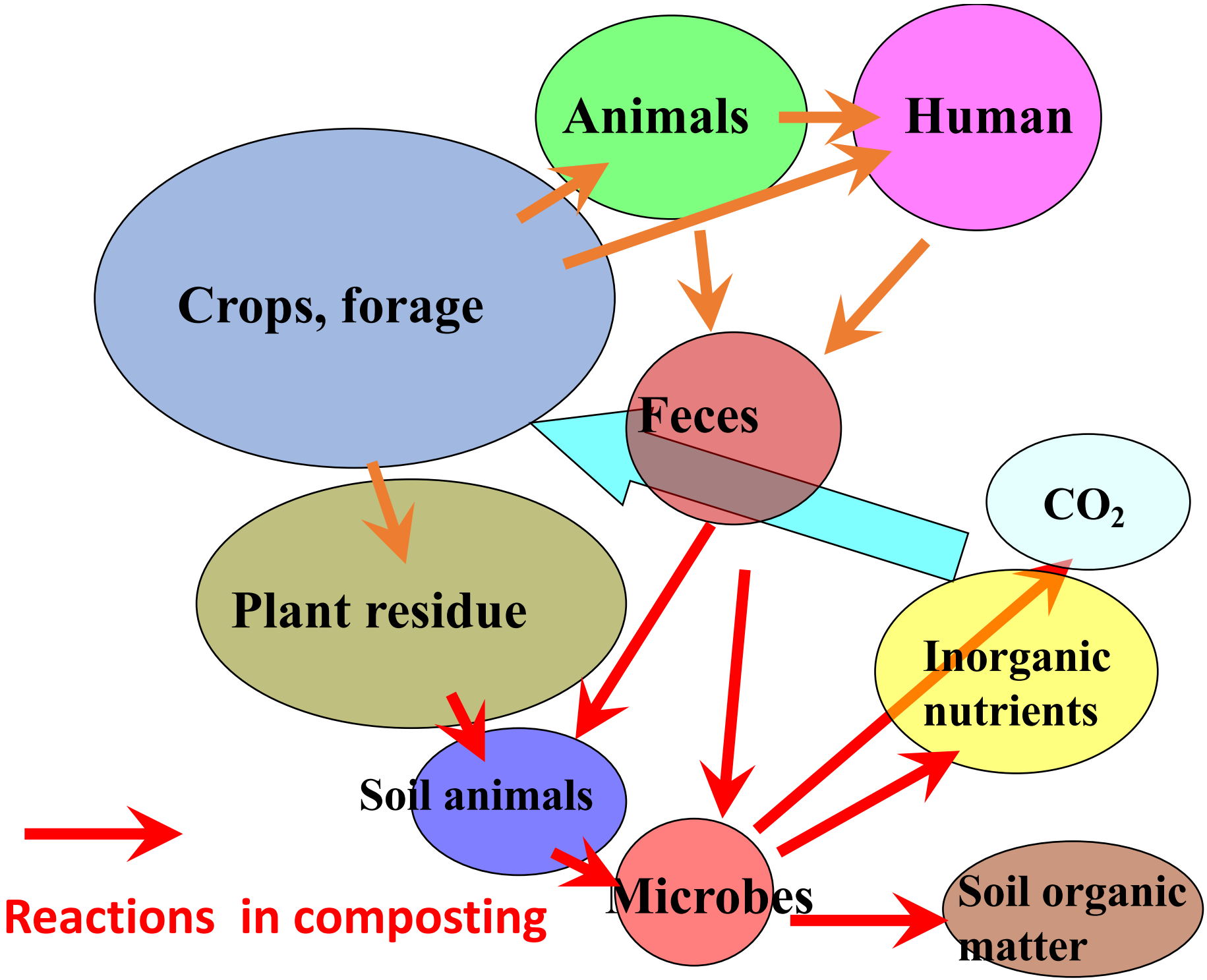
3. To kill pathogens and parasites for human, animals, and plants.
4. To kill the weed seeds which are mixed in feces, hays and feedstocks.
5. To decompose phenolic compounds in feedstocks such as straw and sawdust and low molecular weight organic acids in feces which are assumed to cause growth inhibition of plants.

Significance of composting

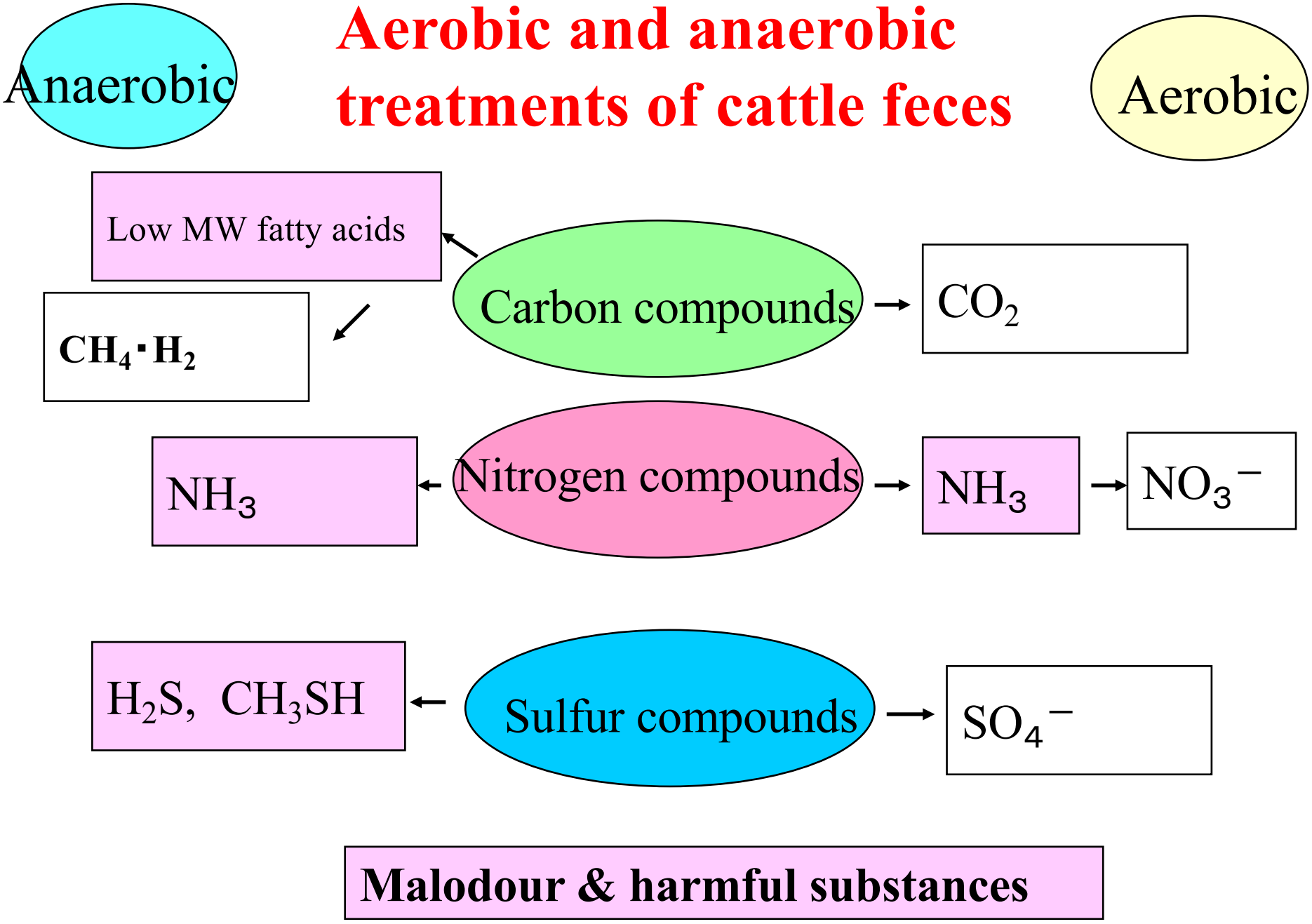
- Source of nutrients for crops.
- However, the function of compost is not limited to the value as nutrients.
- Compost > Fertilizer

Significance of composting

- By composting, we can change the waste to resource.
- Compost can supply energy to soil biota, and stimulate their activity.
- Compost is a source of humic substances, which have physical, chemical, and physiological functions to crops.


Animals
Human
Crops, forage
Feces
CO_2
Plant residue
Inorganic nutrients
Soil animals
Microbes
Soil organic matter
Reactions in composting

Aerobic and anaerobic treatments of cattle feces



Germination rate of weed seeds in compost (%)

	< 50℃	2 days at 60℃	Japanese name
Digitaria ciliaria Koeler	96	0	メヒシバ
Echinochloa spp.	72	0	ノビエ
Cyperus spp.	56	0	カヤツリグサ
Chenopodiium album Linn.	26	0	シロザ
Percicara lapathiolia Linn.	8	0	オオイヌタデ
Portulaca olelacea Linn.	85	0	スベリヒユ
Amaranthus lividus Linn.	68	0	イヌビユ
Acalypha australis Linn.	7	0	エノキグサ
Fatoua villosa Nakai	26	0	クワクサ

Digitaria ciliaria

メヒシバ

Cyperus spp.

