Nutrient management of soil grown greenhouse crops.

Wim Voogt, Wageningen UR Greenhouse Horticulture

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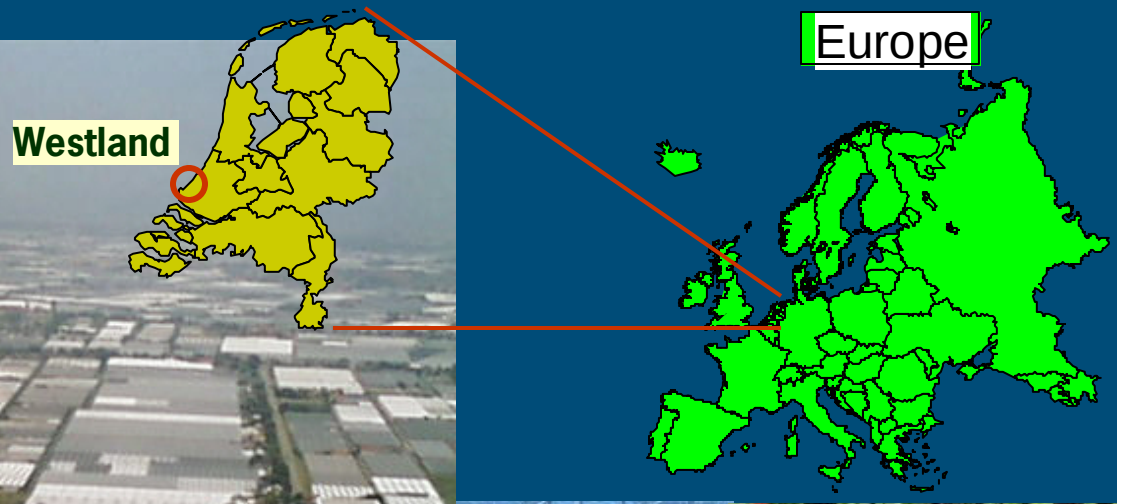
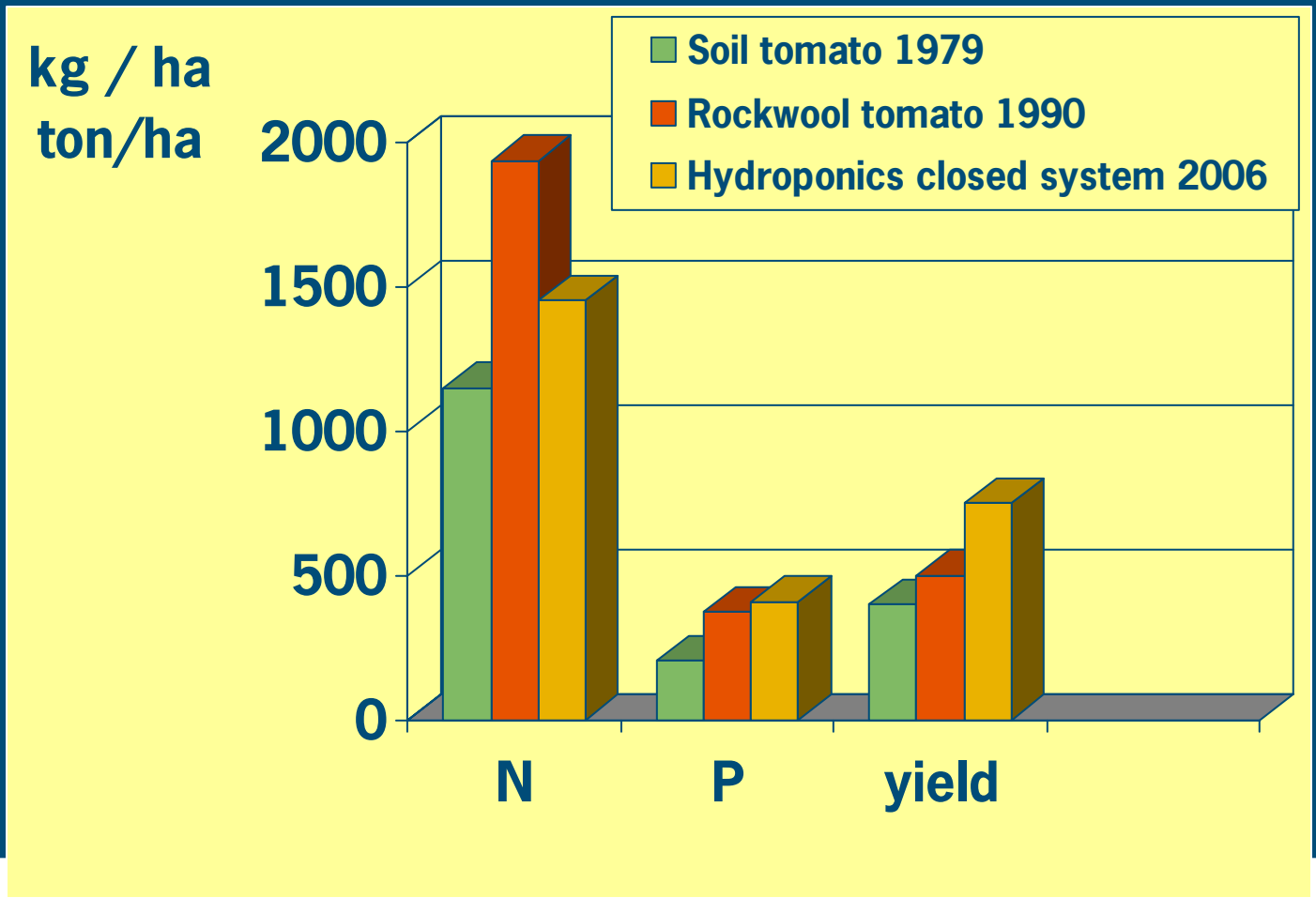
Intensive horticulture in the Netherlands



to total costs.

