# **Organic greenhouse production**, challenge of sustainable management of the root environment.

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Wageningen UR Greenhouse Horticulture
The Netherlands

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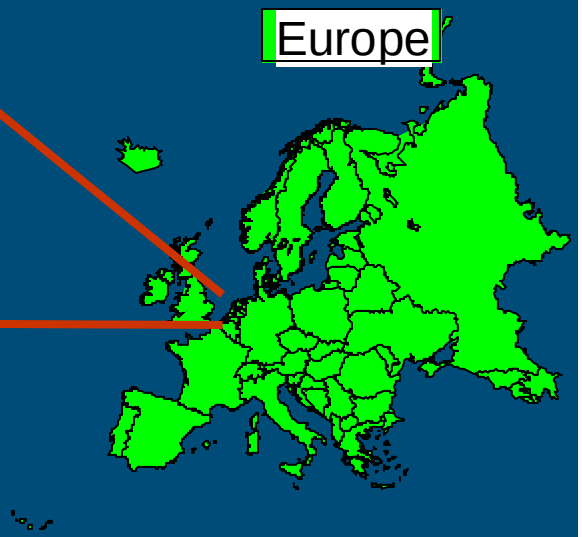
# Netherlands



# Contents

- Statistics
- Organic horticulture, general
- Organic matter, the key
- Bottle necks of organic greenhouse horticulture
- Research and progress last 10 years
- Conclusions and research topics

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# Some data; Netherlands

| | % of category |
|---|---|
| Total agriculture 2 million ha | |
| Organic farming 50.000 ha | 2.5 % |
| Potatoes 1378 ha | 3.1 % |
| Field vegetables 2267 ha | 5.1 % |
| **Glasshouse vegetables 85 ha** | **1.4 %** |
| **Glasshouse flowers < 5 ha** | **< 0.2 %** |

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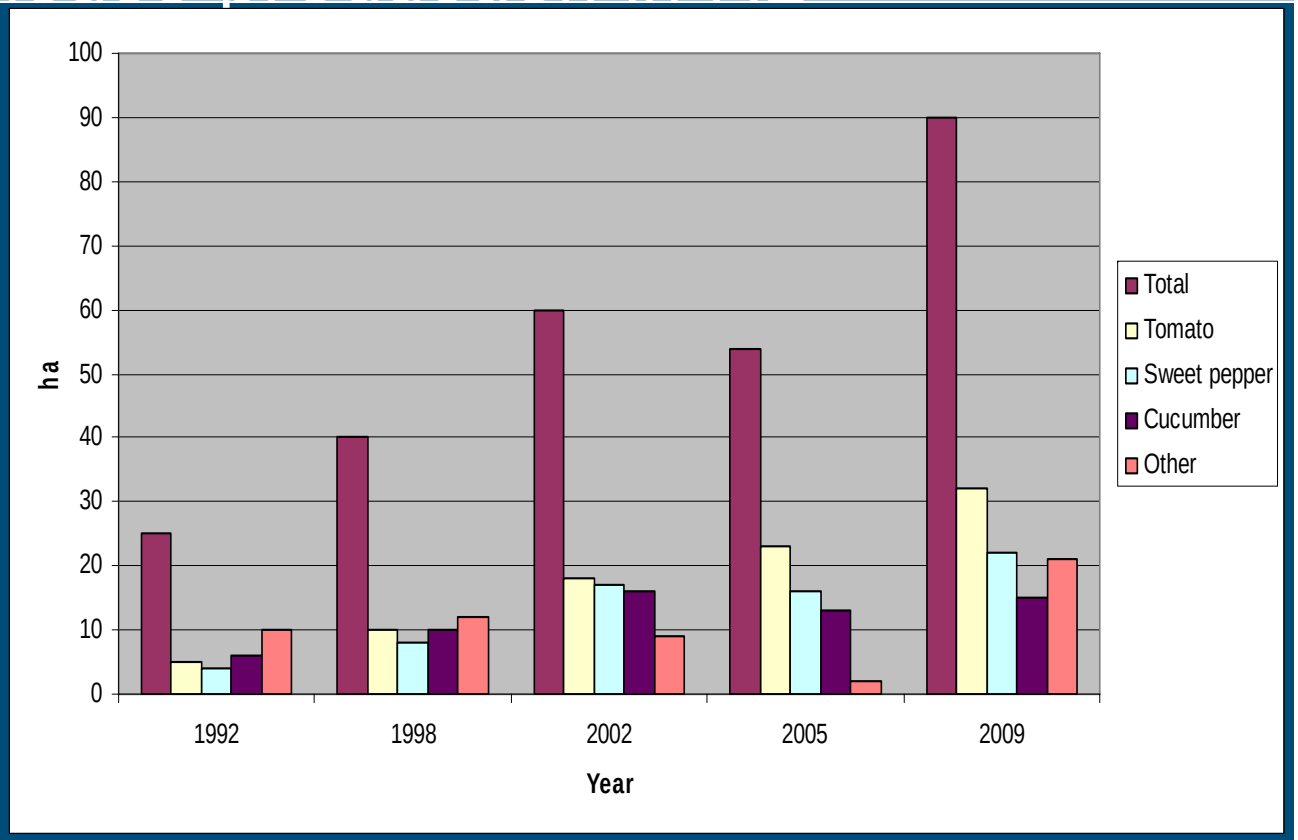
# Organic greenhouse production in NL



# What is organic ?

- No chemicals
- No chemical fertilisers

- More than that

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# European context *Soil – related aspects*

EU-regulation 2091/92

Philosophy of organic farming:

**Soil is the main production factor**

- Soil in its natural status
- Key role: micro flora and –fauna
  - Making nutrients available
  - Disease suppression
  - Growth enhancement

- **<u>Substrate growing excluded !</u>**

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# Organic greenhouse nurseries

Intensive

- Fruit vegetables:
  - Heated greenhouses
  - Tomato, Pepper, Cucumber,
  - Limited crop rotation
  - Intensively grown
  - Soil sterilization

Extensive

- Variety of crops:
  - Cold or minimal heated greenhouses
  - Leafy vegetables,  Beans, e.g.
  - extensively grown (non-heated)
  - abundant crop rotation
  - No sterilization

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# Important aspects

- Crop rotation
- Base dressing
  - Organic matter supply, primarily compost:  feeding microorganisms
  - Manure only supplemental (source organic farming !)
- Top dressing, only supplemental
  - Additional fertilizers
  - No synthetic fertilizers (N,P, K)
  - Only mined minerals
  - Bone products prohibited
  - Other slaughterhouse products restricted
- Certification of fertilisers obligatory  (Dutch: SKAL)

# Additional regulations (not specific organic)

**(Dutch legislation)**

- restriction in P input from manure
  - (200 kg P $ha^{-1}$ $yr^{-1}$)
- restriction in total N input animal source
  - 170 kg N ha-1
- restriction in total N and P input
  - *(crop specific: tomato 1620 N, 300 P kg $ha^{-1}$ $yr^{-1}$)*
- reuse of drainage water
- rainwater collection 500 $m^3$/ ha

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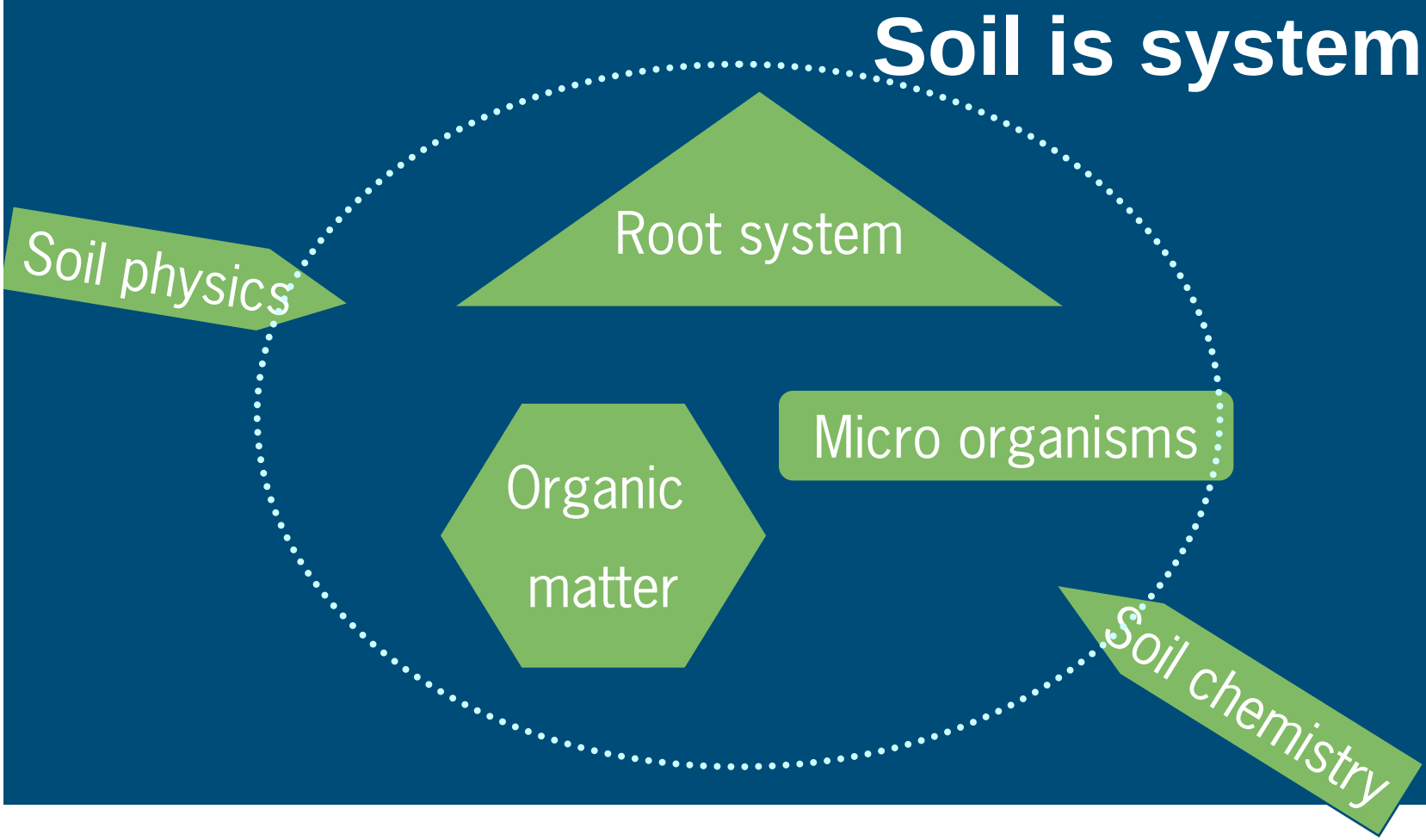
# New “threads”

- European regulation
  - “Water Framework Directive”
  - Nitrate Directive
- Dutch regulations towards “Restriction of emissions from the root zone”

  → 2010: emission targets

# Organic farming = Holistic approach

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# Key role organic matter

- Physical properties: structure, pores, water holding capacity, etc
- Chemical: nutrient buffer
- Food/energy for micro organisms
- Source of plant nutrients (N P,K….etc)