カヤツリグサ

Chenopodium album Linn.

シロザ

Percicara lapacifolia Linn.

オオイヌタデ

Portulaca oleracea Linn.

スベリヒユ

Amarantus lividus Linn.

イヌビユ

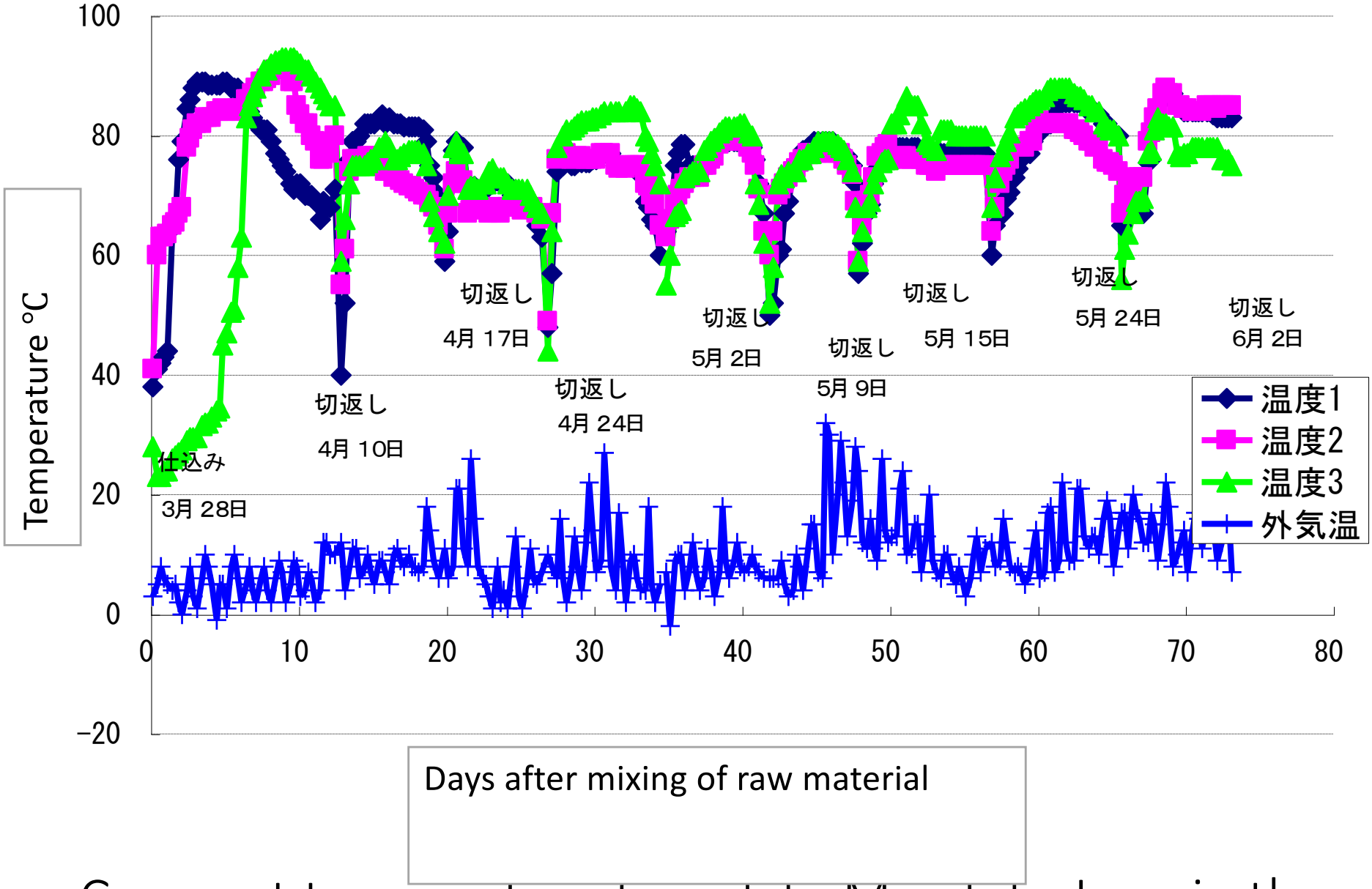
Acalipha australis Linn.

エノキグサ

Fatoua villosa Nakai

クワクサ

Compost turning (Ultra-high temperature composting plant)



Compost temperature from late March to June in the ultra-high temperature composting plant