Fertiliser use in greenhouse crops



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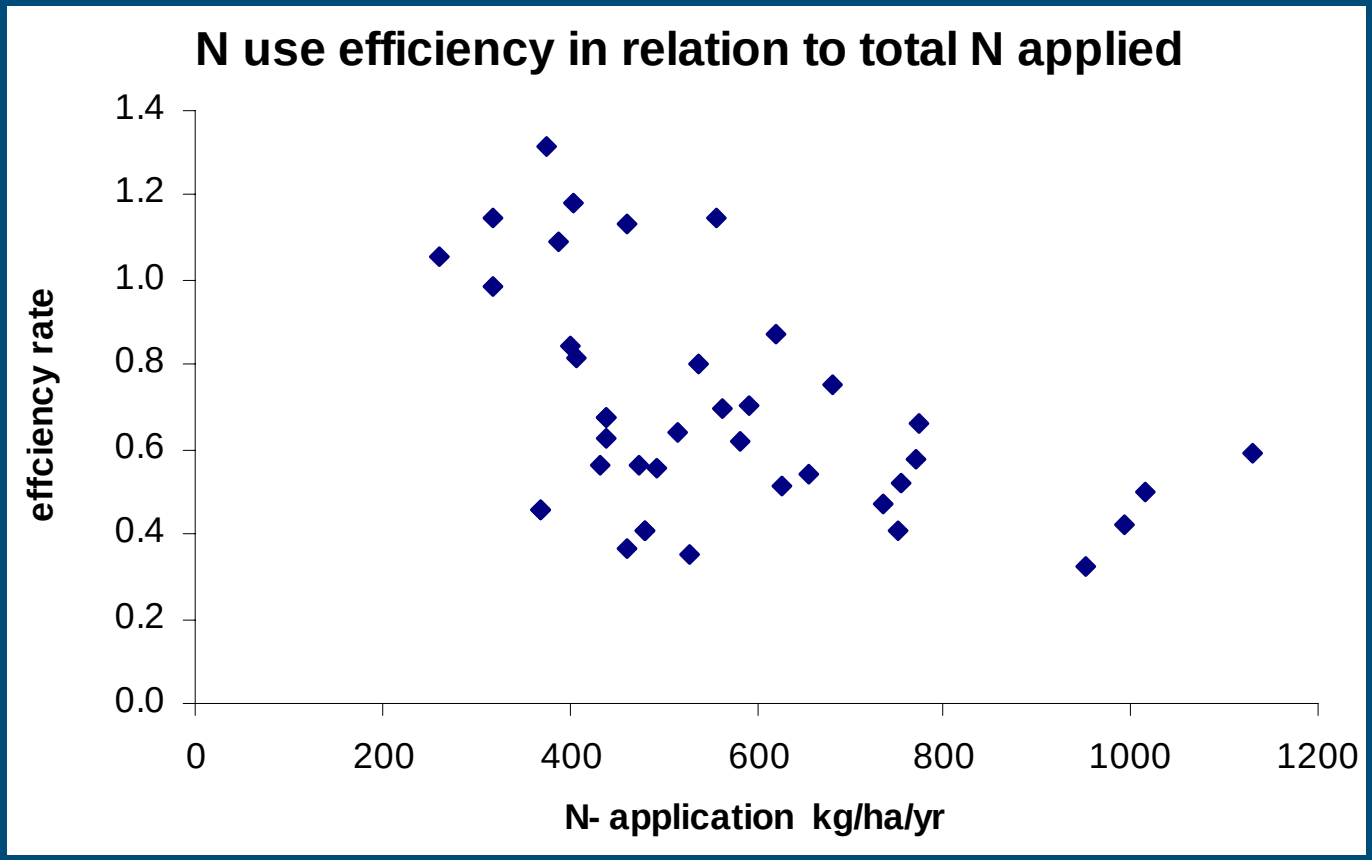
Low efficiency !!