# The fate of Nitrogen: Soil processes involved

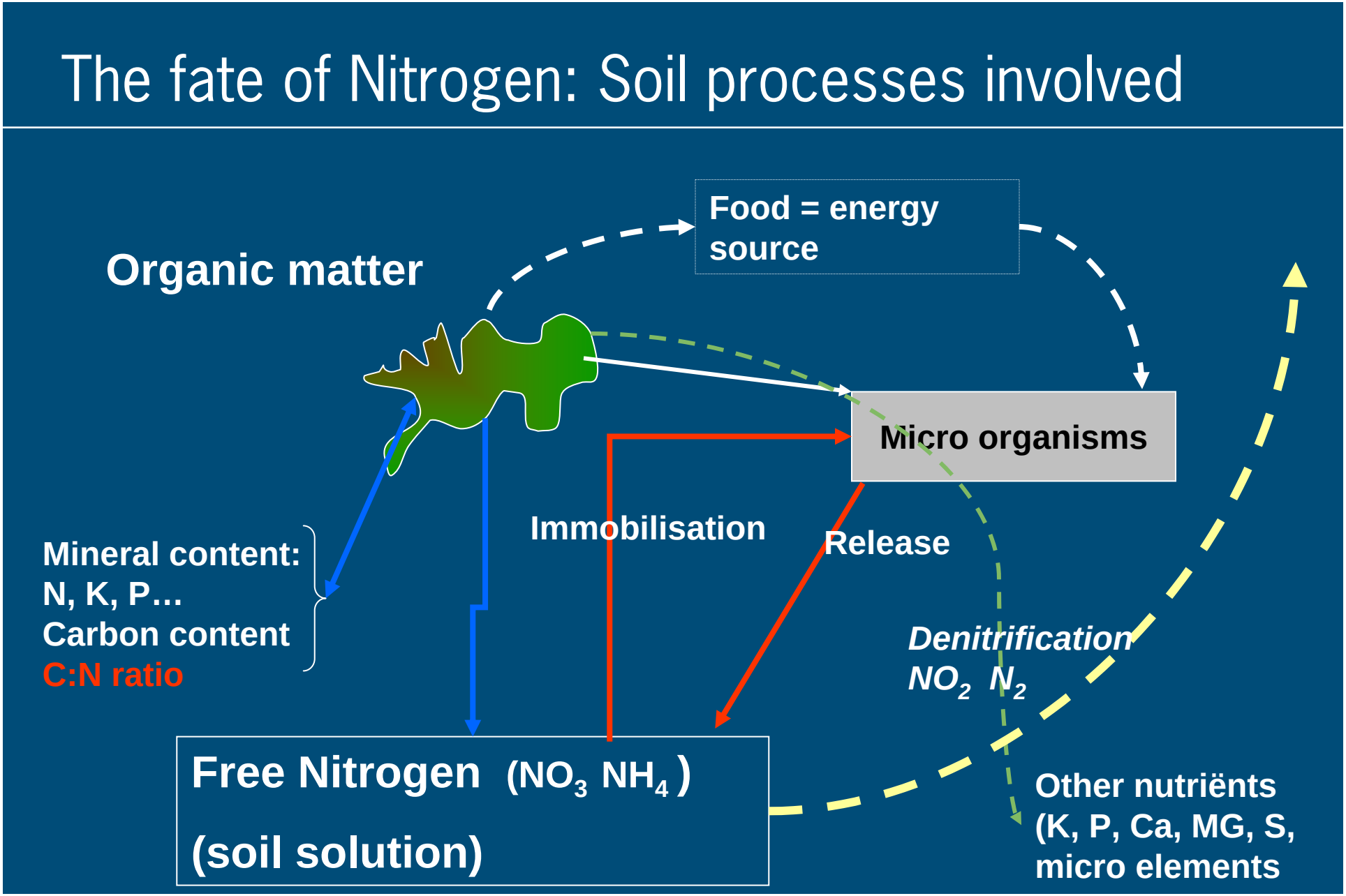
- Supply
  - fertilisation

    ≠
- Availability
  - mineralisation: Manures, SOM (soil organic matter), Organic fertilisers
- Removal
  - Crop
  - Immobilisation
  - Denitrification
  - Leaching

Aim: Balancing

- At the right time
- At the right spot (roots)
- Equal quantity

# The fate of Nitrogen: Soil processes involved

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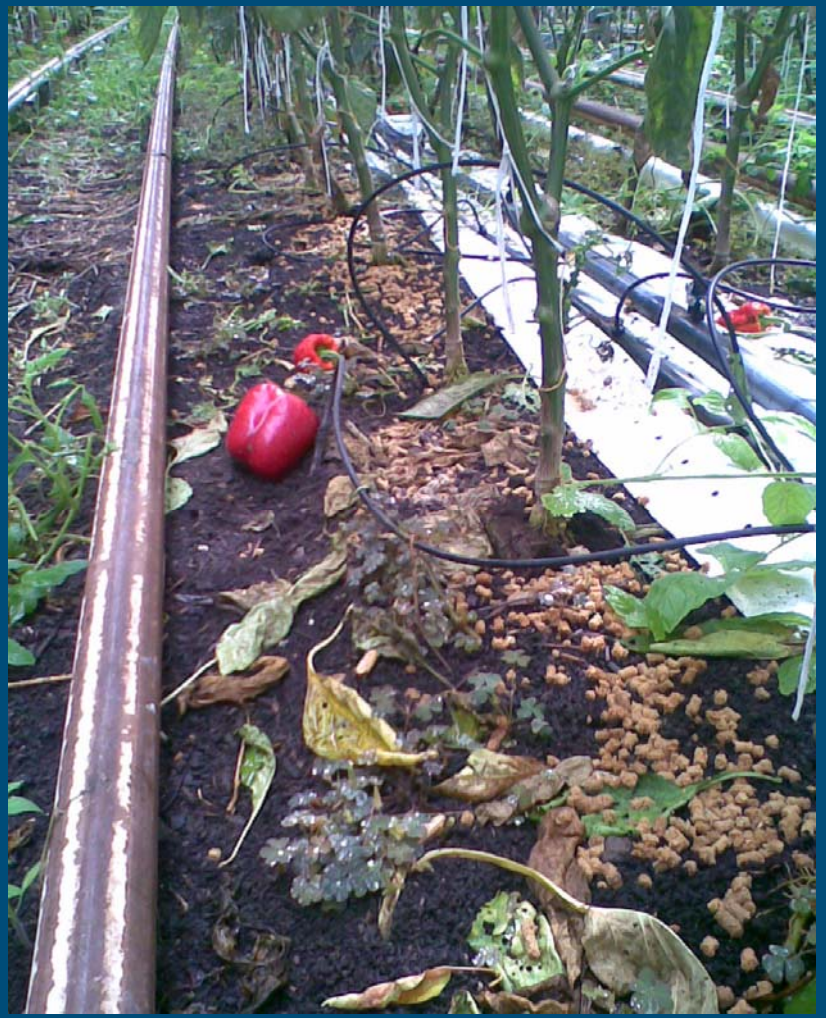
# Nitrogen availability

- Soil temperature
- Source specific factors
  - C/N ratio
  - Particle size
  - Organic compounds
- Soil specific factors
  - Mineral N content
  - moisture / air
  - pH
- Way of fert. application



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# Organic matter: sources

- Animal source
  - Manures, Slurries, Waste: Slaughter-house, Fish industry
- Plant source
  - composts
  - waste products:
  - food industry: rice-, poppy-, cocoa-, ricinus
  - wine / beer industry

# Organic fertilisers

- Base dressings
  - Manure, Compost
- Top dressings
  - Broadcasting (pellets, granules, crystalines)
    - Dried manure pellets, compound granules
  - Liquid
    - Vinasse, hydrolised organic waist



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# Choice of organic inputs

- Nutrient content  e.g. quantity
  - Crop demand
  - Soil properties
  - Legislative restrictions
- Nutrient delivery
  - decomposition/ mineralisation

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# Bottle necks

| Bottle necks | Problem |
| --- | --- |
| Restrictions on mineral inputs and fertilizers allowed | less flexibility |
| Surpluses of N and P | Potential leaching |
| Unequal nutrient ratios | Unbalanced fertilization |
| N delivery and crop demand not synchronous | Potential leaching and deficiency |
| Irrigation surplus and N leaching | Environmental pollution |
| Soil borne diseases | Yield reduction |
| Nematodes | |

# Research topics

- **Minerals and fertilizers**
  - **Nutrient availability and crop demand**
  - **Understanding the N- Dynamics**
  - Search for alternative N-sources
  - Search for fertilizers low in residual salts
  - Alternatives for animal manure
- **Organic matter**
  - Type, application, availability
  - Disease suppression
- **Soil borne diseases**
  - Suppression organic matter
  - Rootstocks
  - Alternatives for steam sterilization
  - Biological control of pathogens and nematodes

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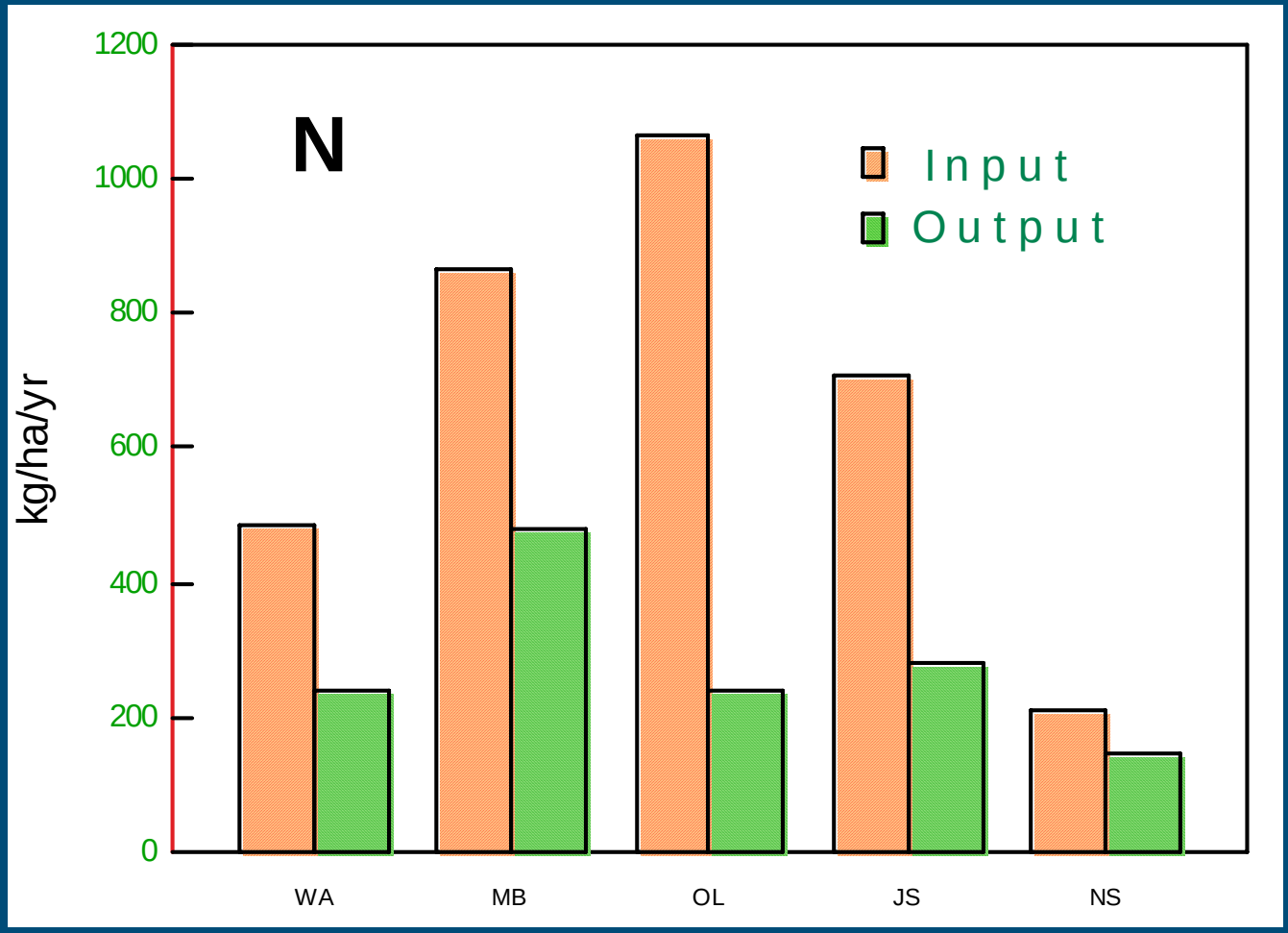
# Mineral balance:
# Results monitoring five organic nurseries (1999 - 2002)