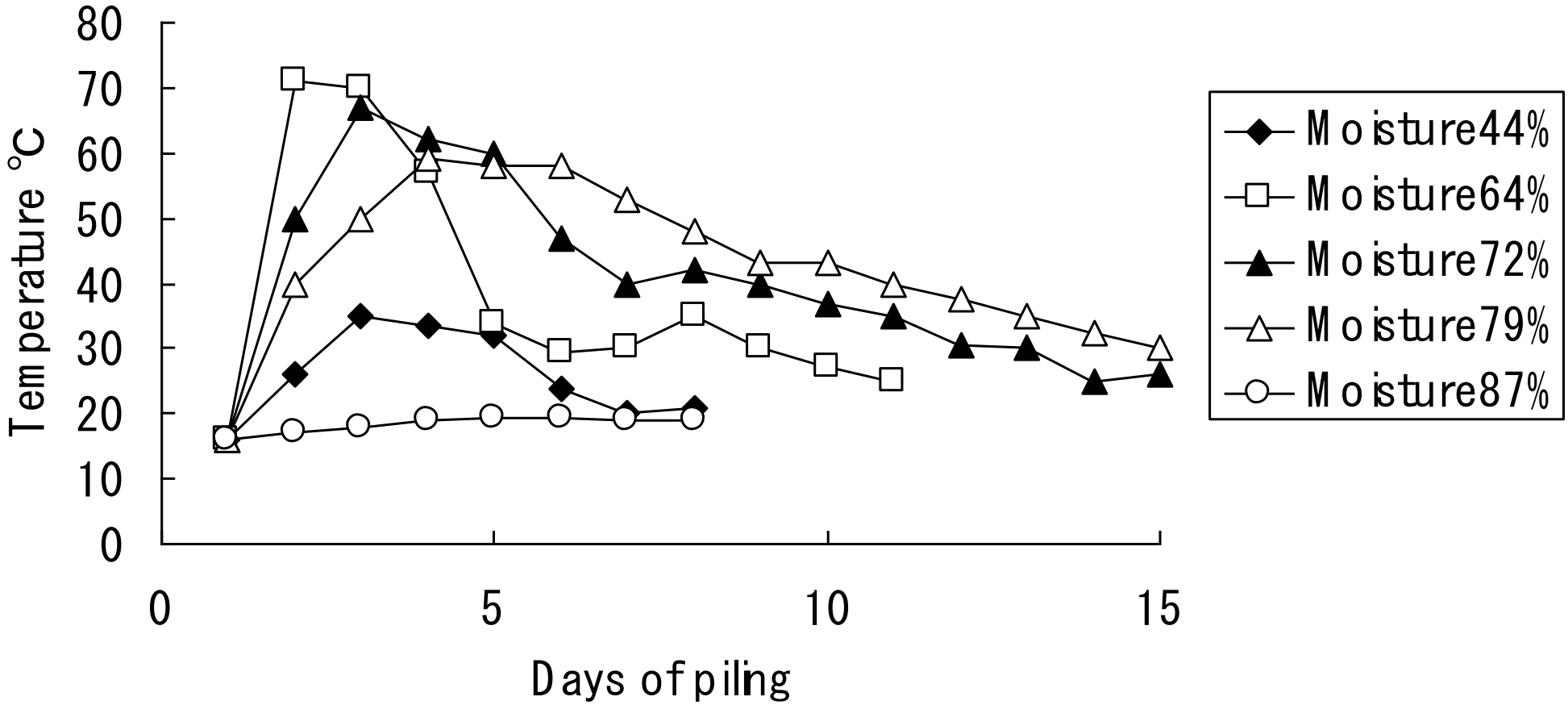
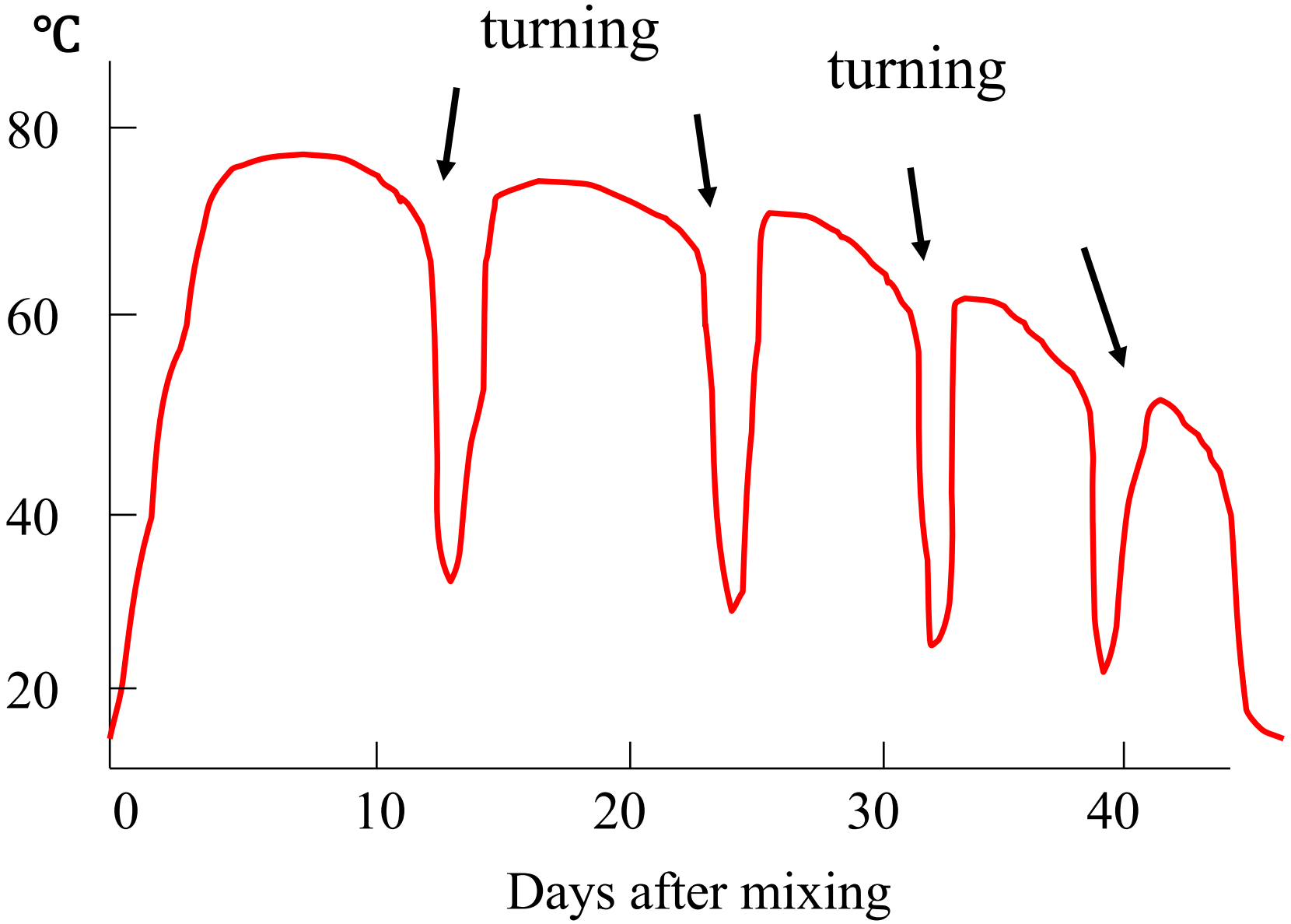
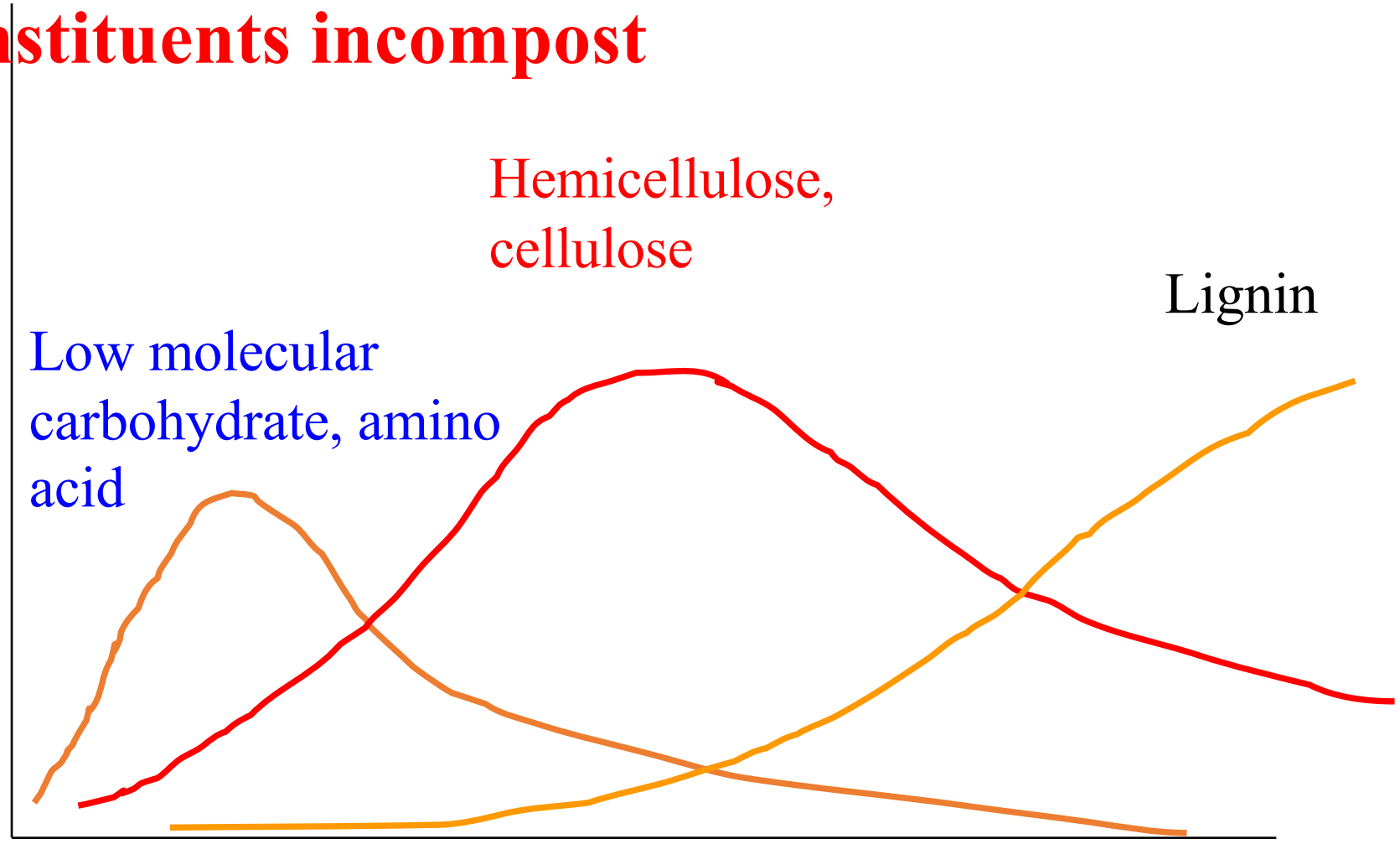