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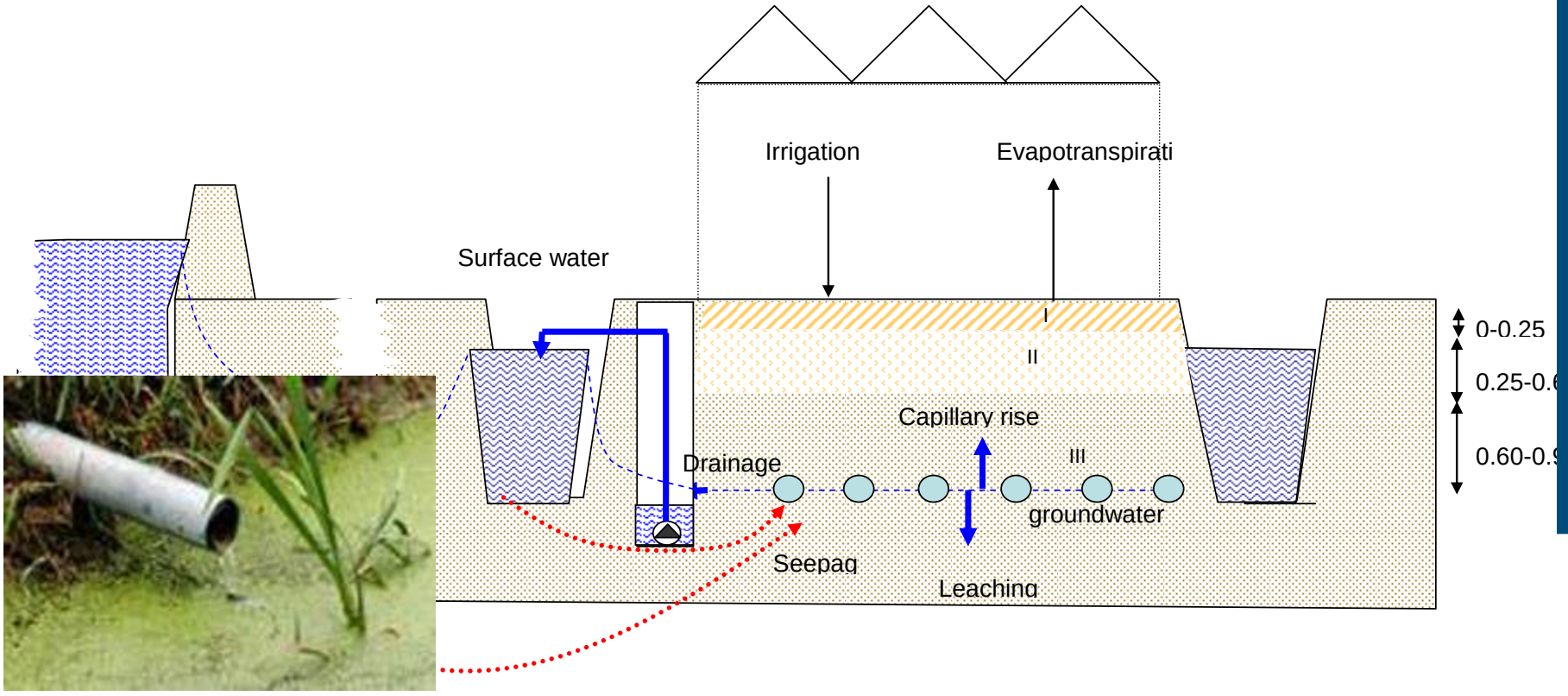
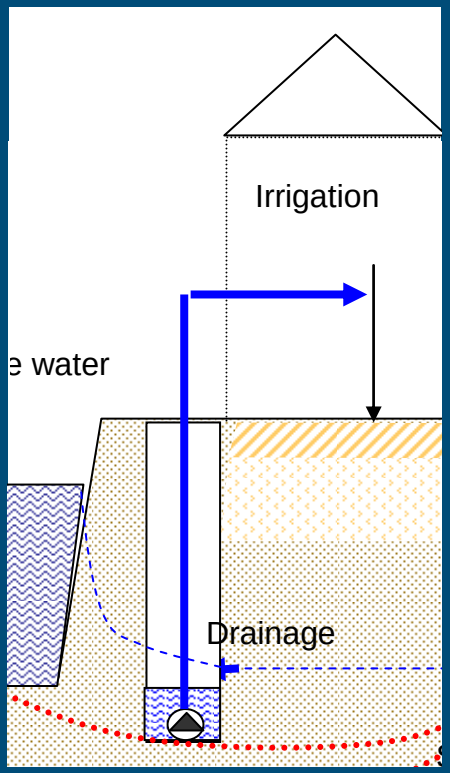
Dutch greenhouse system