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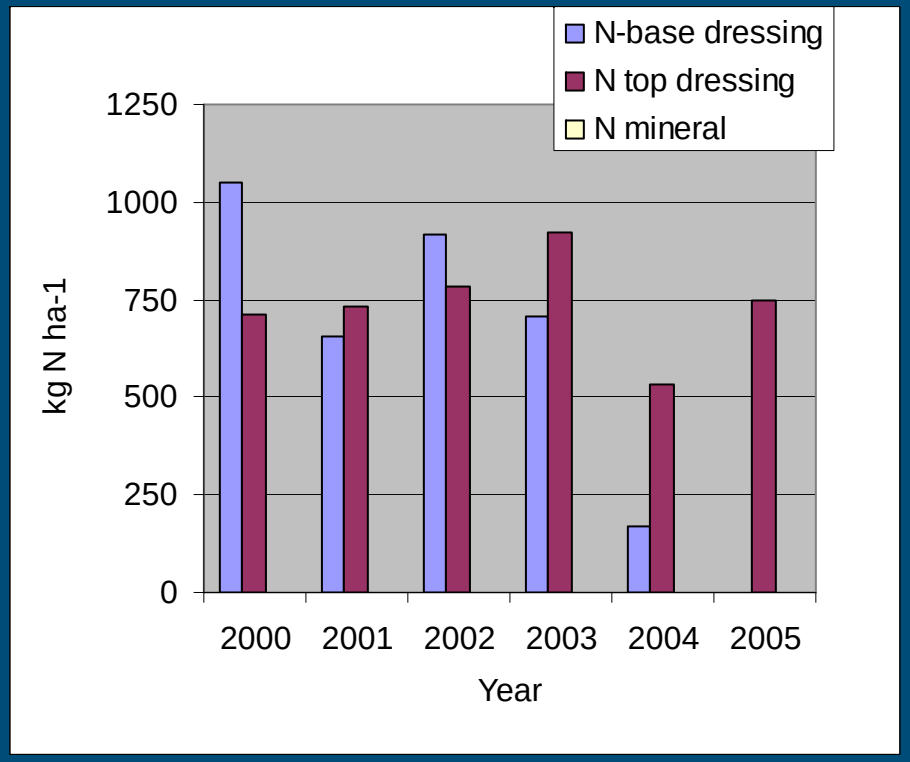
## **Case**:

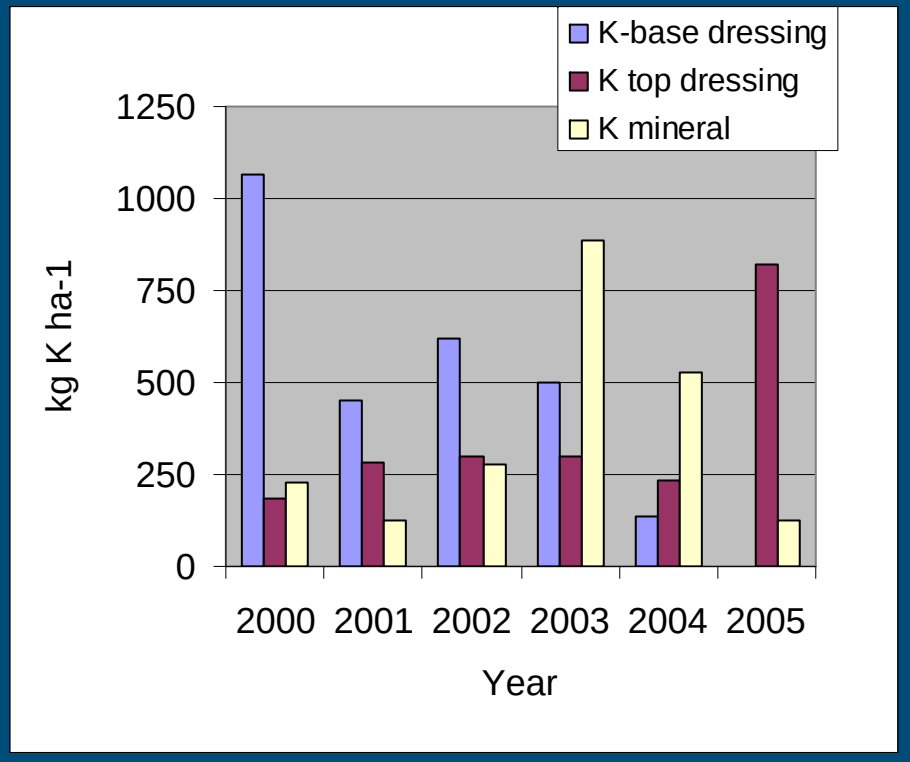
Six year monitoring typical organic vegetable nursery

Aim: tuning supply and demand of nutrients

- Rotation: Tomato – Cucumber – sw. pepper crop rotation
- Base dressings:
  - Compost + organic fertilisers + minerals
- Top dressing:
  - Compost + organic fertilisers

# Changing fertilization strategies

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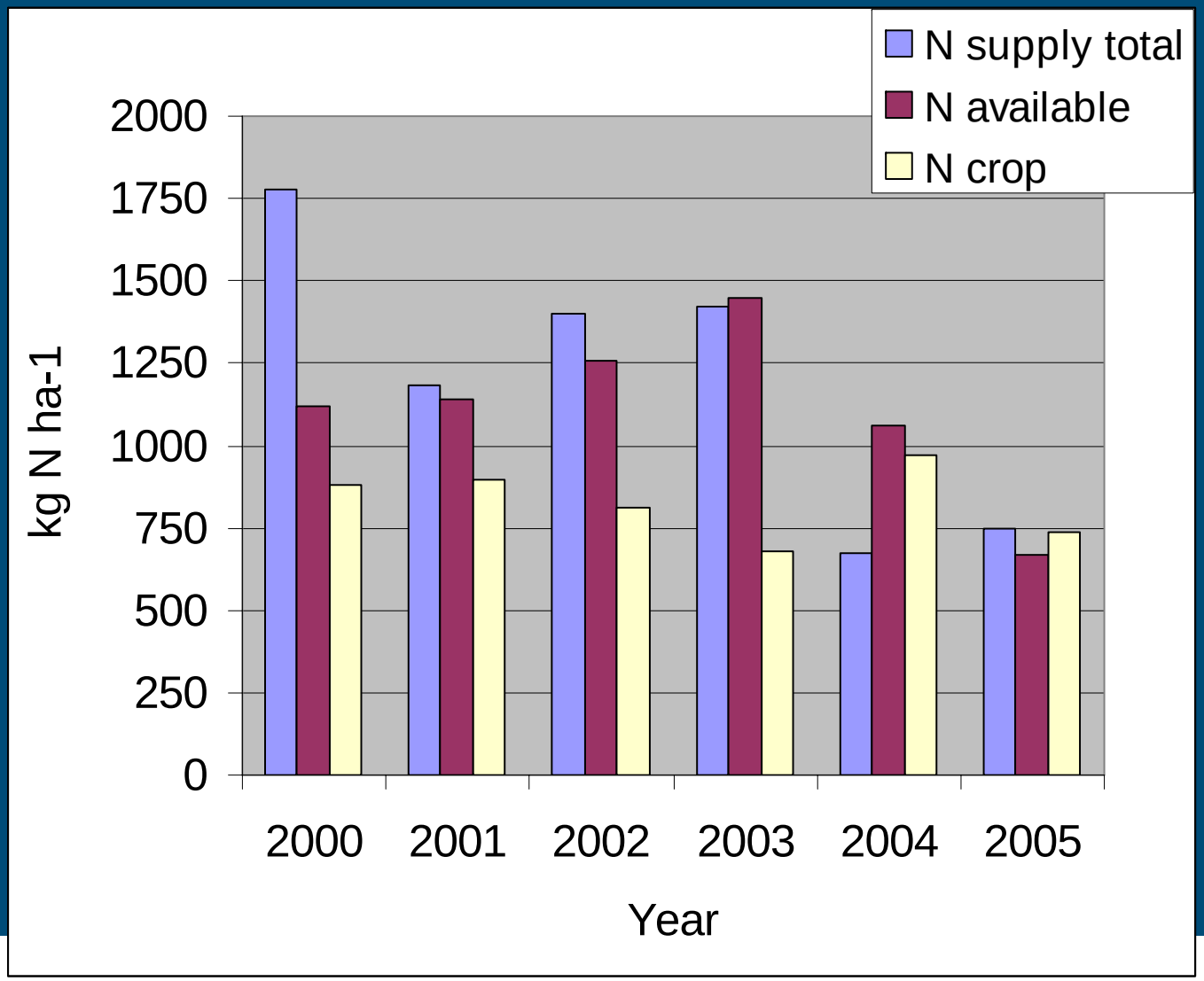
# Nitrogen balance

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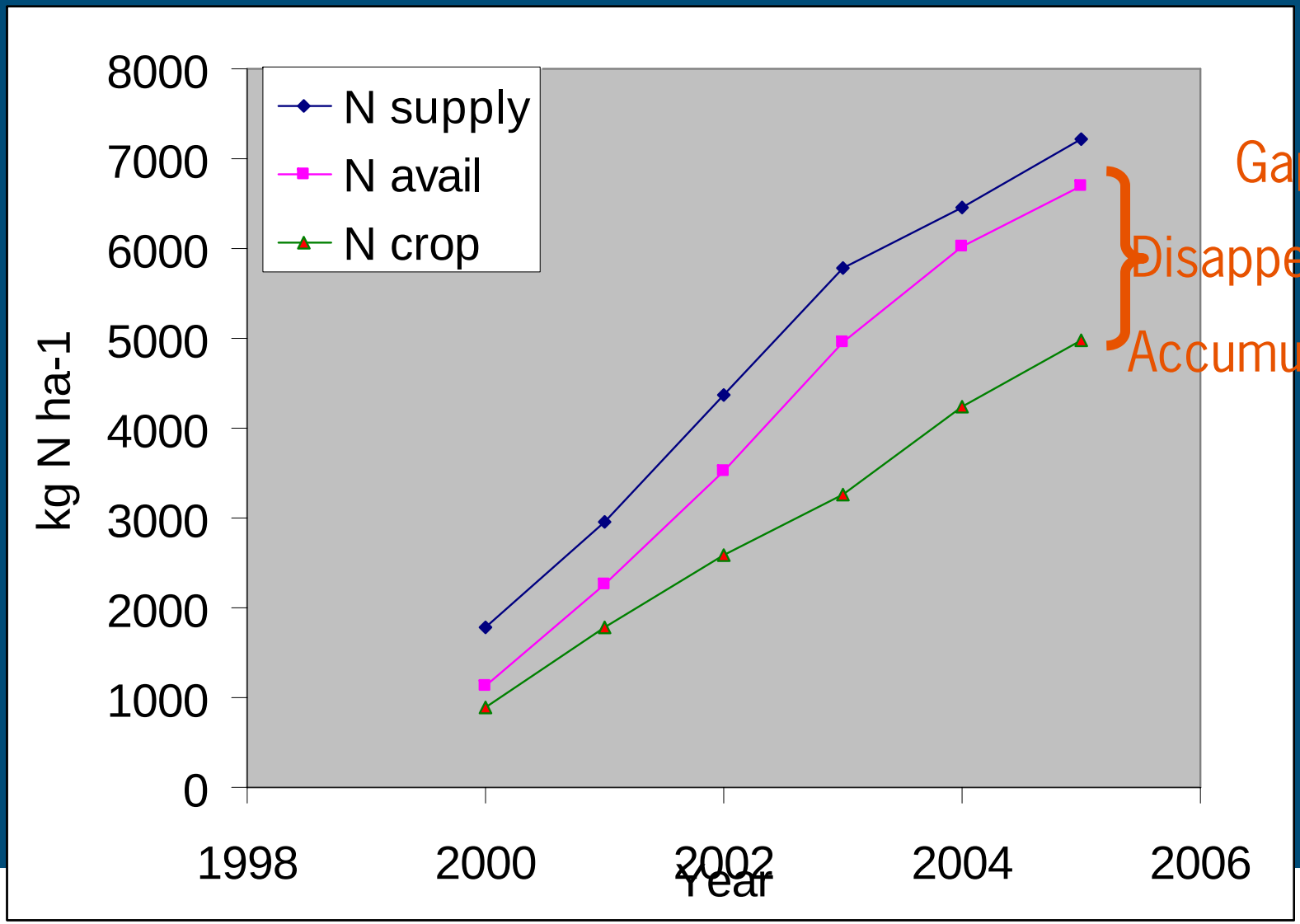
# Cumulative N supply and crop uptake