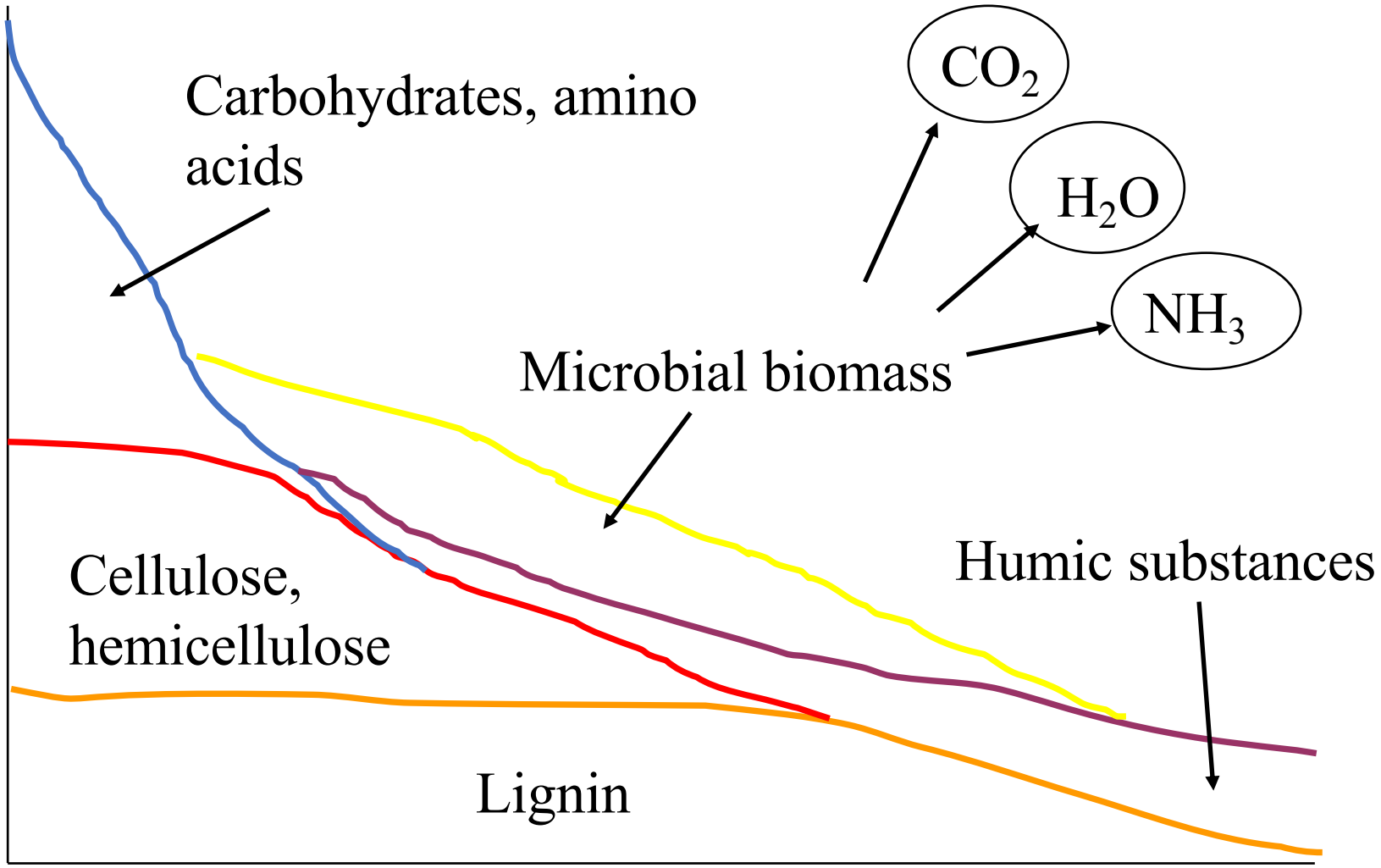
Fig. 1. Fermentation temperature of cow manure depending on different moisture contents.
(Shintoku Experiment Station of Animal Husbandry, 1998)