Greenhouse system



Re-use of drainage water

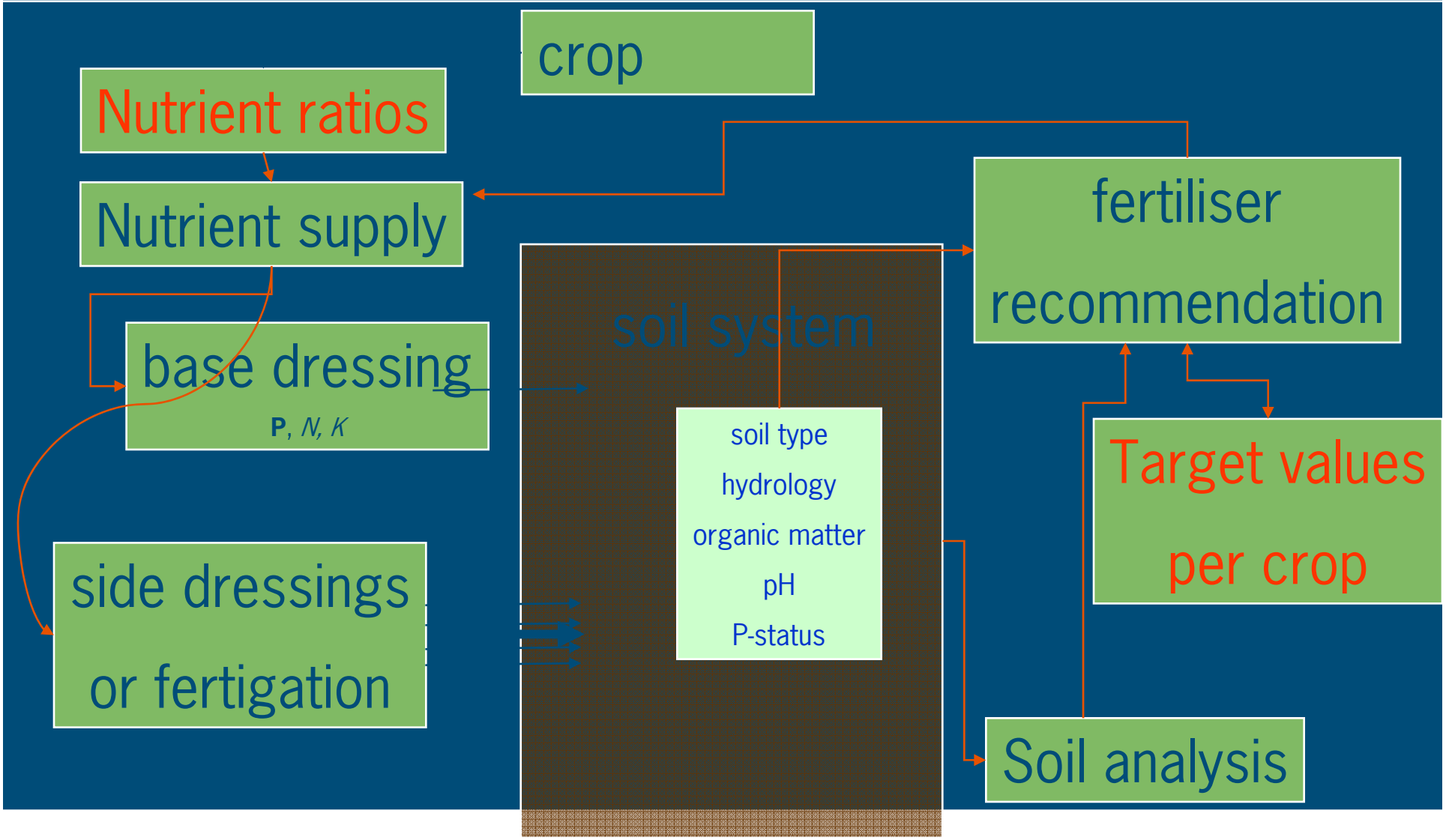


- High efficiency water and fertilisers
- Quantity problem
  - Periodically too much drain water
- Quality problem
  - Brackish groundwater

Fertilisation soil grown crops

- Basic judgment and recommendation
  - soil pH → liming
  - organic matter status → organic fertiliser
  - salinity → rinse
- Mineral status and recommendation

Fertiliser recommendation system



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Organic inputs

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

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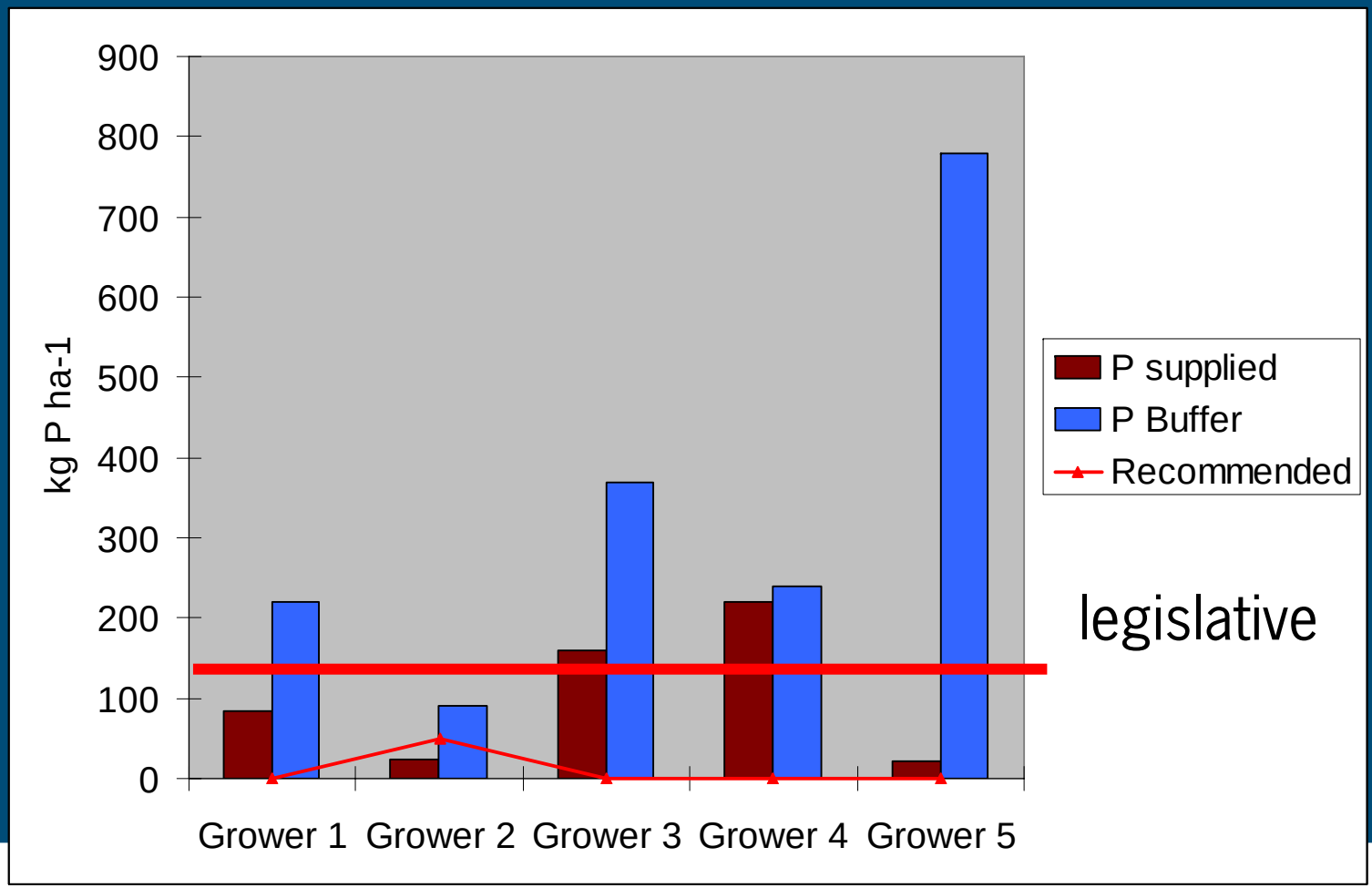
P supply in relation to available P in soil (buffer)