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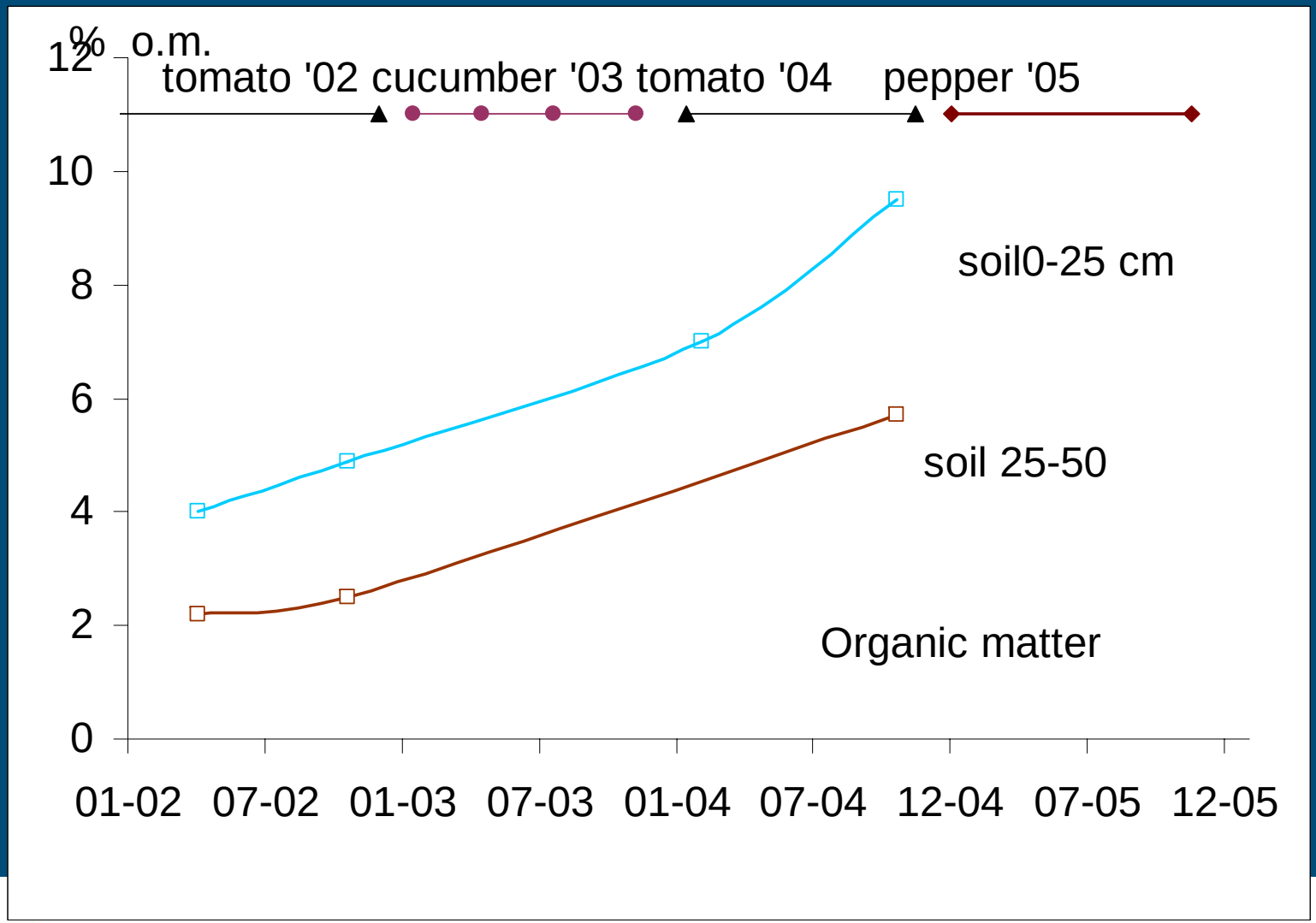
# Organic matter accumulation

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# Nitrogen Gap

- Immobilisation
- Denitrification

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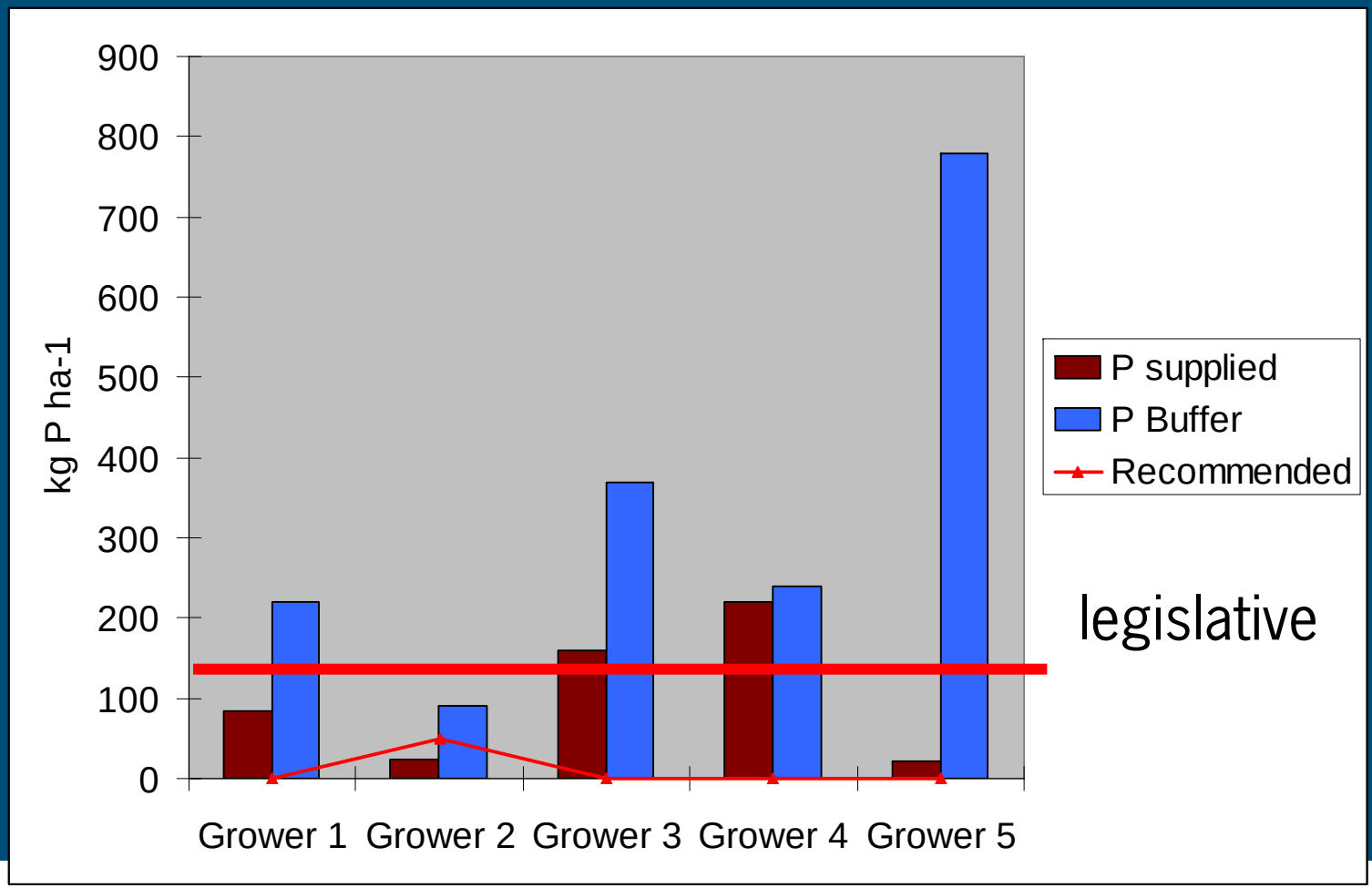
# P supply in relation to available P in soil (buffer)

## more supply than needed

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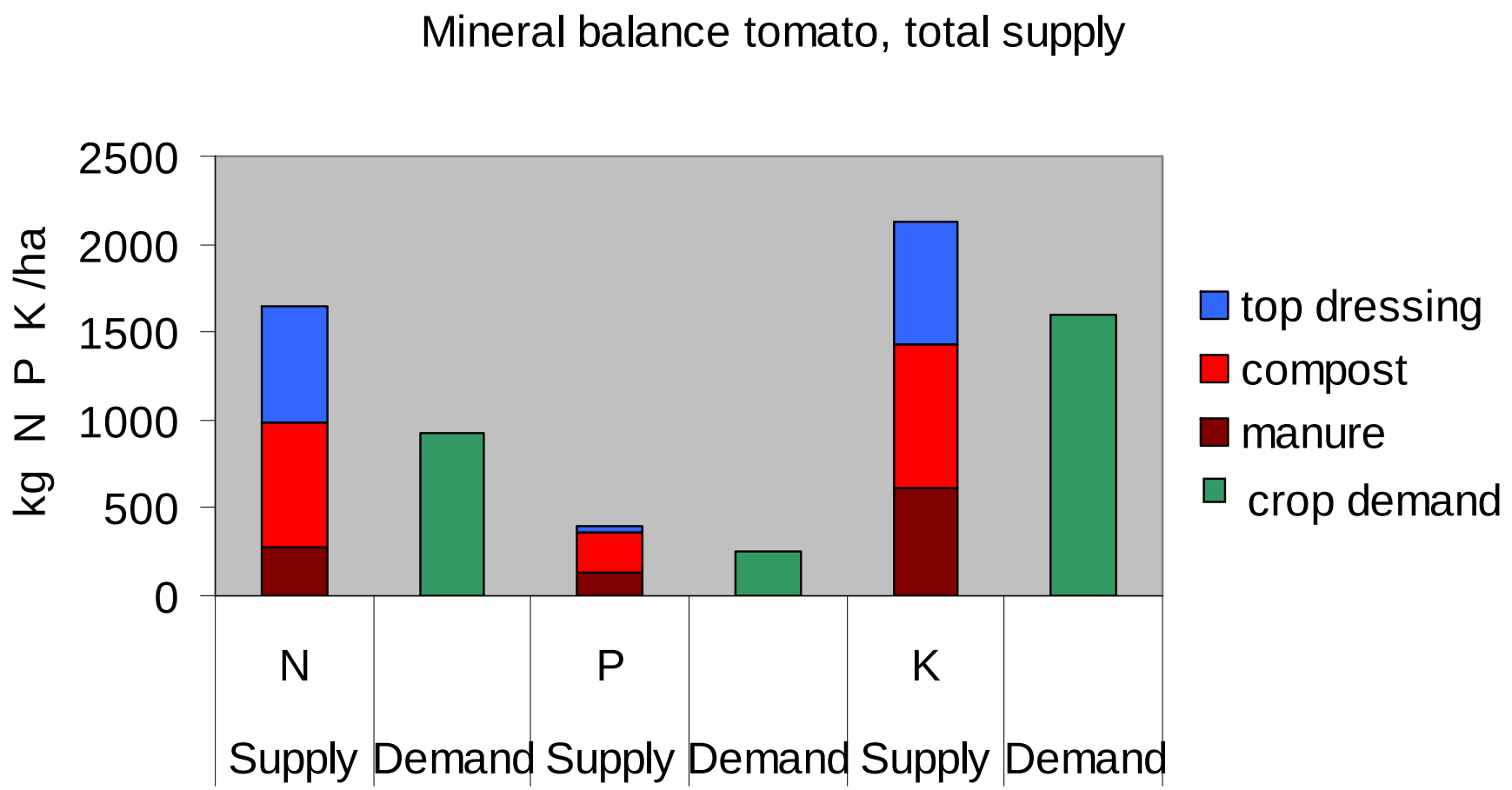
# Base dressing, top dressing and mineralisation