Change in compost temperature

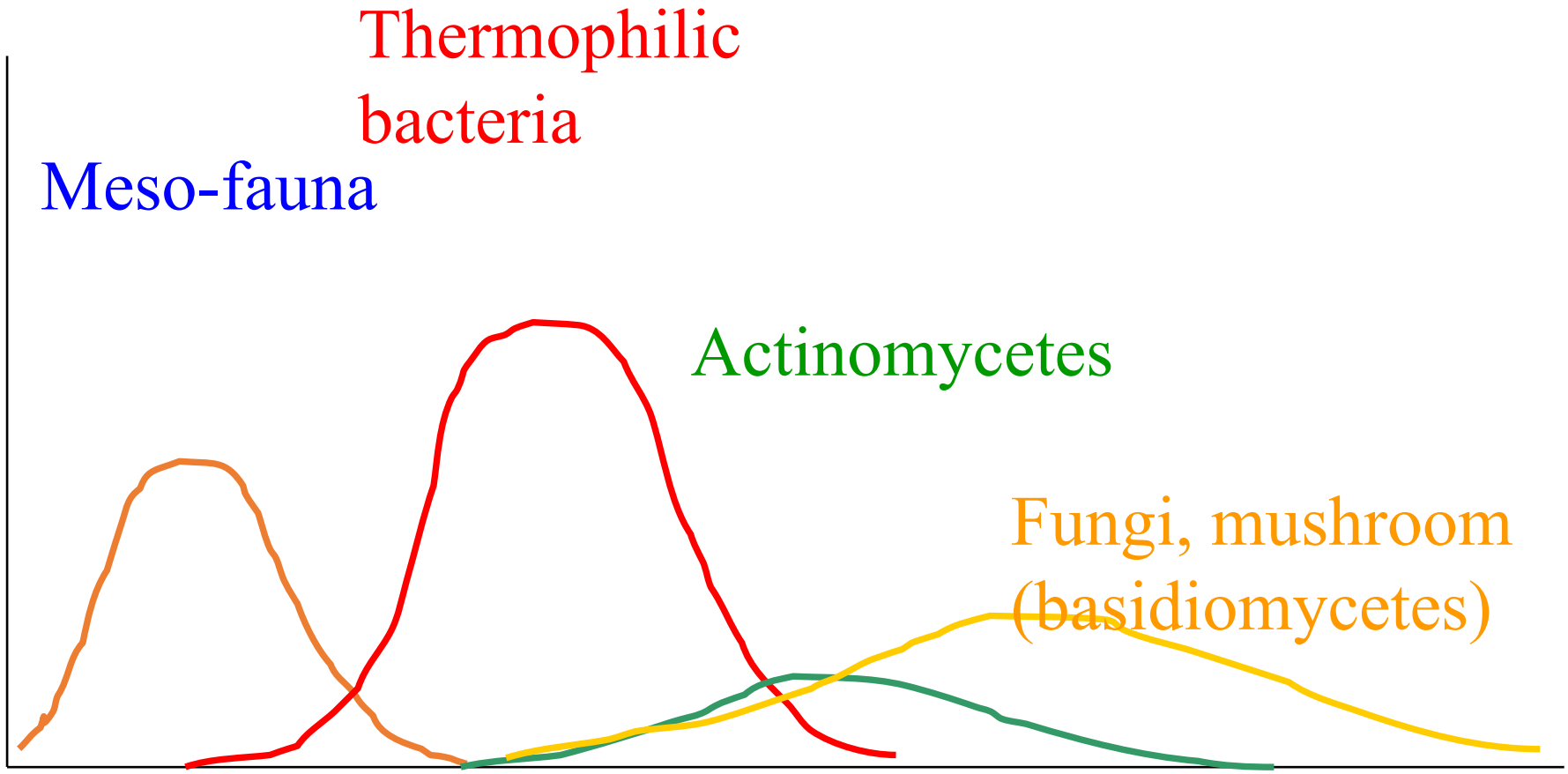


Decomposition rates of different constituents incompost



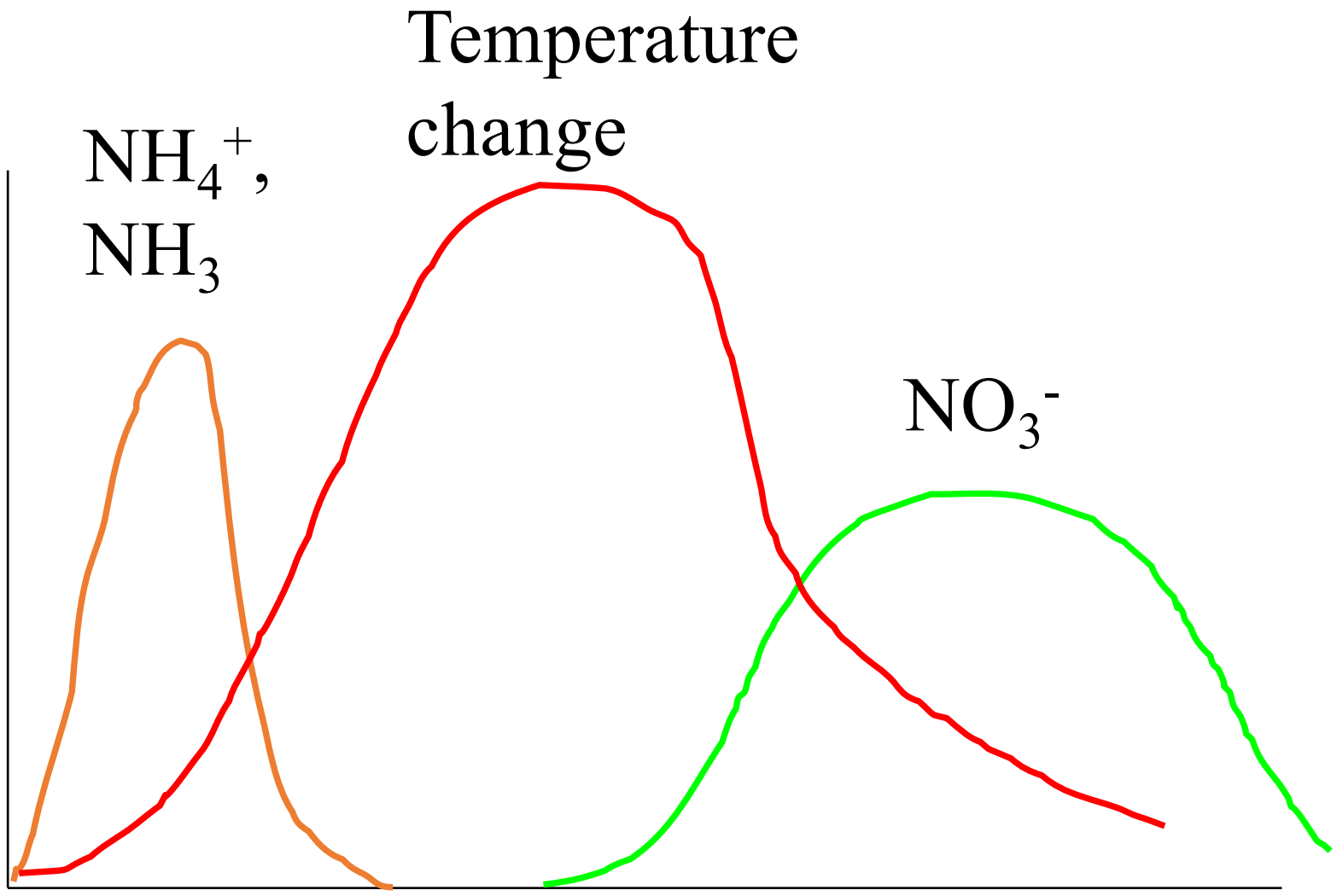


Change in organic matter constituents during composting

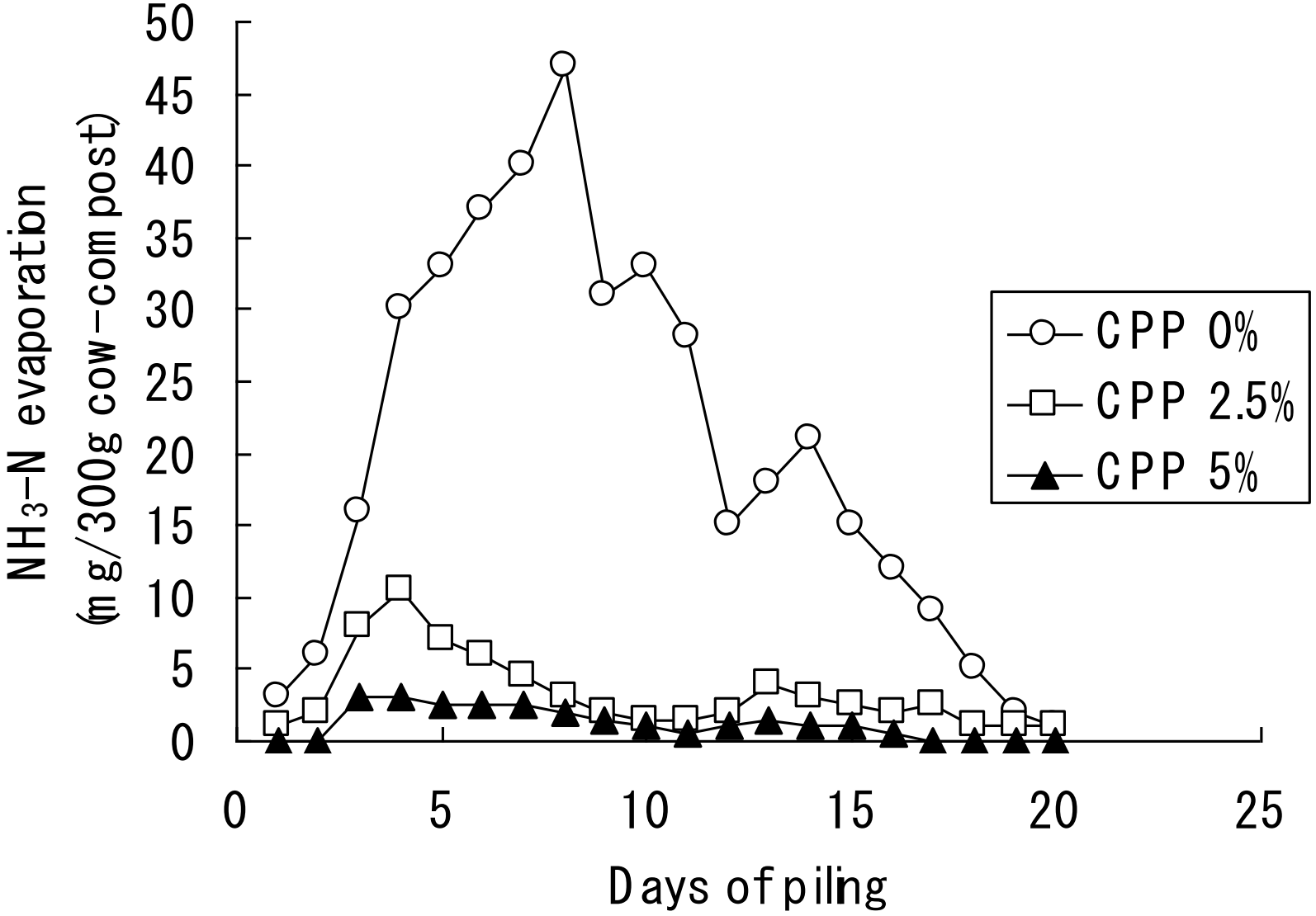


Succession of microbial fauna during composting

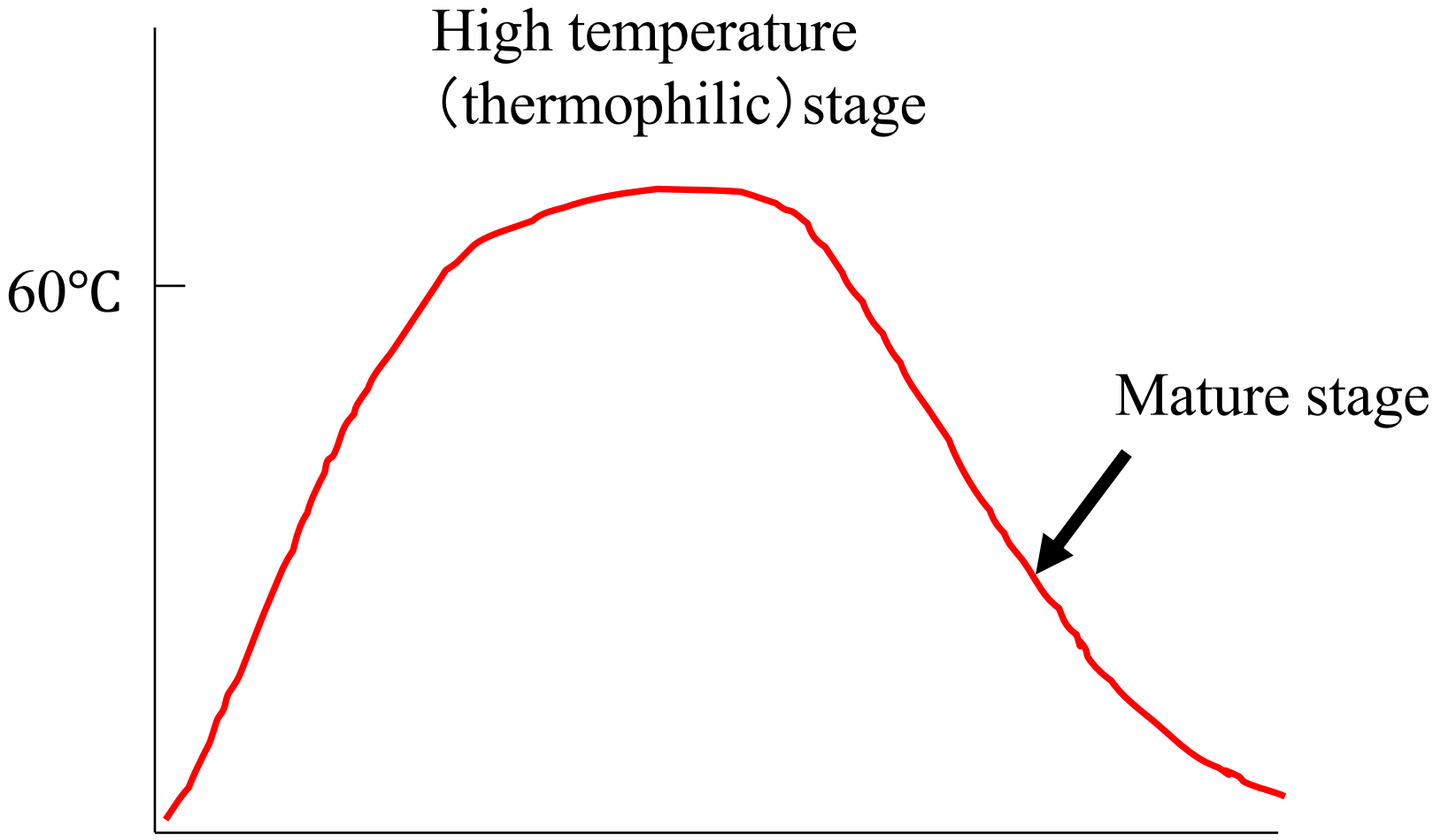
Criteria for the maturity of compost



Detection of ammonium and nitrate ions during composting



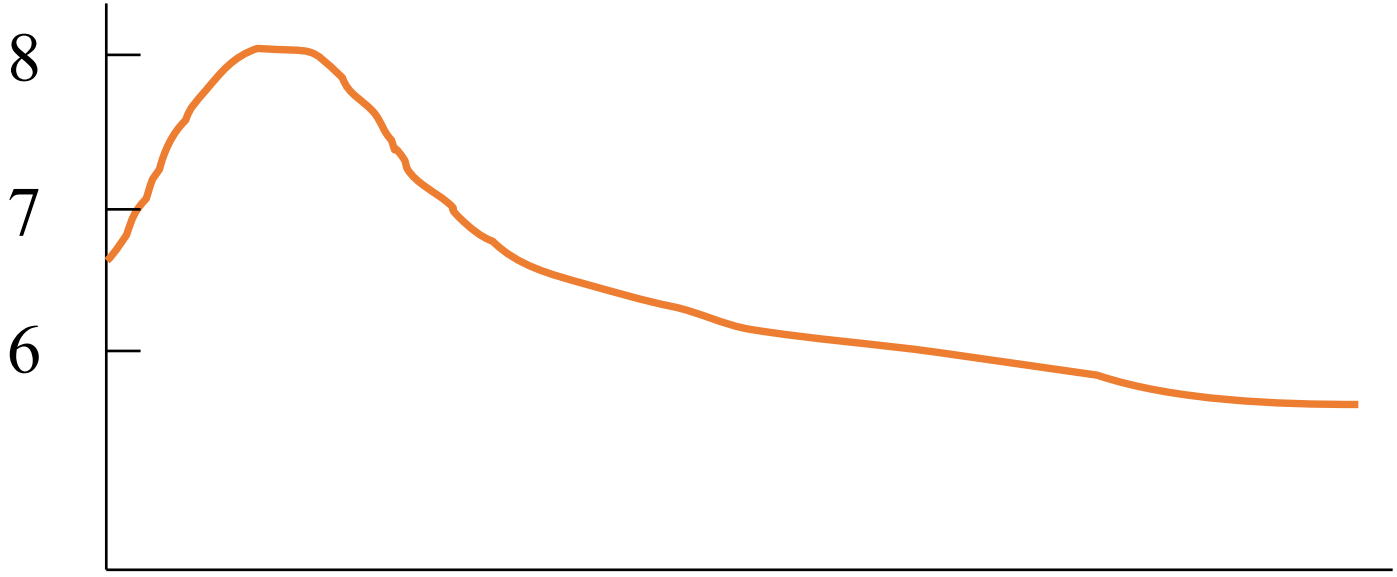