more supply than needed



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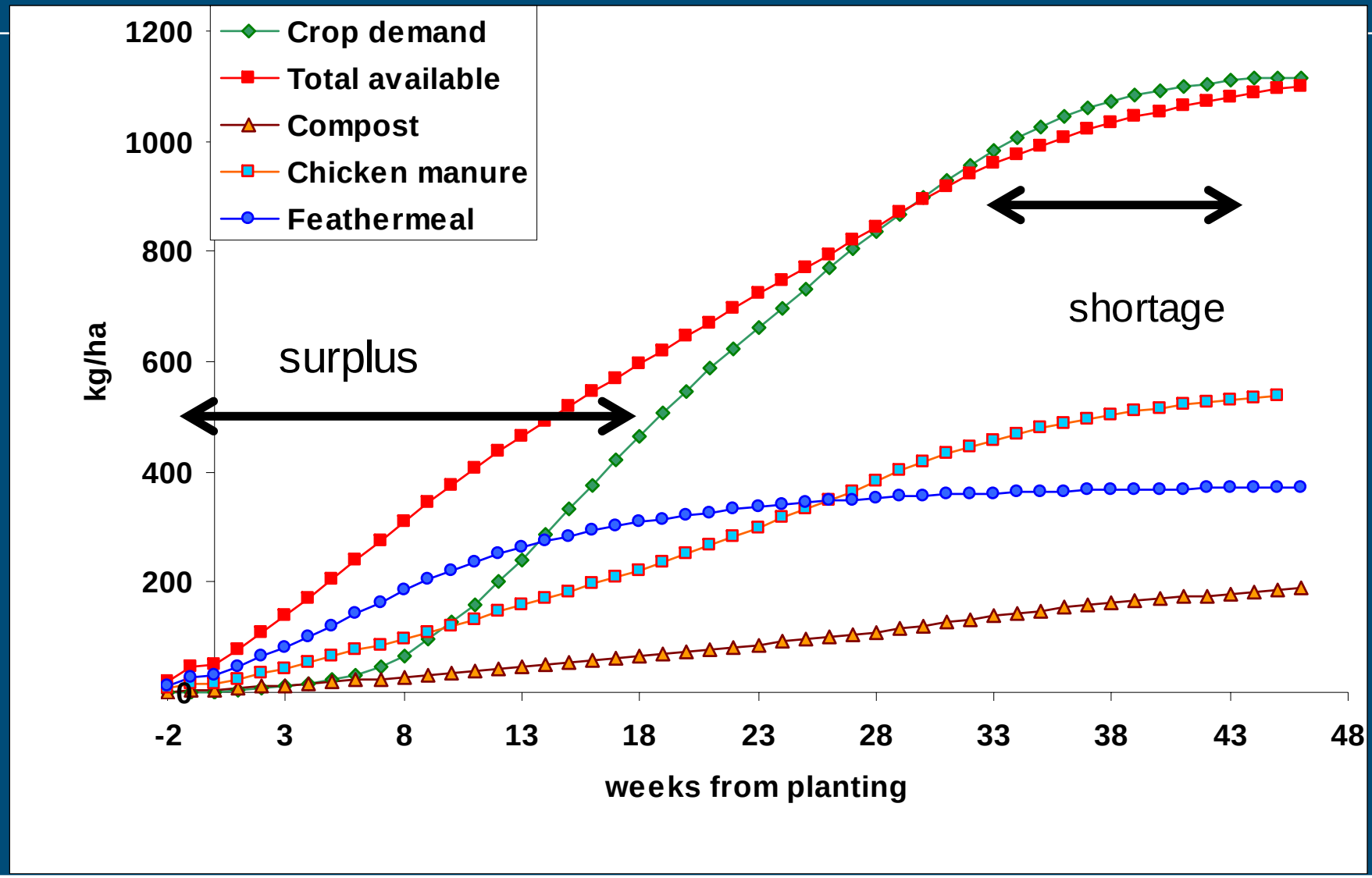