Example tomato, yield 45 kg/m2

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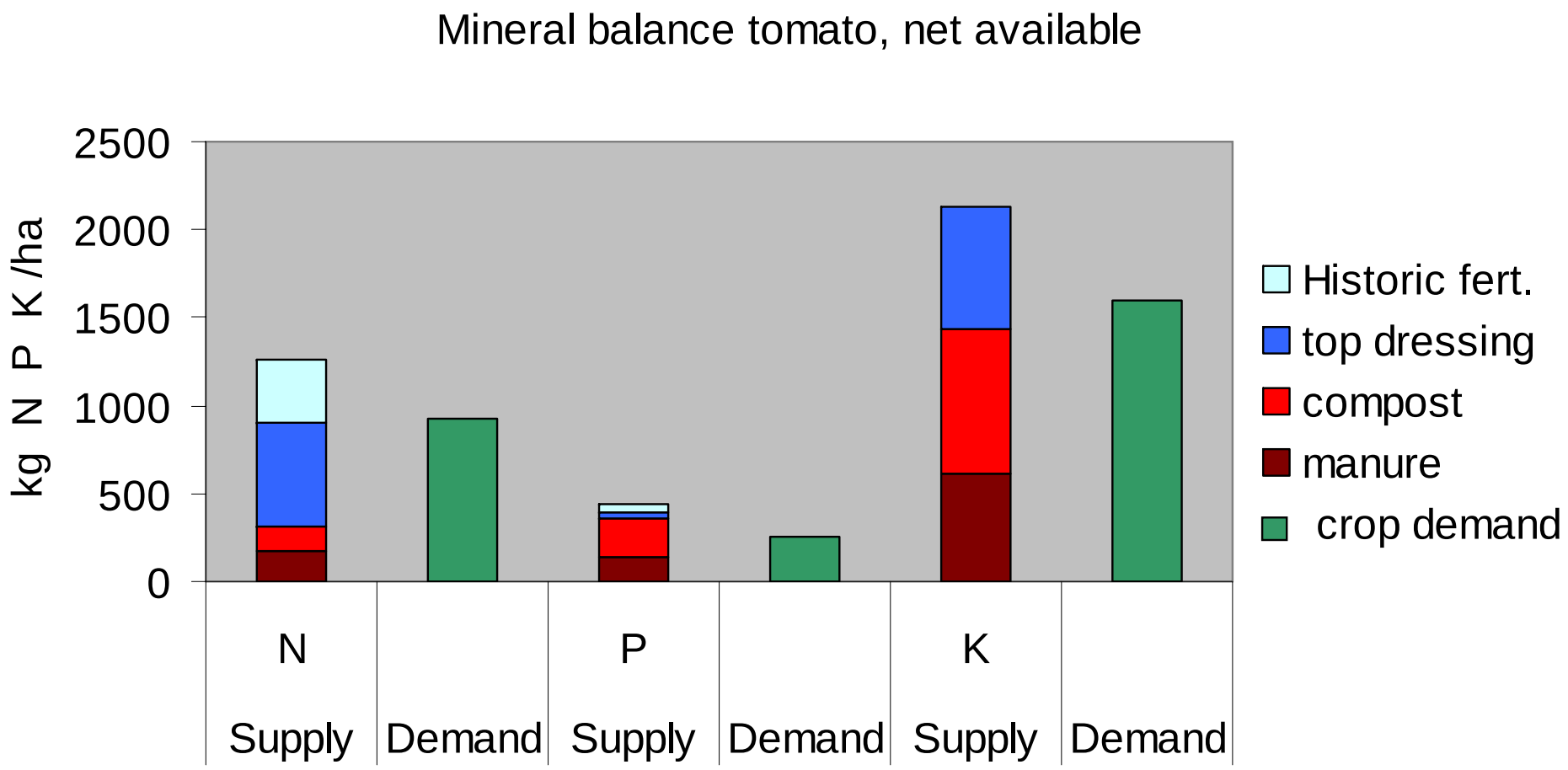
# Availability per year

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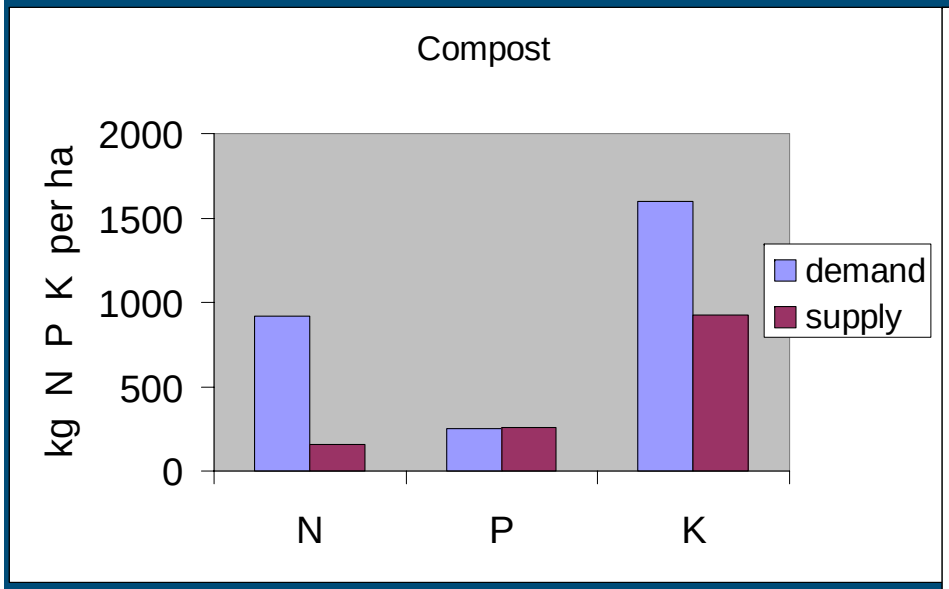
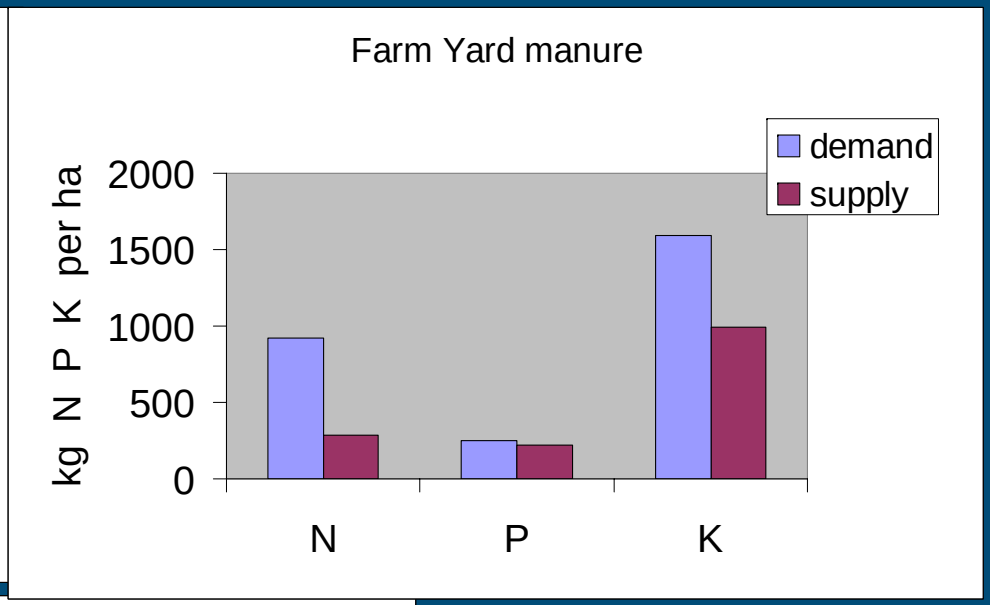
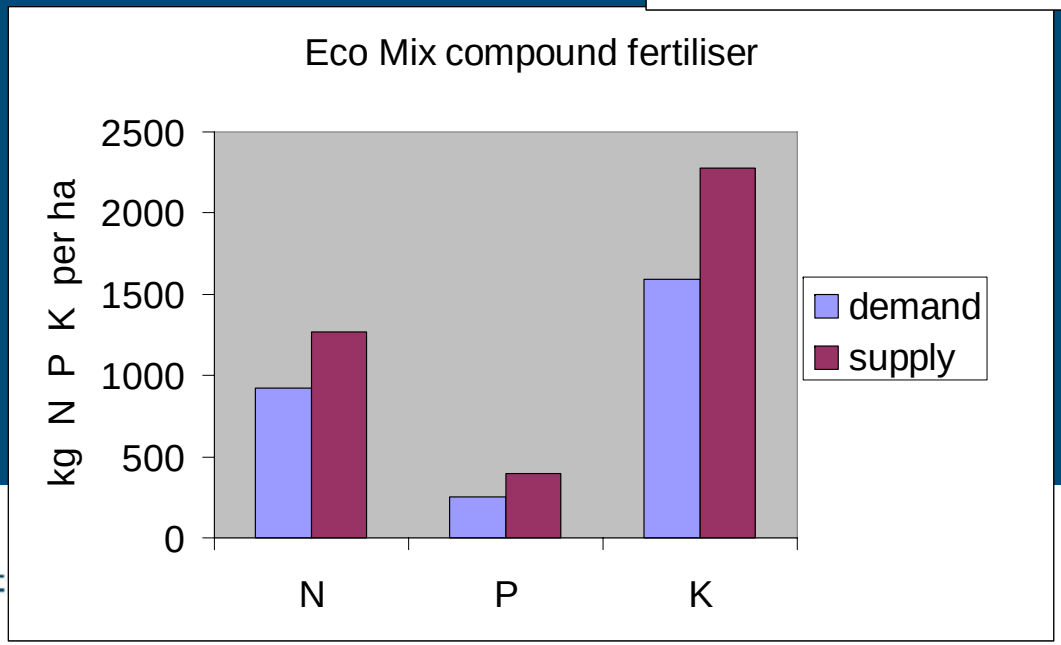
# Unequal mineral ratios

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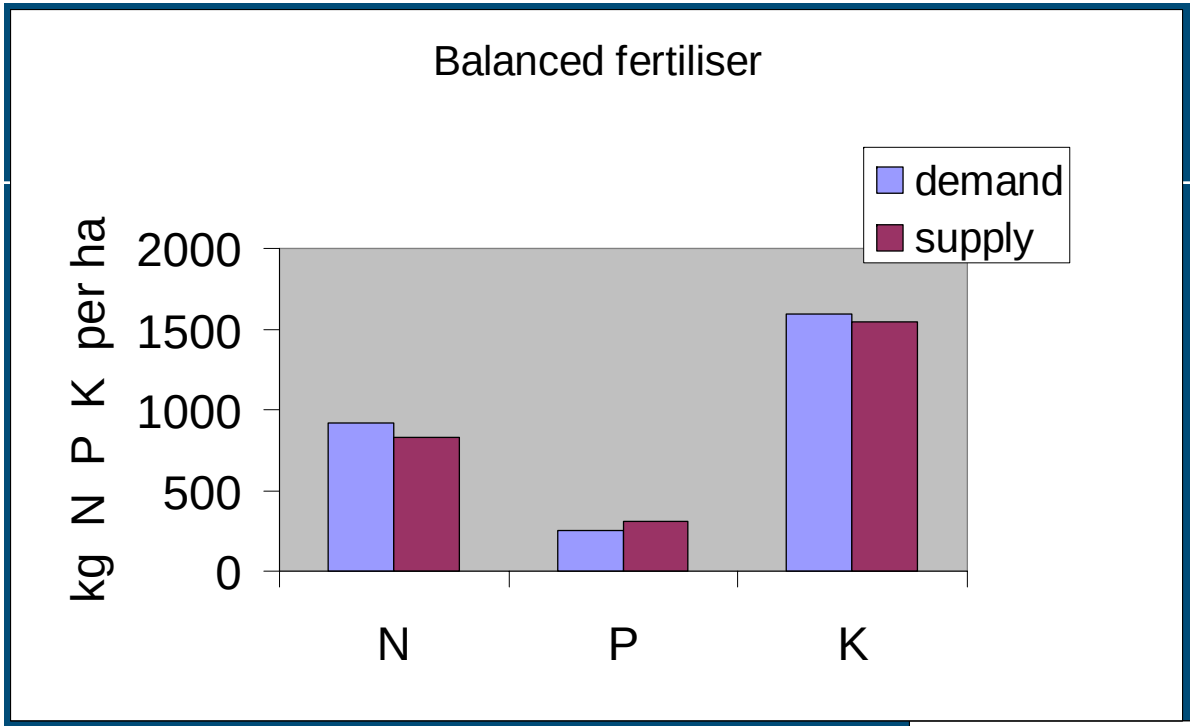
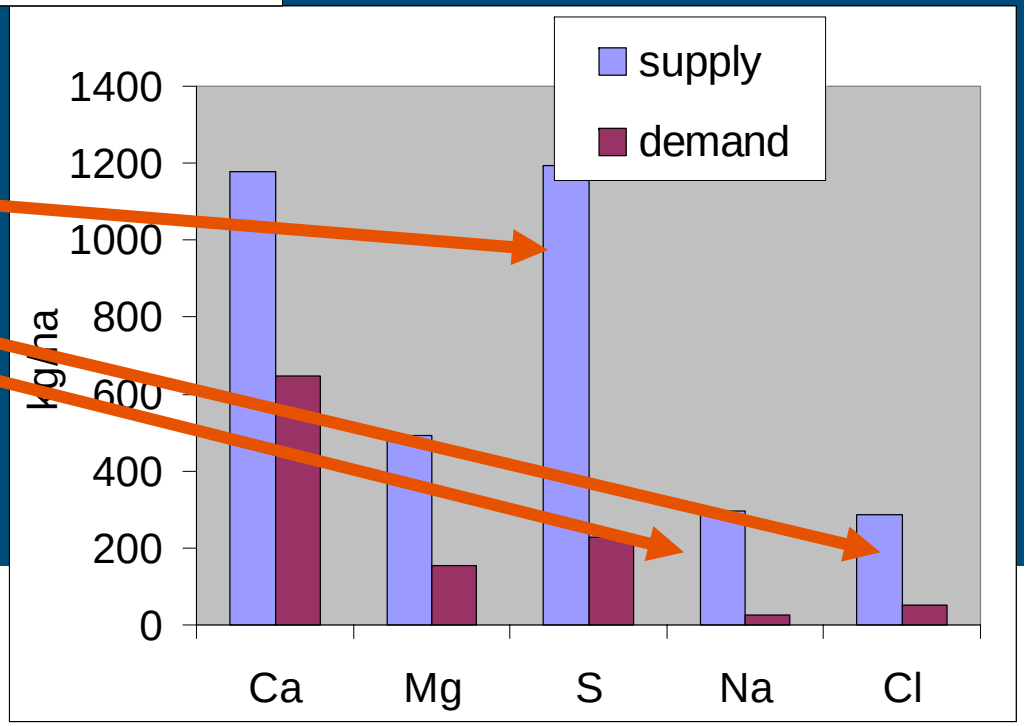



