# Demand for nutrients and soil condition to get „good quality“ food products

## Perspective of plant nutrition

Henrike Perner, Leif Nett, Anja Müller

Leibniz Association

Leibniz-Institute for Vegetable and Ornamental Crops Grossbeeren / Erfurt e.V.

# Environmental stress factors influencing the yield

**cultivation methods**

fertilization plant protection

**abiotic stress factors**

climate soil

- Temperature
- Water – drought, floods
- Radiation - UV
- Nutrient deficiency
- Pollutants (heavy metals)
- Mechanical stress (soil movement)


culture cultivar

**biotic stress factors**

Diseases / pests Competition

- Herbivory
- Pathogens / Parasites
- Competition for ressources
- Allelopathy

**yield**

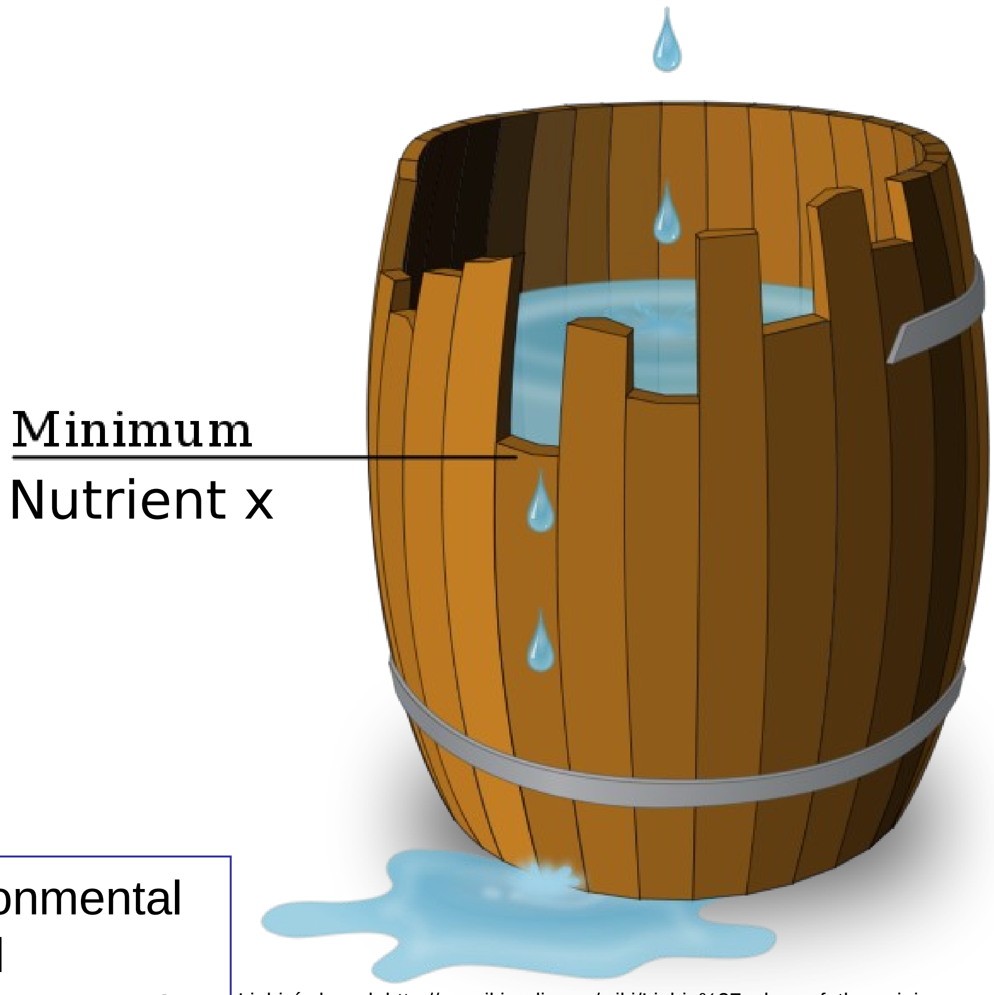
amount quality

- Content of specific plant metabolites
- Percentage of edible product on total crop



Henrike Perner, Leif Nett, Anja Müller

The availability of the most abundant nutrient in the soil is only as good as the availability of the least abundant nutrient in the soil *




Liebig´s barrel, http://en.wikipedia.org/wiki/Liebig%27s_law_of_the_minimum

* when all other environmental conditions are optimal (water, light, temperature etc.)