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Decision support model for organic matter management

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

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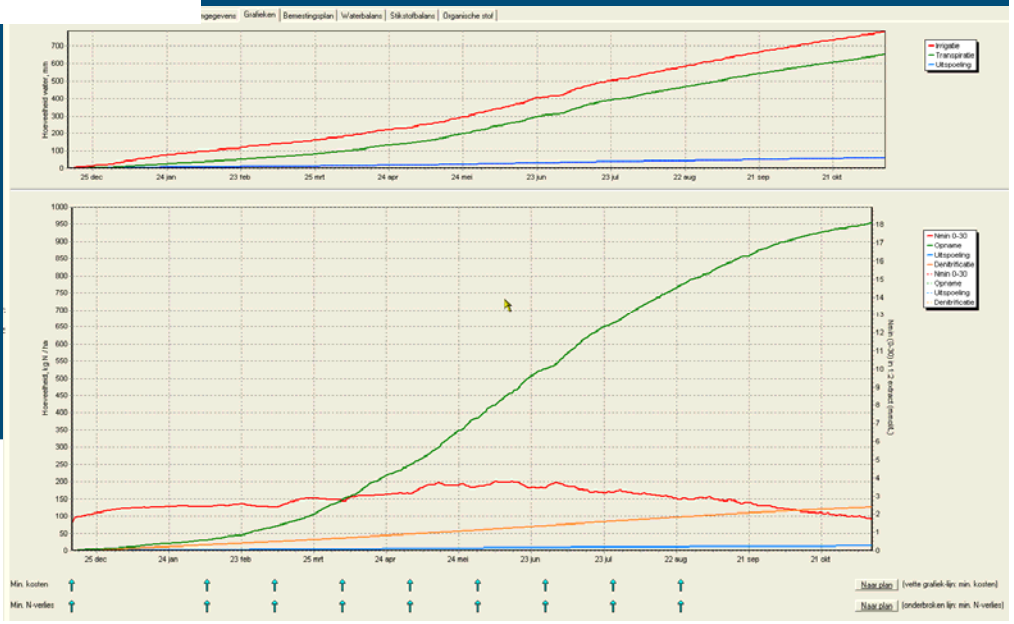
Example output

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 **********



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Fertigation in current practice

- Nutrient control
  - Nutrient solutions
  - Target values in soil
  - Crop stage adjustments
  - Soil type adjustments
- EC control
- pH management
- Tuning supply and demand

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Nutrient solutions

Composition of the basic nutrient solution for fertigation for some greenhouse crops

	Nutrient solution mmol l^{-1}					
Crop	**NH4**	**K**	**Ca**	**Mg**	**NO3**	**SO4**
Tomato	0.4	5	2	1.5	9.4	1.5
Cucumber	0.9	3.5	2	1	8.4	1
Sweet Pep	0.4	5	2	1	8.4	1
Rose	0.9	3.5	2	1.1	8.1	1.1

Adjustments water quality

	Nutr. Sol.	Water	Adjusted nutr. Sol.
	mmol/l	mmol/l	mmol/l
NH4	0.4		0.6
K	5		7.5
Ca	2	3	0
Mg	1.5	1	0.7
NO3	9.4		12.4
SO4	1.5	2	0
Na		2.5	0
Cl		2.8	0

P supply

- Only by base dressing

P distribution in vertical direction as function of application rate and way of application (by fertigation or base dressing) Van den Bos, 1996

		Fertigation			Base dressing		
		P as kg P/100 m2					
soil depth cm	0	1	2	3	1	2	3
0-12.5	0.10	0.15	0.25	0.29	0.19	0.23	0.25
12.5 - 25	0.12	0.10	0.13	0.11	0.21	0.19	0.17
25-37.5	0.15	0.14	0.13	0.13	0.17	0.16	0.19
37.5-50	0.09	0.08	0.1	0.08	0.08	0.09	0.08