However,

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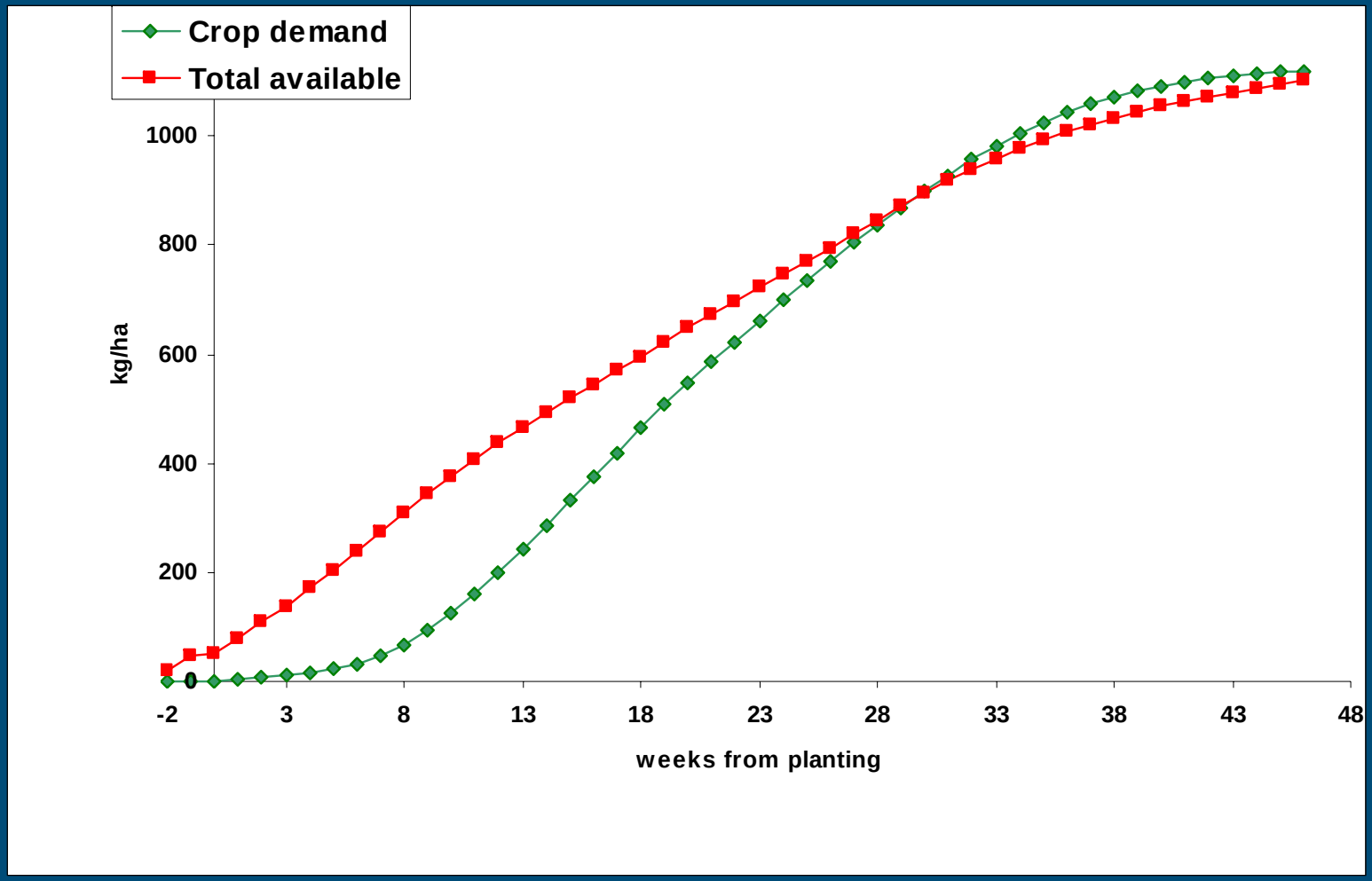
# N-dynamics during the growing period

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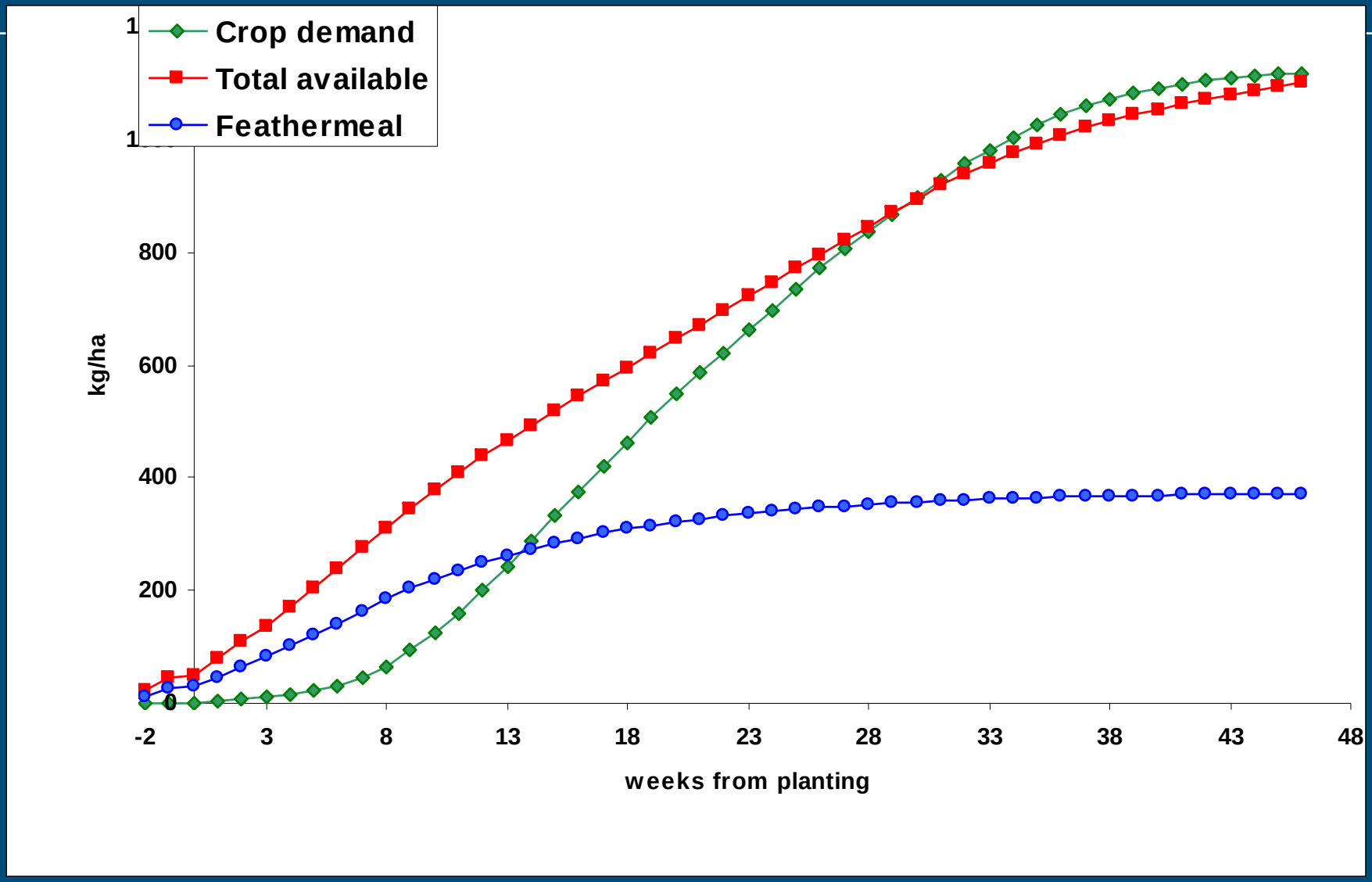


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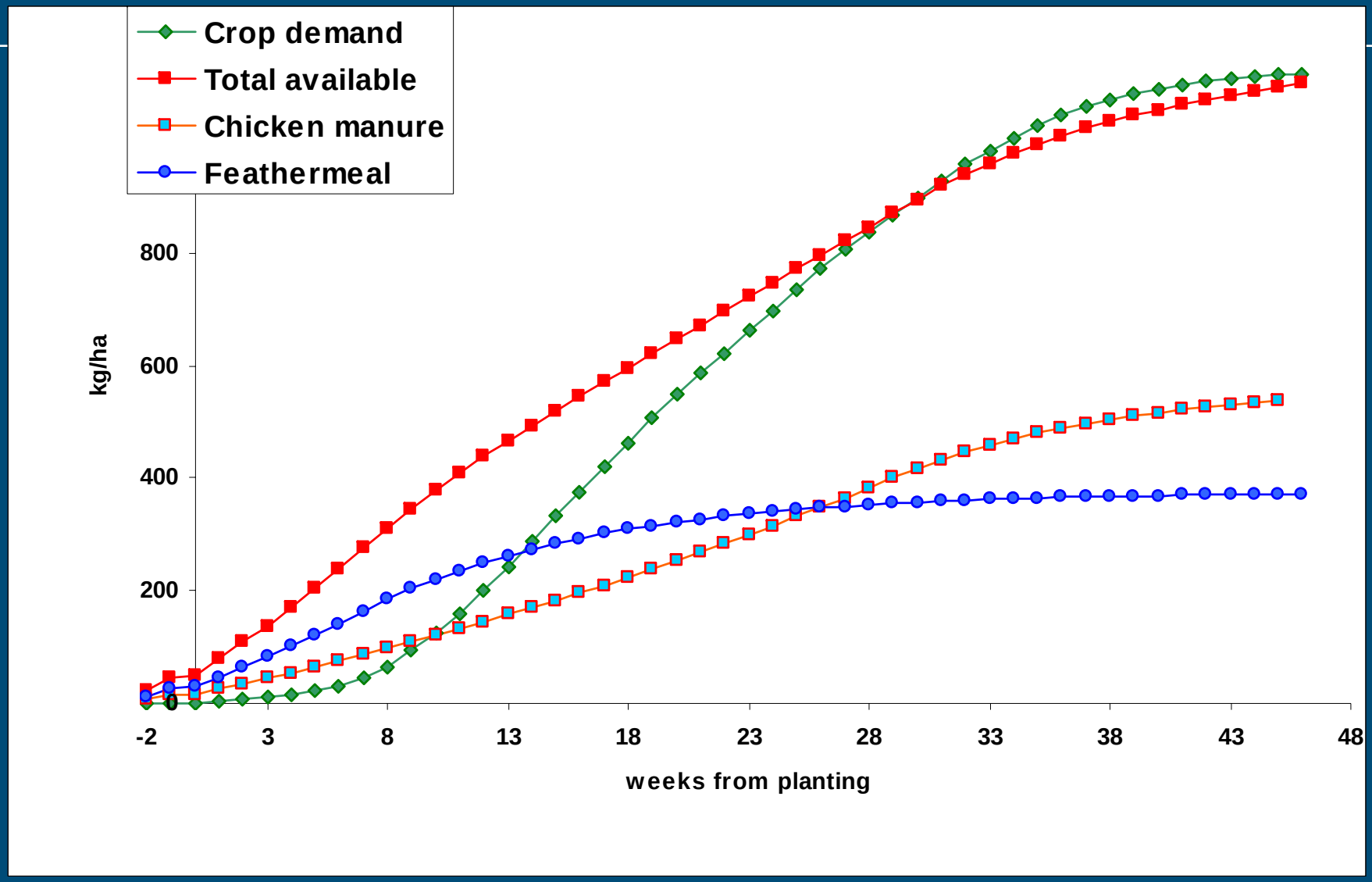