Suppression of the evaporation of Ammonia N from cow manure by mixing calcium perphosphate.
(Shintoku Experiment Station of Animal Husbandry, 1998)



Temperature change during composting
(simplified)

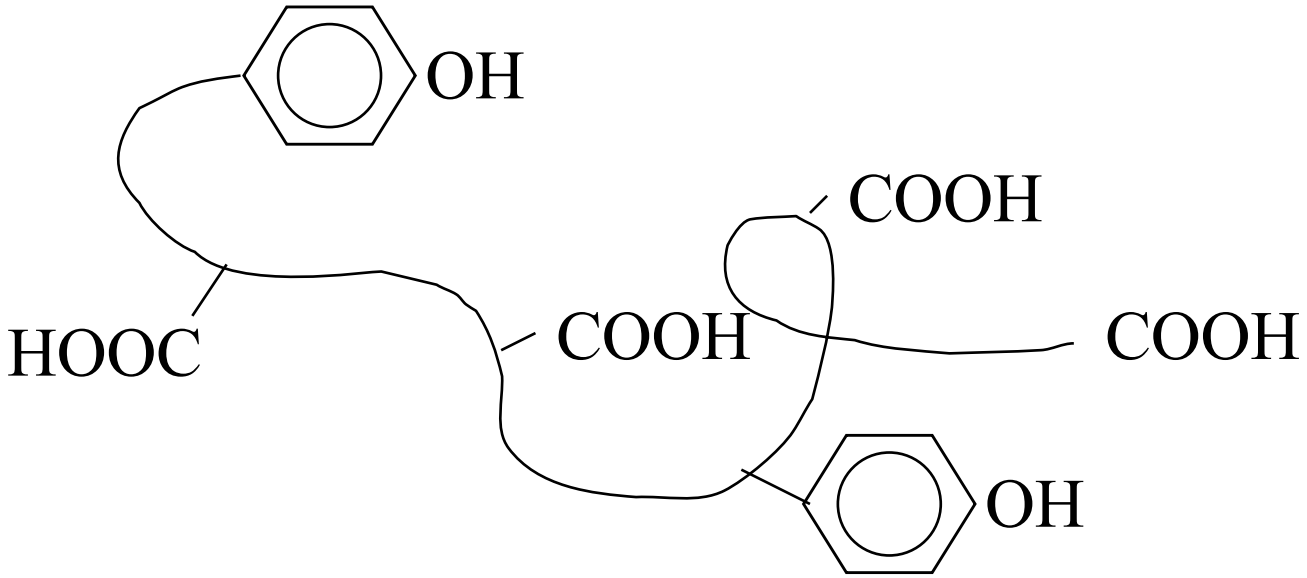
Change in pH of compost

- First rise in pH is due to ammonia formation.
- Following decrease is due to the formation of nitrate, carbonate, and humic substances.



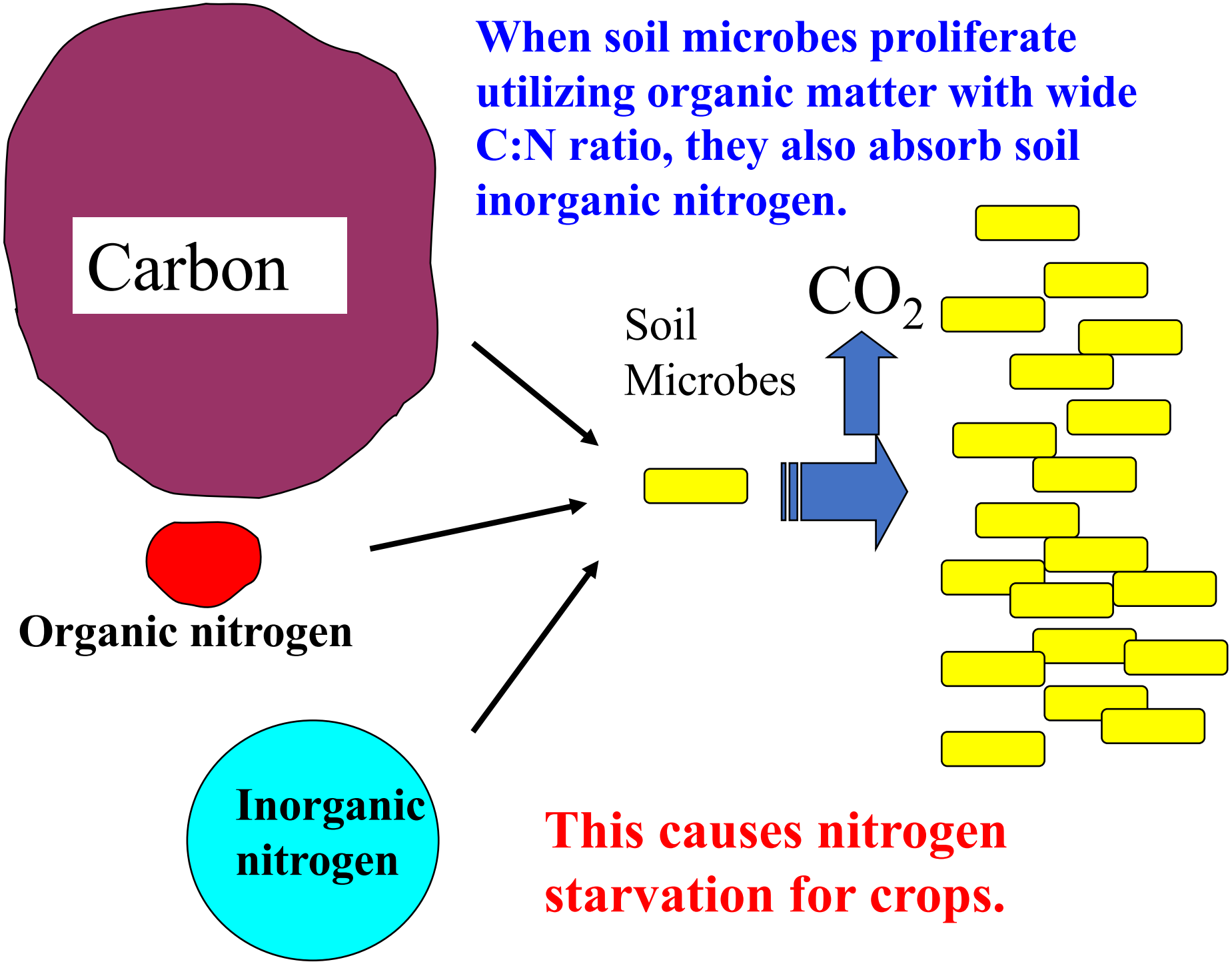
Increase in cation exchange capacity (CEC)