specifications

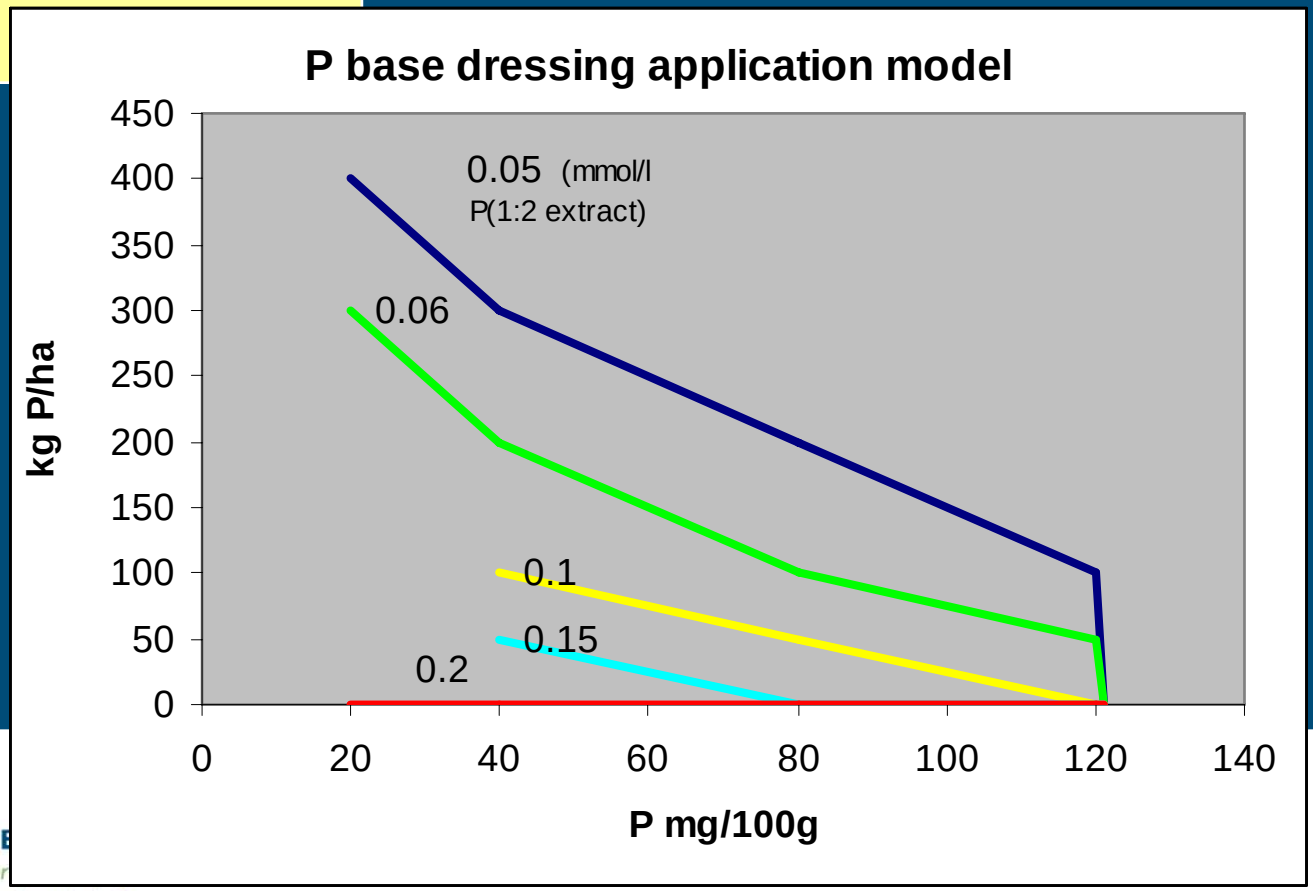
P

just base dressing

Soil analyis:

P-Al method (capacity)

Water extraction (intensity)



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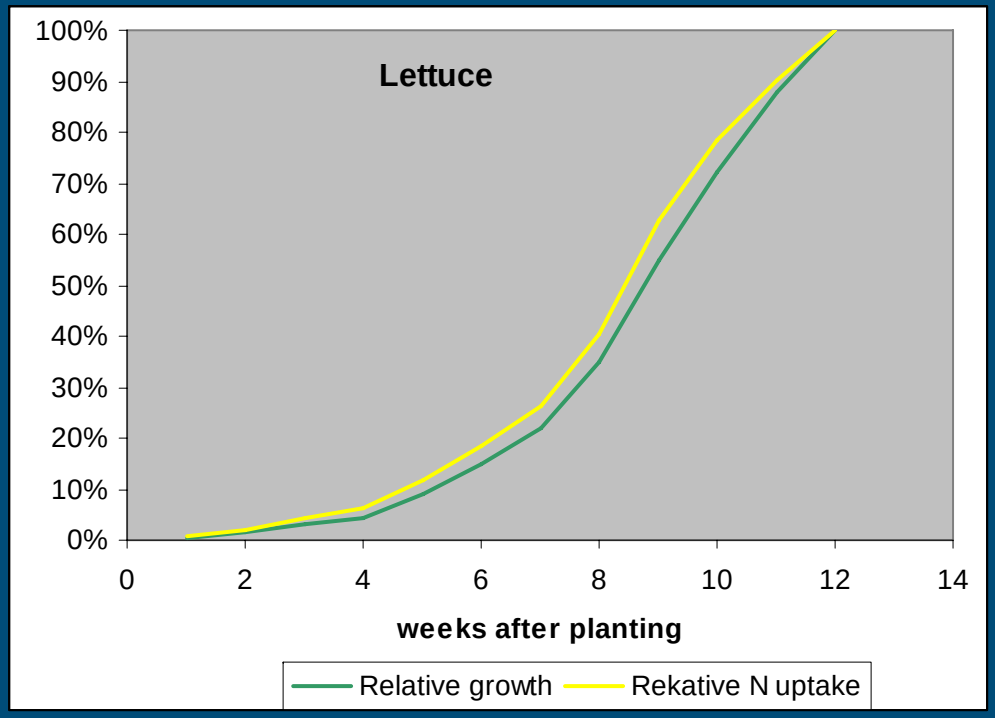
Tuning supply and demand