# Nutrient uptake needed for good growth and reproduction

**Nutrient uptake from soil into plant tissue**

## Macro nutrients

| Element | Nutrient concentration in plant tissue [mg $kg^{-1}$ dry weight] |
|---|---|
| nitrogen (N) | 15000 |
| potassium (K) | 10000 |
| phosphorus (P) | 2000 |
| magnesium (Mg) | 2000 |
| calcium (Ca) | 5000 |
| sulfur (S) | 1000 |

Carbon (C)
Oxigen (O)
Hydrogen (H)
derived from air, water

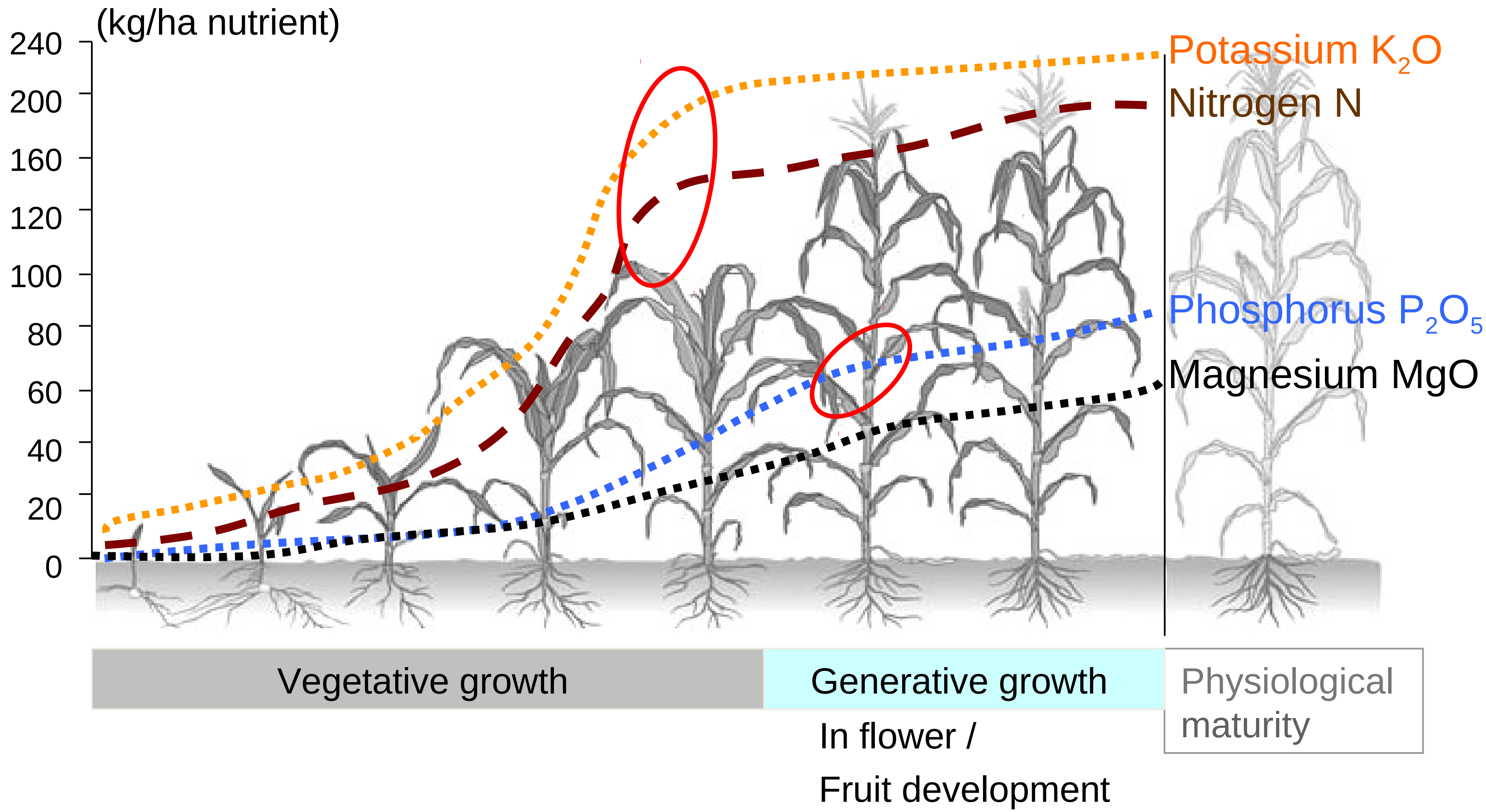
= 95% i. dry matter

## Micro nutrients

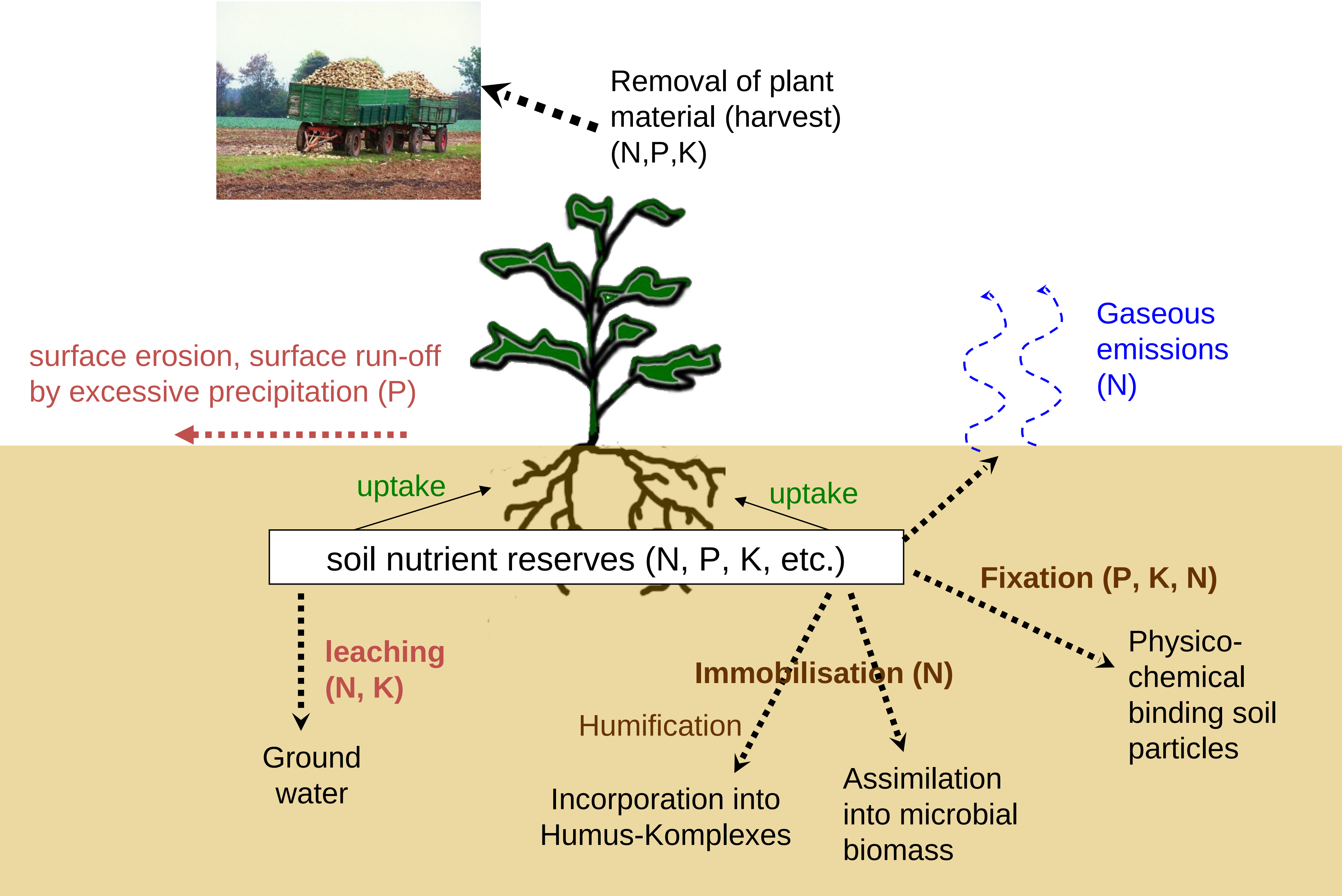
| Element | Nutrient concentration in plant tissue [mg $kg^{-1}$ dry weight] |
|---|---|
| Iron (Fe) | 100 |
| chlorine (Cl) | 100 |
| manganese (Mn) | 50 |
| boron (B) | 20 |
| zinc (Zn) | 20 |
| copper (Cu) | 6 |
| nickel (Ni) | 0.1 |
| molybdenum (Mo) | 0.1 |