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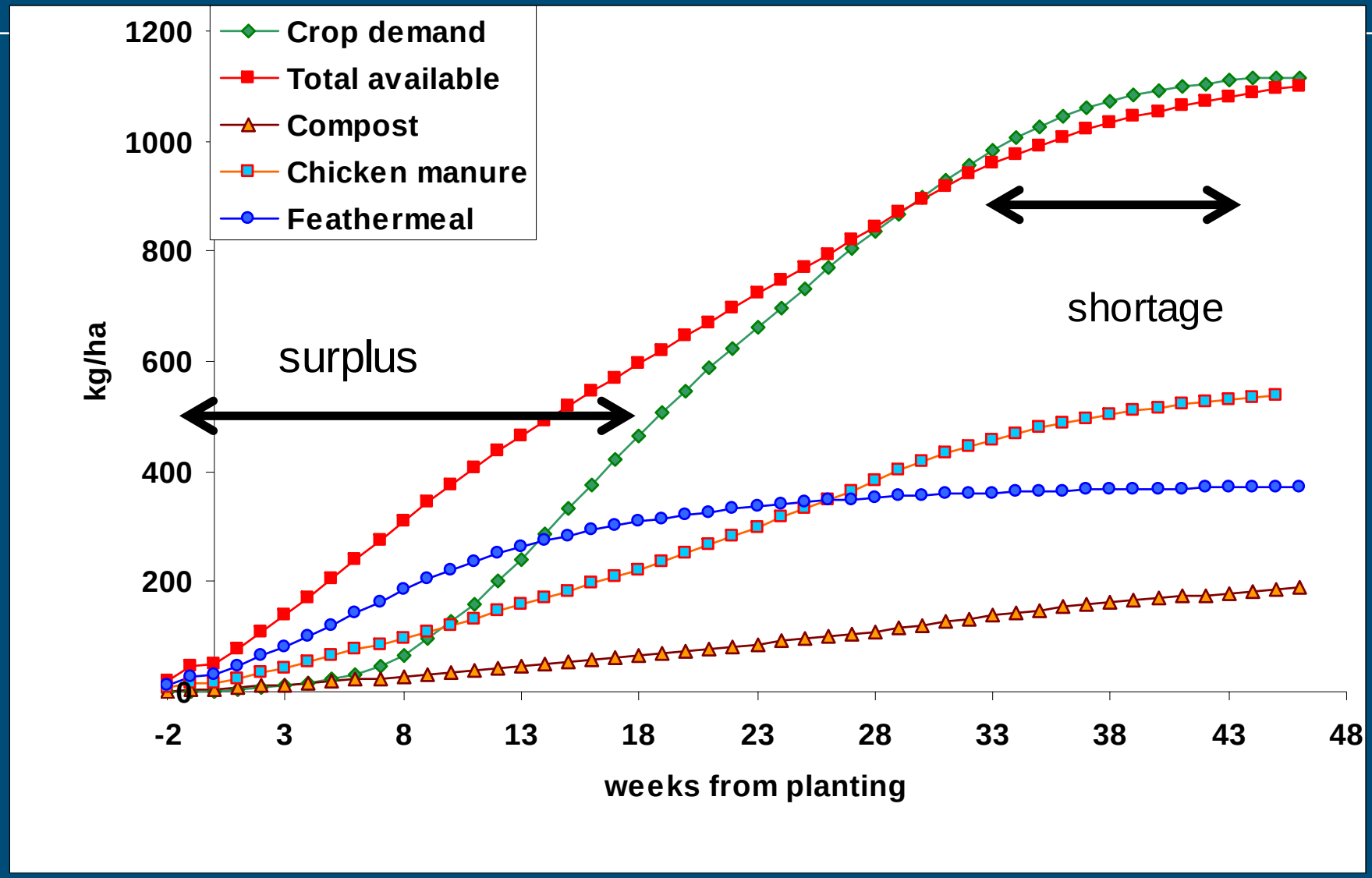


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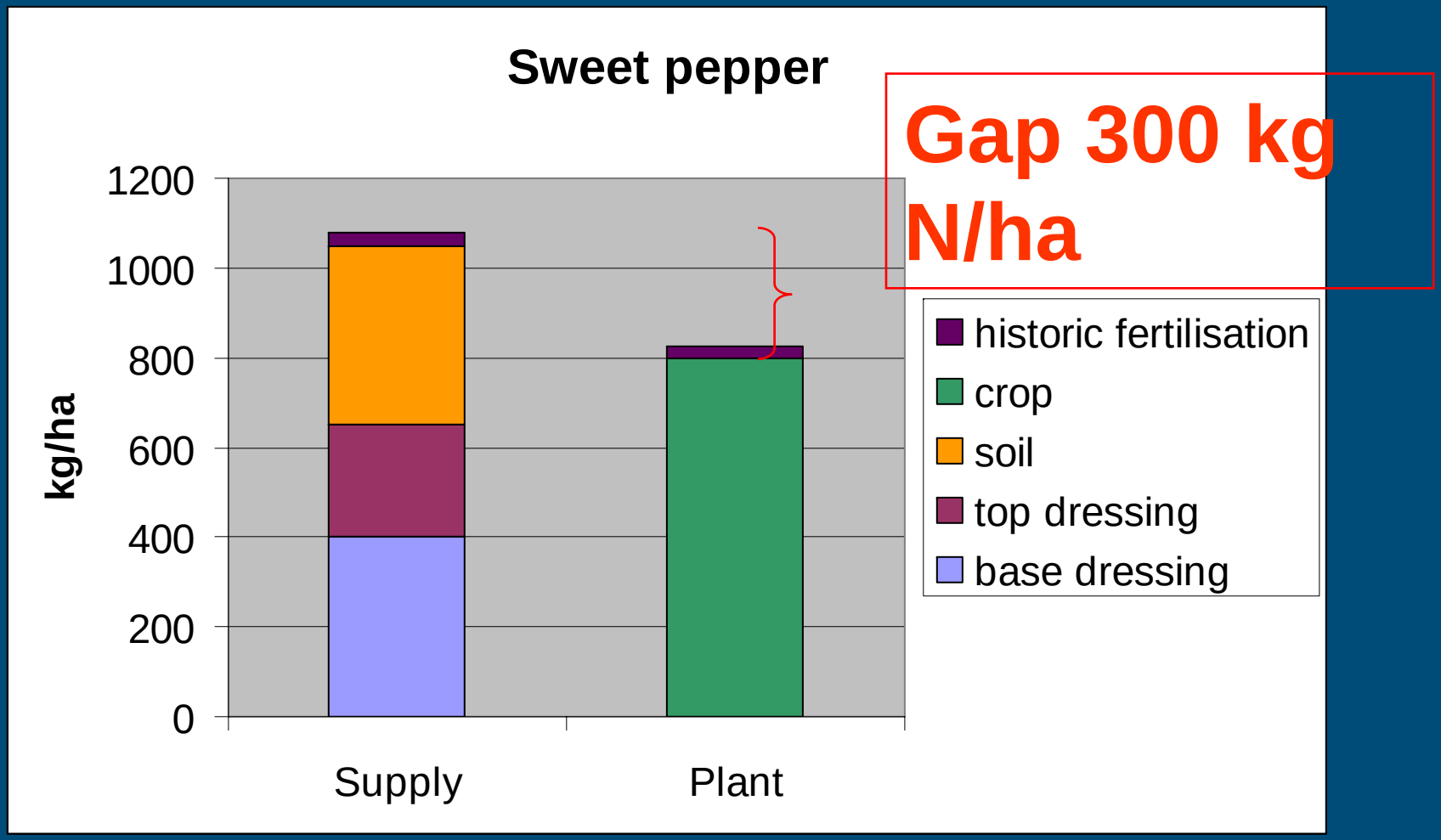
# Results sweet pepper experiment

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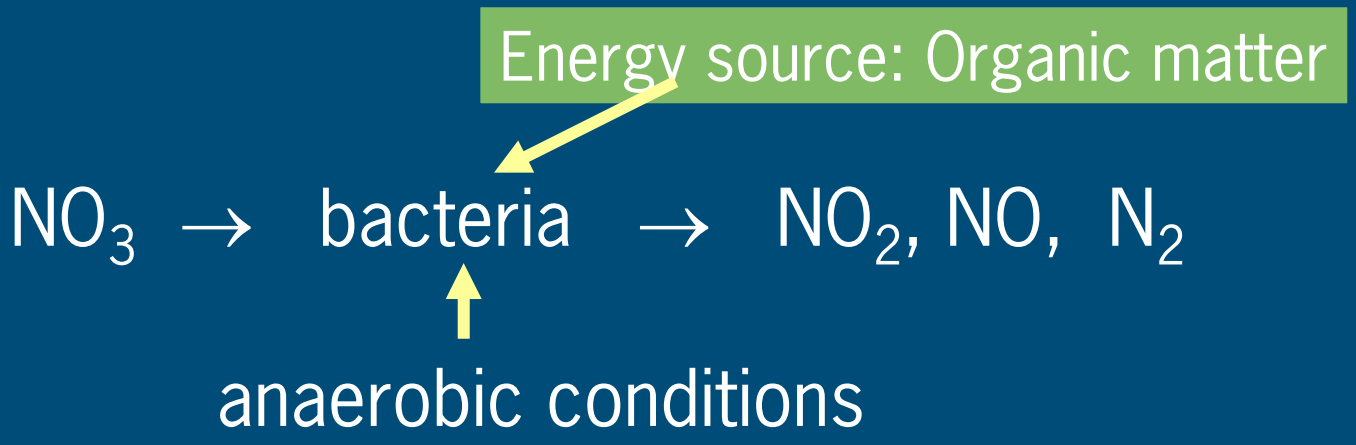
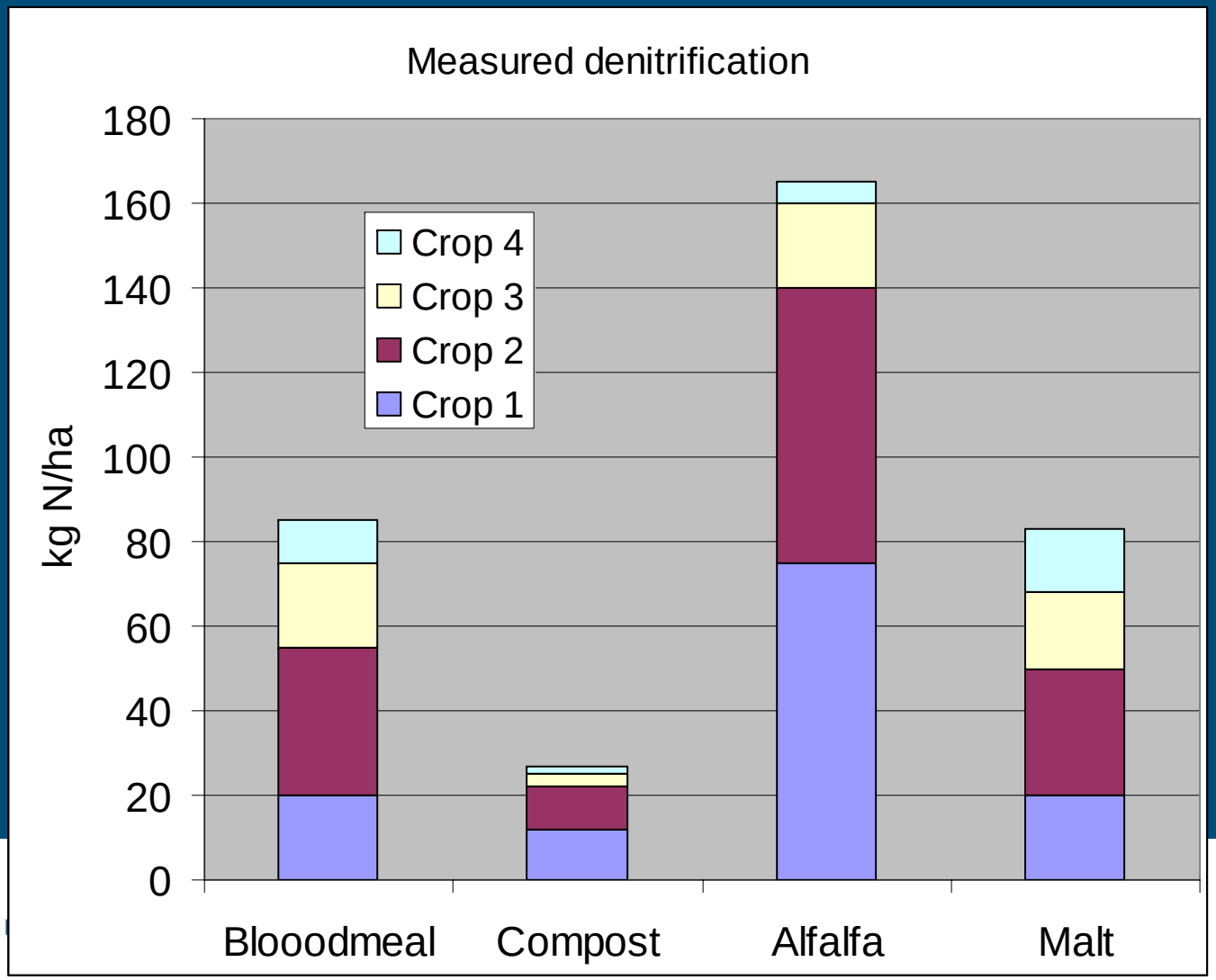
# Denitrification