- Increase in CEC is remarkable in composts made from rice straw, woods, bark, sewage sludge, and municipal refuse



C/N ratio

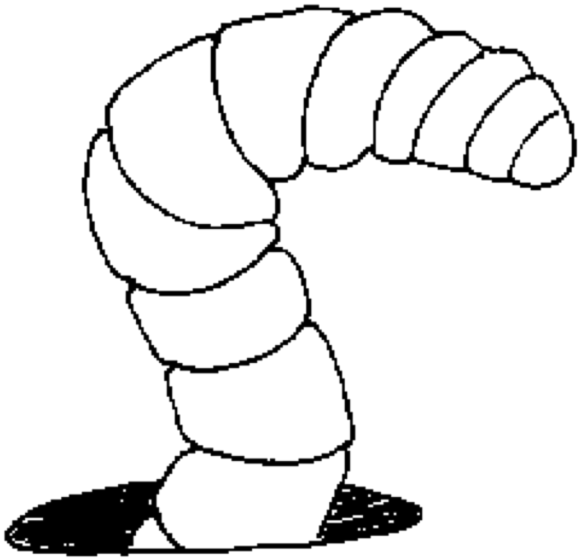
- C/N ratio was higher than 30 in the beginning, then reaches 15-20, it will be the sign of maturity. However, when the C/N was low from the beginning (such as cow manure), this criteria cannot be applied.


When soil microbes proliferate utilizing organic matter with wide C:N ratio, they also absorb soil inorganic nitrogen.
Carbon
Soil Microbes
CO_2
Organic nitrogen
Inorganic nitrogen
This causes nitrogen starvation for crops.

Earthworm method

- Put a compost sample in a cup.
- Place a few earthworms on it.
- Cover the cup with a black cloth.
- If the earthworms creep into the compost, it is mature.
- If they try to escape, it is immature.

Earthworm escapes if your compost does not taste good.



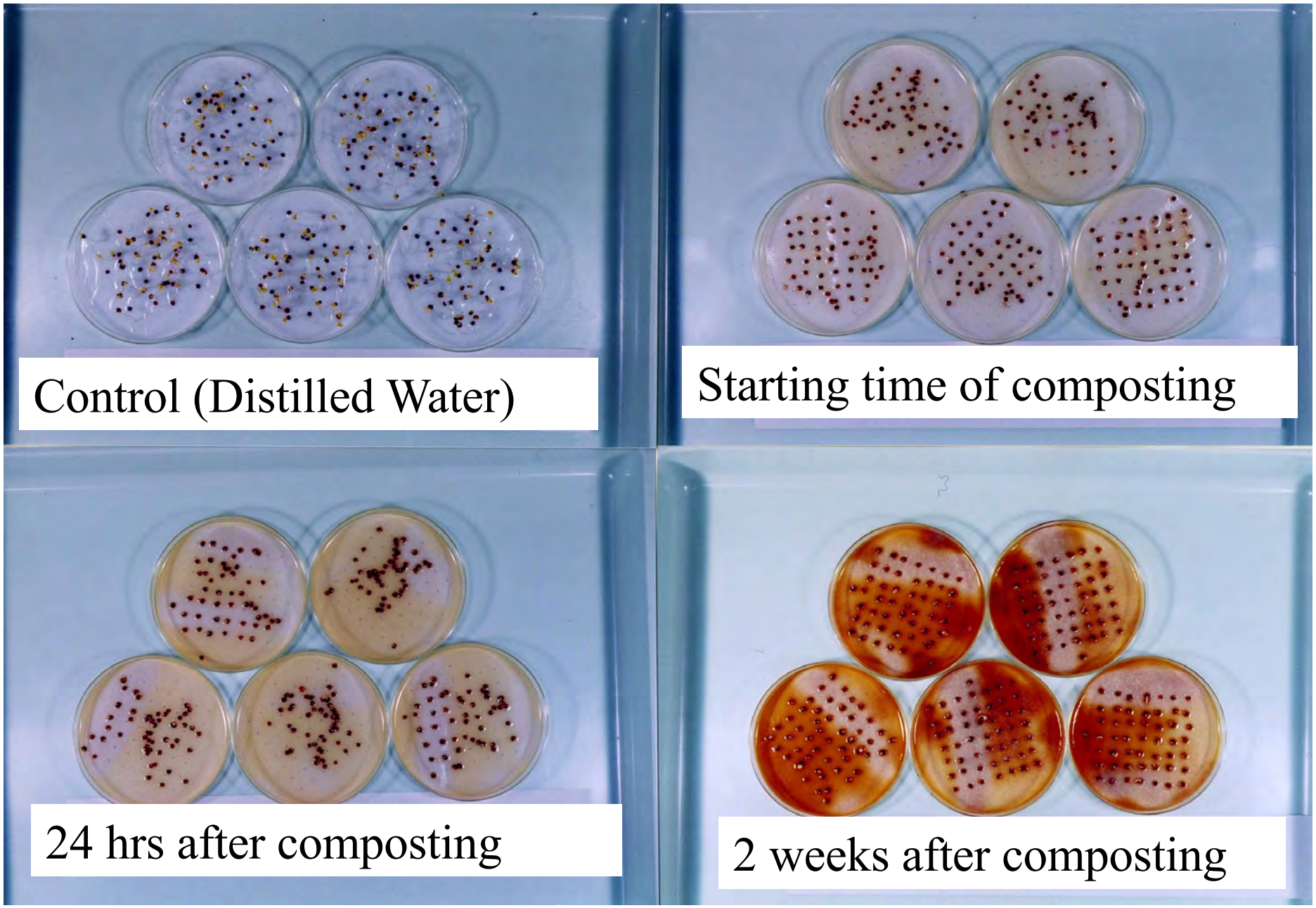
Vermi-composting

- Earthworm can also be used for preparing compost itself.
- Earthworm is a powerful decomposer of vegetable wastes, and turn the wastes into valuable and safe compost.
- Earthworm cast is enriched with nutrients and it is a soil aggregate already.

Germination test

- Seeds of Komatsuna(*Brassica campestris*), Cress (*Lepidium sativum*), or radish (*Raphanus sativus*) may be used, because these seed are small, quick to germinate, and sensitive to phytotoxic (plant damaging) substances like the organic acids temporarily present in immature composts. Using the water extract of the compost, germinating rate is compared with the control (distilled water).

Germination Test



Example of Failure Case in Composting

Seedling growth method

- Compost (150 g) and soil (350 g) are mixed and put in a Neubauer pot. The control is only the soil (500 g). Each 35mg of N, P_2O_5, and K_2O are applied to each pot in forms of ammonium sulfate, ammonium phosphate, and potassium sulfate. Water is applied to about 60 % of the water holding capacity. Twenty seeds of *Brassica campestris* are sawn on the surface of mixture, and germination rate and growth rate are observed.