# Nutrient demand changes during plant development !

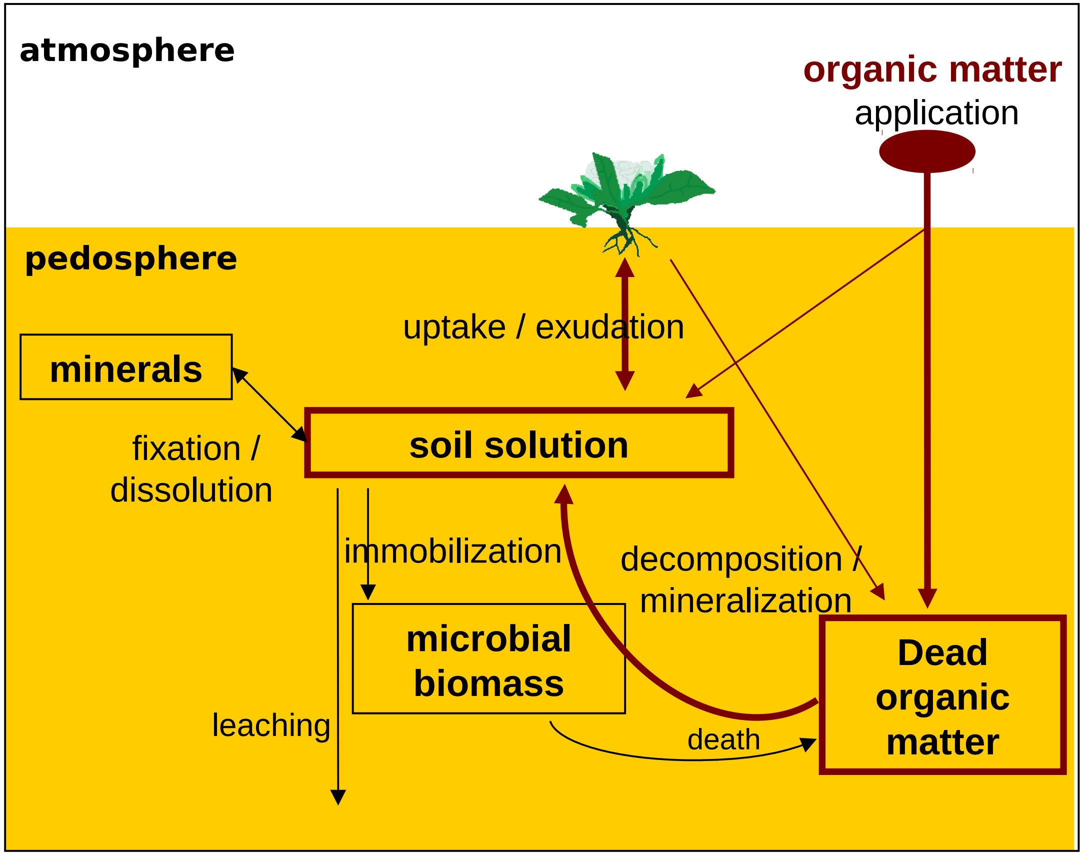
Uptake of macro-nutrients by maize plants during growth (example)



# Nutrient losses from the soil solution



# Organic matter as a source of plant nutrients




**Effects of organic matter application:**

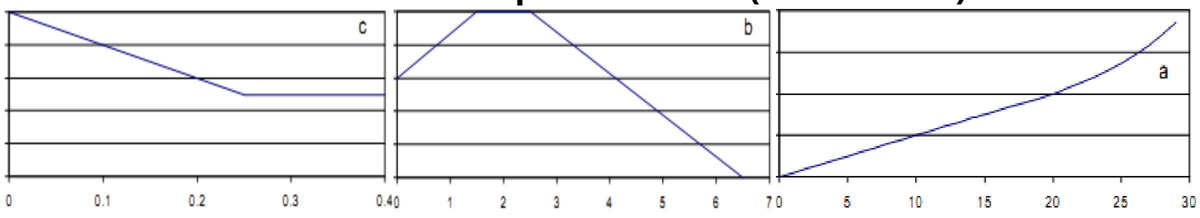
**soil chemistry**
- pH / Eh
- salt concentration