- Los of Nitrogen through:



# Denitrification

**Measured N denitrification in chrysanthemum crops with 4 organic fertilizers cumulative N kg ha$^{-1}$**



# Denitrification

In organic (greenhouse) horticulture:

- Highs risks
  - Rich in organic matter
  - Abundant  micro organisms
  - Sufficient free $NO_3$
  - Frequent irrigation $\rightarrow$ anaerobic sites

# Sofar: Fertiliser application complicated

- Choice of organic source
- Tuning supply and demand
- Soil processes
- Unbalanced N P K  etc. supply
- Residual salts

# Decision support model for organic matter management

- Cropping plan + expected yield
- Soil properties and minerals
- Water management
- Choice organic fertilisers
  - Base dressing
  - Side dressings

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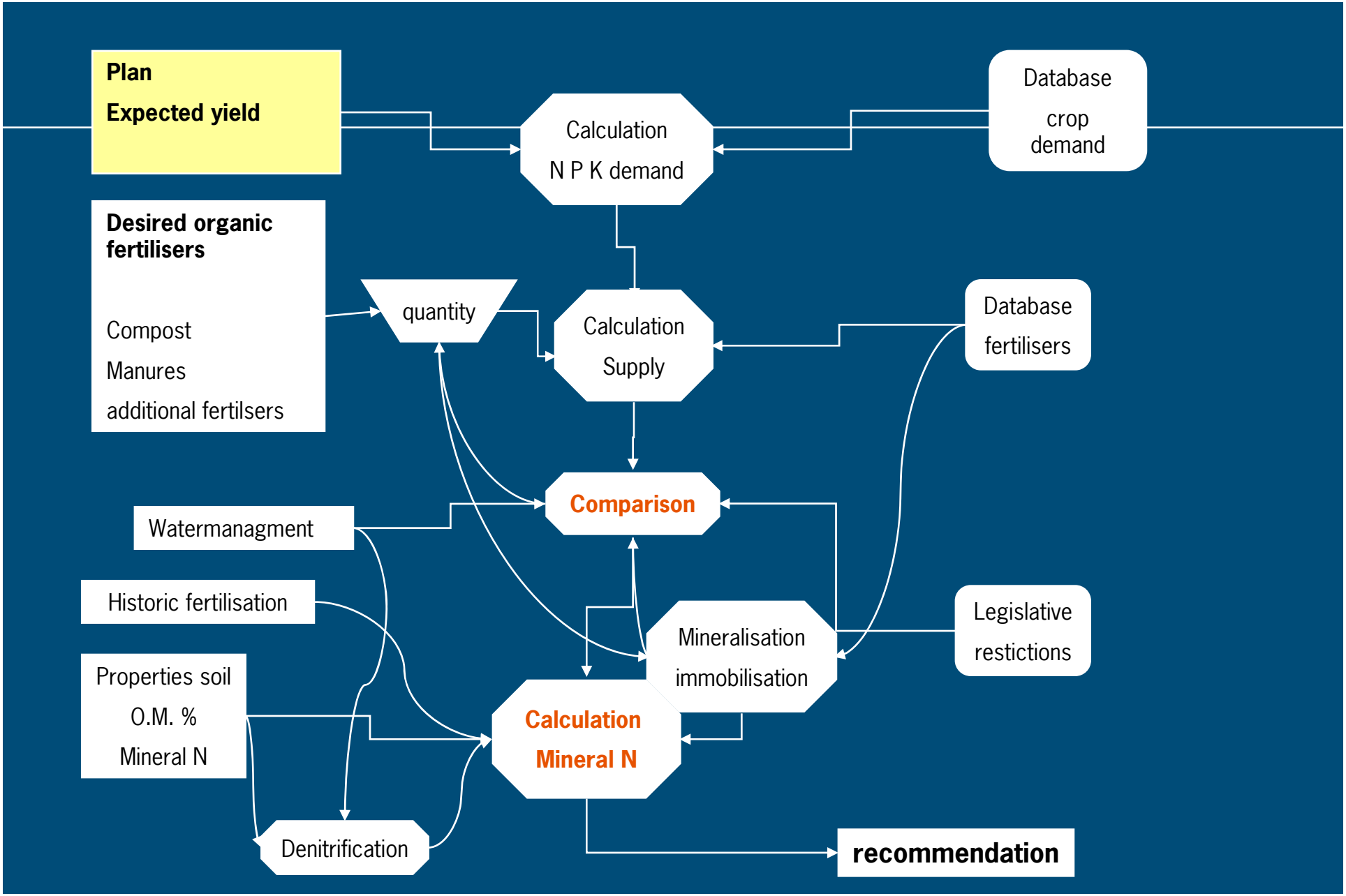


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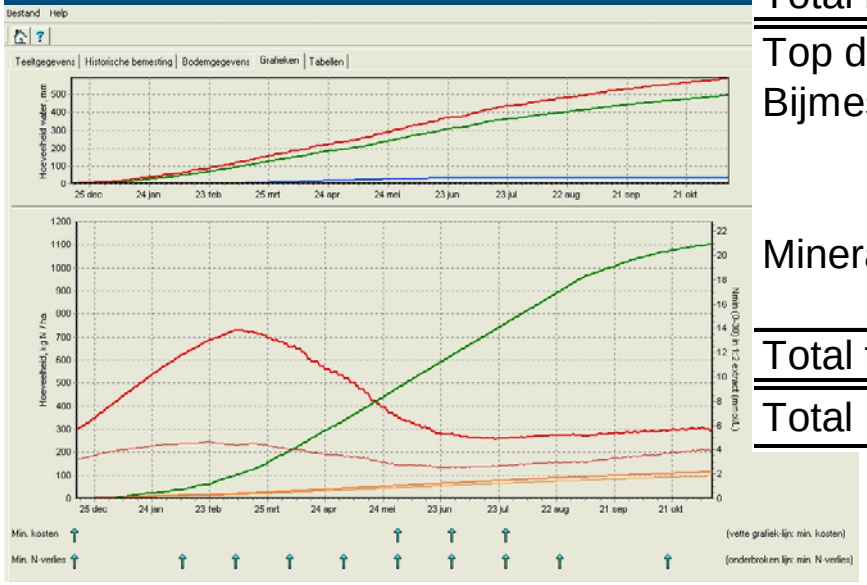
# Example

| **Andel** | 10000 m2 | Estimated yield | *Datum* |
|---|---|---|---|
| Area | | | Estimated dem |
| Croppings | | kg/m2 | **N** |
| Lettuce | | 6 | 200 |
| Tomato | | 45 | 921 |
| **Total demand** | | | **1122** |
| Fertilisation plan | | Ton/ha | |
| Base dressings | | | |
| Manure | FYM | 10 | 57 |
| Compost | groencompost | 80 | 375 |
| | Megrow structuur | 20 | 104 |
| Total base dressings | | | **535** |
| Top dressings | | | |
| Bijmesten | Feathermeal 13 0 0 | 1.0 | 130 |
| | ECO mix 17 4 12 | 2.0 | 140 |
| | Monterra Malt | 6.4 | 319 |
| Mineral fertil. | Potassium sulphate | 3.0 | 0 |
| | | | 0 |
| Total top dressings | | | **589** |
| Total | | | **1124** |



# Example output

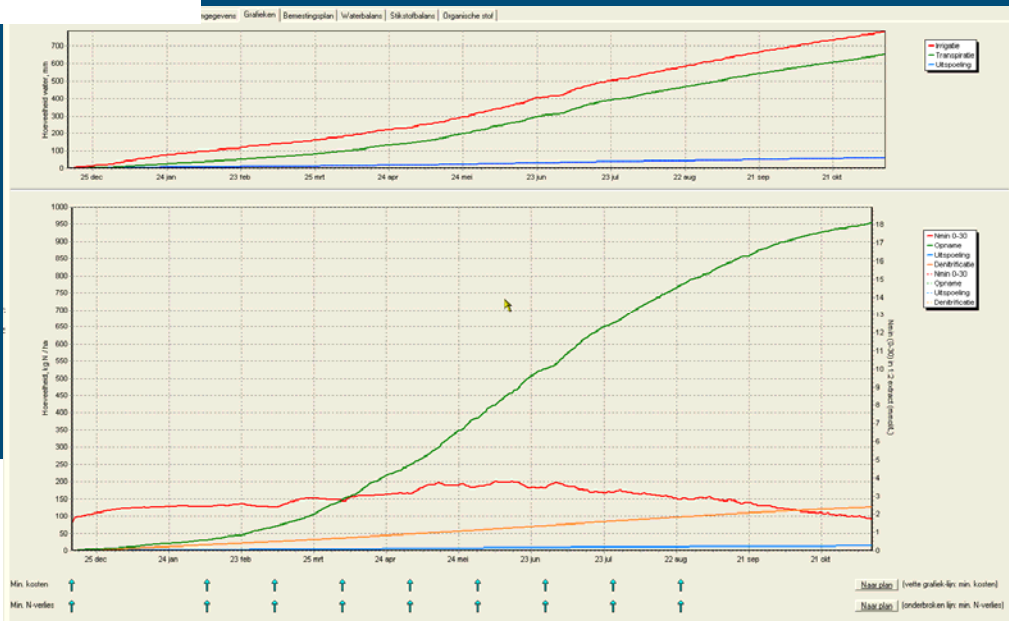
inimaal N-verlies

******* BEMESTINGSPLAN **********

| Type | Naam van de meststof | Datum | ton/ha | N, kg/ha |
|---|---|---|---|---|
| - | bodem o.s. | - | 105.000 | 1680 |
| gewasresten | komkommer_rest | - | 30.800 | 77 |
| compost | groencompost | 15-dec-04 | 53.383 | 250 |
| hulp | 13 x x Verenmeel | 09-feb-05 | 0.500 | 65 |
| hulp | 13 x x Verenmeel | 09-mrt-05 | 1.558 | 202 |
| hulp | 13 x x Verenmeel | 06-apr-05 | 1.375 | 179 |
| hulp | 13 x x Verenmeel | 04-mei-05 | 1.955 | 254 |
| hulp | 13 x x Verenmeel | 01-jun-05 | 1.446 | 188 |
| hulp | 13 x x Verenmeel | 29-jun-05 | 1.162 | 151 |
| hulp | 13 x x Verenmeel | 27-jul-05 | 0.706 | 92 |
| hulp | 13 x x Verenmeel | 24-aug-05 | 0.766 | 100 |
| compost | groencompost | hist. over: | 80.366 | 353 |
| compost | groencompost | hist. over: | 69.357 | 304 |
| compost | groencompost | hist. over: | 62.291 | 273 |

******* EIGENSCHAPPEN van de toegediende meststoffen **********

Recommended applications



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# To conclude.. Organic greenhouse crops

- Tight up by many rules and regulations
- Main remaining bottle necks:
  - Crop rotation too limited
  - N and P imbalanced supply
  - Reduction in leaching imply salinity
  - Soil born diseases
  - Zero emission from root zone
- Challenges and Chances:
  - Convince growers to use DSS organic matter
  - Meeting the standards for sustainable horticulture
  - Fine tuning (N) supply and demand
  - Controlled irrigation (using innovative tools)
  - Search for fertilizers low in residual salts

*Lots of work lays ahead*

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