Seedling growth method 2

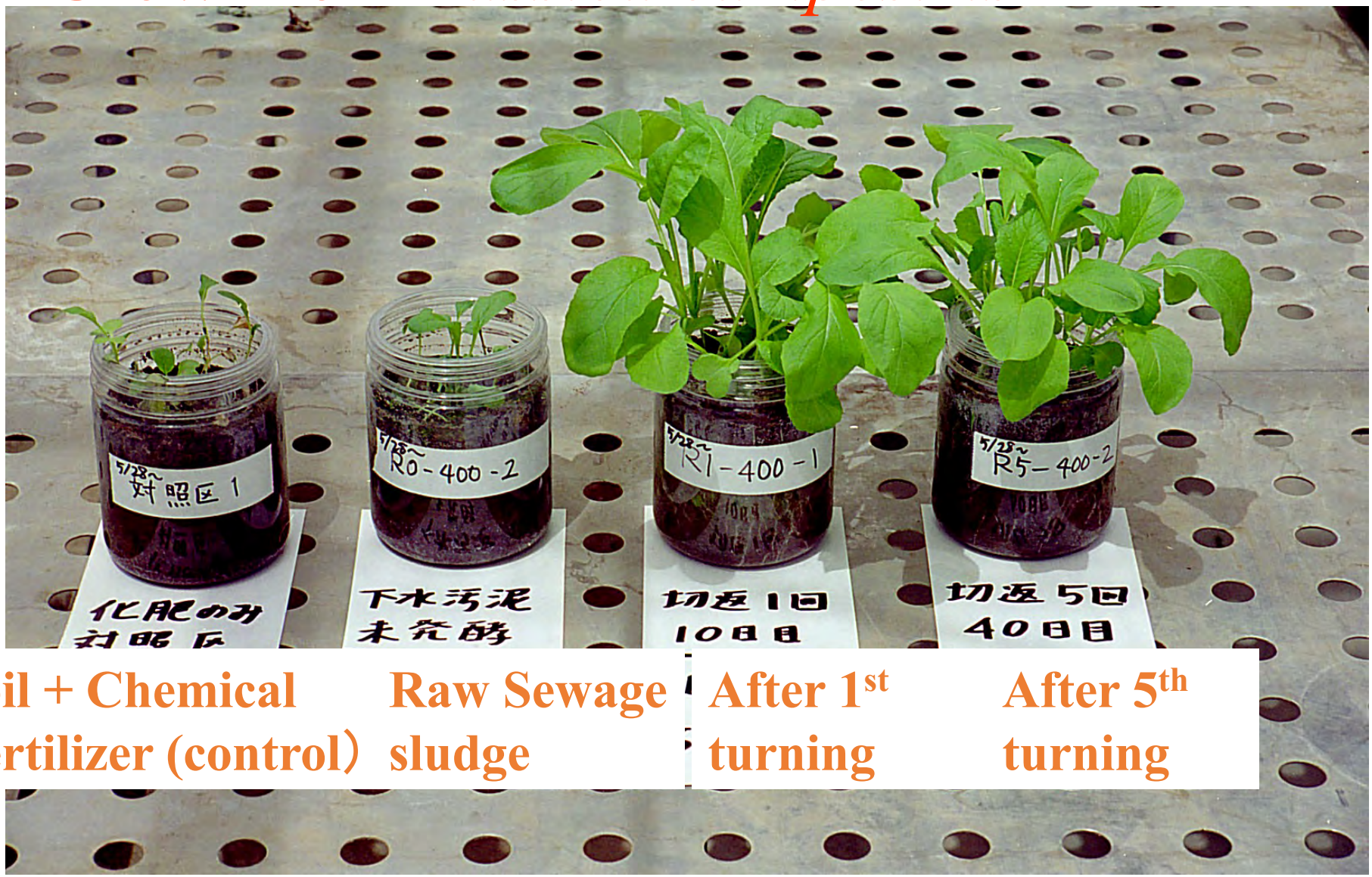
- Compost (equivalent to 100, 200, 300, 400 mg of nitrogen) are mixed with soil (500 g) in Neubauer pots. The control is only the soil (500 g). 25 mg of N, P_2O_5, and K_2O are applied to each pot in forms of ammonium sulfate, ammonium phosphate, and potassium sulfate. Water is applied to about 60 % of the water holding capacity. Twenty seeds of ***Brassica campestris*** are sawn on the surface of mixture, and germination rate and growth rate are observed.

Soil + Chemical Fertilizer (control)	Raw Sewage sludge	After 1st turning	After 5th turning

Growth of Brassica campestris

To 500mL of soil, compost equivalent to 400mg of N was applied（1 week after seed sowing）

Effect of Sewage Sludge Compost on the Growth of *Brassica campestris*



Soil + Chemical Fertilizer (control) | **Raw Sewage sludge** | **After 1st turning** | **After 5th turning**

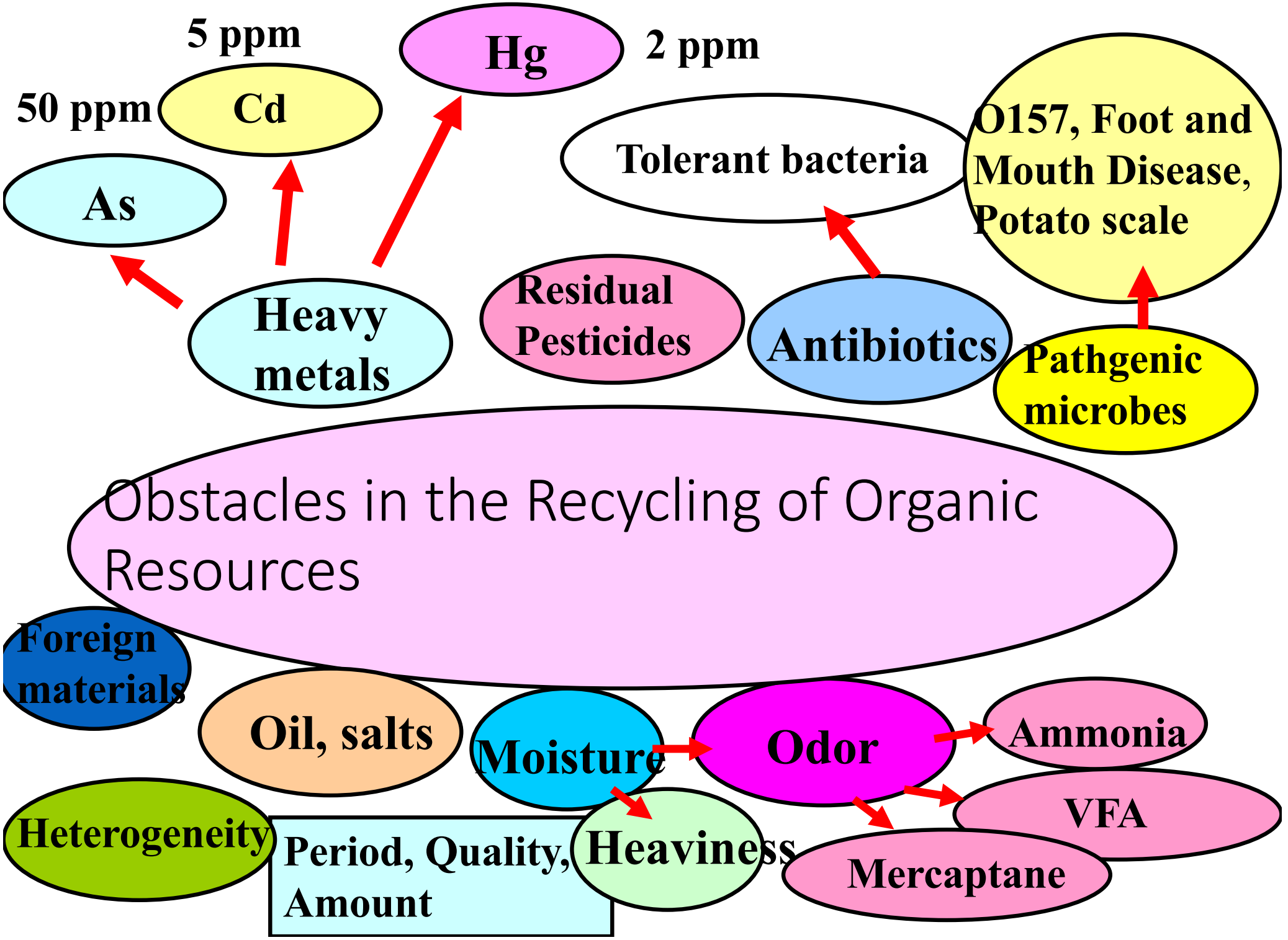
To 500mL of soil, compost equivalent to 400mg of N was applied（19 days after seed sowing）

Difficulties in Compost Utilization

- Uneven distribution and deficiency of raw materials for compost making
- Hard work for preparation and application of compost
- Special technology, skill, and facilities are required for the production of compost
- Variation in constituents and effectiveness of compost

Difficulties in Compost Utilization 2

- Occurrence of microbes tolerant to antibiotics, and germ microbes (in case compost was produced at low temperature)
- Enhancement of soil born plant disease for potato and soy bean.
- Contamination of raw materials by heavy metals （by radioactivity, recently)


5 ppm
Hg
2 ppm
50 ppm
Cd
As
Tolerant bacteria
O157, Foot and Mouth Disease, Potato scale
Heavy metals
Residual Pesticides
Antibiotics
Pathgenic microbes
Obstacles in the Recycling of Organic Resources
Foreign materials
Oil, salts
Moisture
Odor
Ammonia
VFA
Heterogeneity
Period, Quality, Amount
Heaviness
Mercaptane

Conclusion 1

- Production of compost is indispensable for reducing the environmental load of dairy farming, maintaining the fertility of farm soils, and creating healthy soils and crops. The qualities of composts, however, differ considerably from product to product, because different kinds of raw materials are used besides animal feces and various methods of compost preparation are adopted.

Conclusion 2

- Some of the composts may be unfavorable for use in agriculture. It is important for us to keep the principles in compost preparation (for example, activating aerobic process, experiencing the thermophilic period, providing enough duration for maturing, minimizing the mixing of heavy metals and foreign / artificial materials), in order to make safe and effective composts.

Conclusion 3

- On the other hand, preparation and utilization of compost both require a huge labor. Reward for this labor is not remarkable, because higher yield of crops can be achieved by the use of cheaper chemical fertilizers and cheaper crops may be imported from foreign countries.

Conclusion 4

Community based organic matter recycling project -- Subsidy

and the understanding from the consumer is, therefore, very important.

Awareness to environment, ecology, and health helps the utilization of compost.