**soil physics**
- humus accumulation
- water holding capacity
- aeration

**Factors influencing decomposition:**

- organic matter chemistry
- soil biology
- abiotic conditions

**decomposition rate (relative units)**



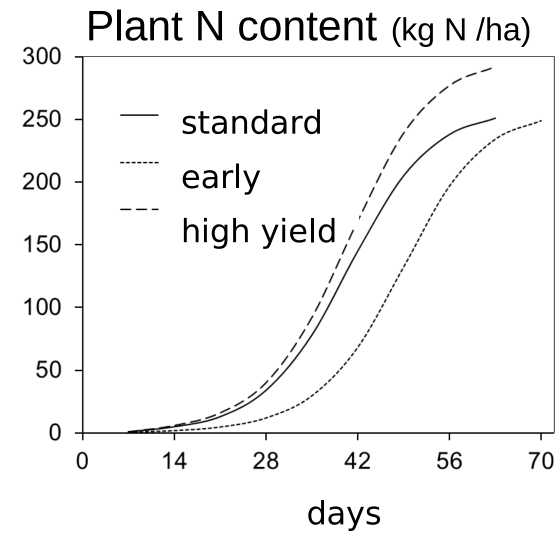

Hansen 2002. DAISY, a flexible soil-plant-atmosphere system model. (modified)

# Prediction of nutrient demand and availability - Example Nitrogen

Fertilizer = Plant N demand − N availability

**Plant N demand:**

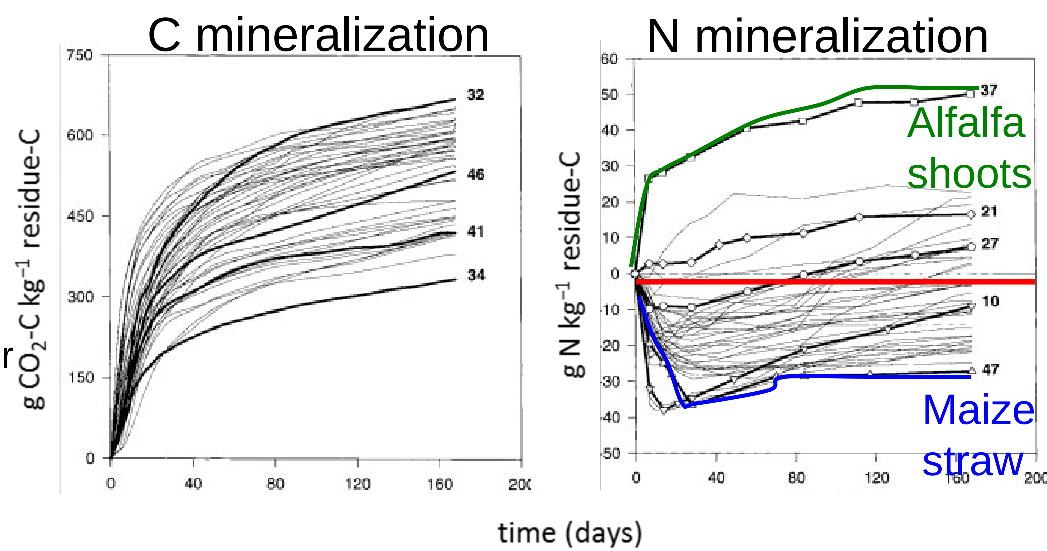
- expected N uptake
- required excess soil Nmin (0–50 kg ha$^{-1}$)




Feller et al. 2010 Düngung im Freilandgemüsebau. In: Fink M (ed) Schriftenreihe des IGZ, 3rd edn., issue 4, Großbeeren, 265 pp. (modified)

**N availability:**

- soil Nmin at start
- soil Nmin losses
  - leaching
  - gas emissions
  - immobilization
- soil Nmin input
  - N mineralization from soil organic matter (added organic matter)
  - N deposition / N fixation




Trinsoutrot et al. 2000. Soil Science Society of America Journal 64, 918-926. (modified)