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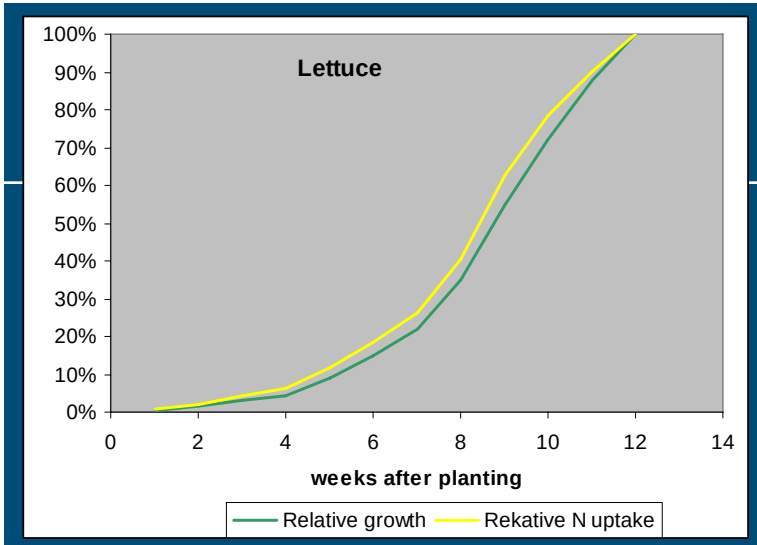
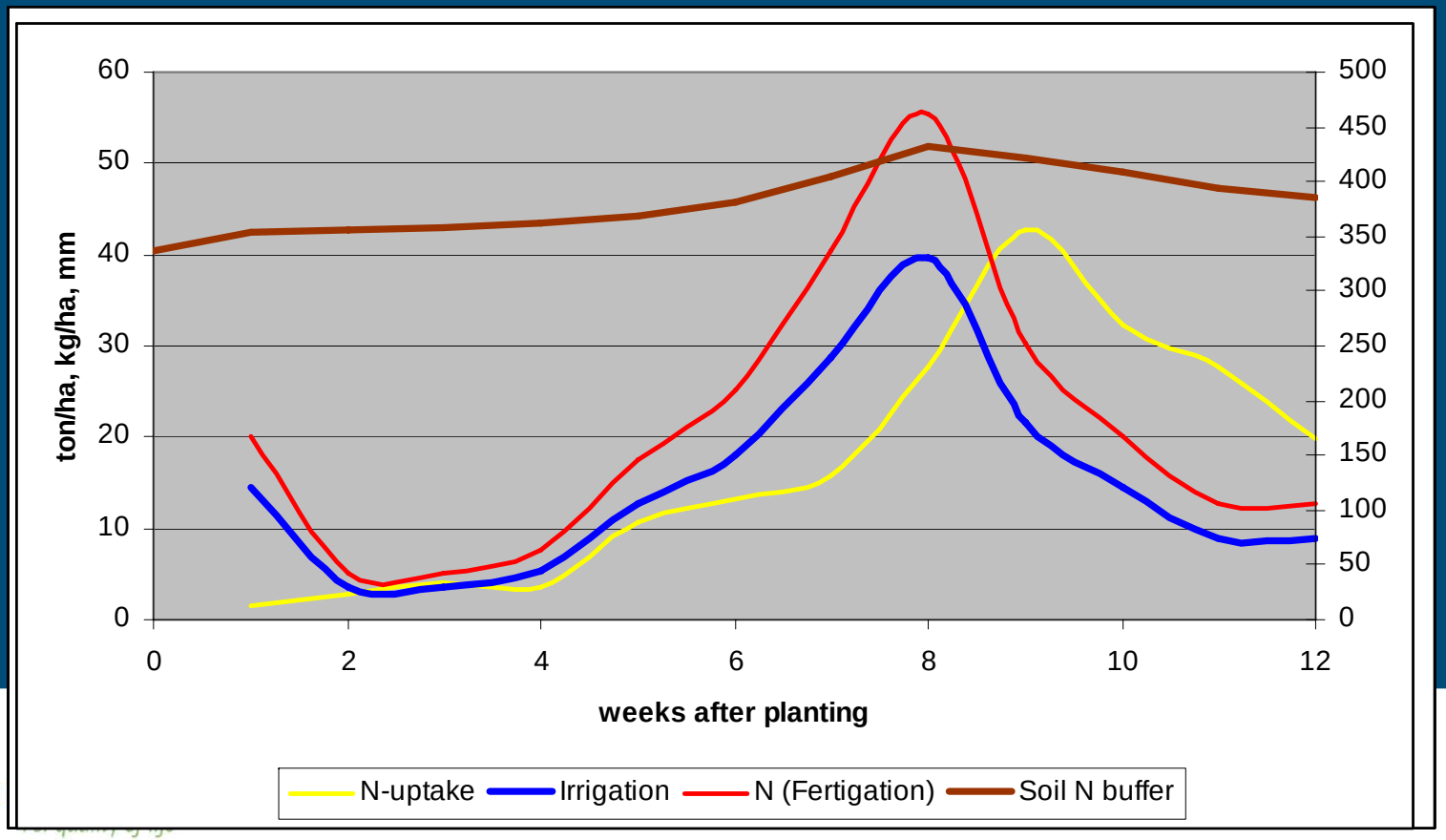

Lettuce
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
2
4
6
8
10
12
14
weeks after planting
Relative growth
Rekative N uptake


ton/ha, kg/ha, mm
60
50
40
30
20
10
0
500
450
400
350
300
250
200
150
100
50
0
0
2
4
6
8
10
12
weeks after planting
N-uptake
Irrigation
N (Fertigation)
Soil N buffer

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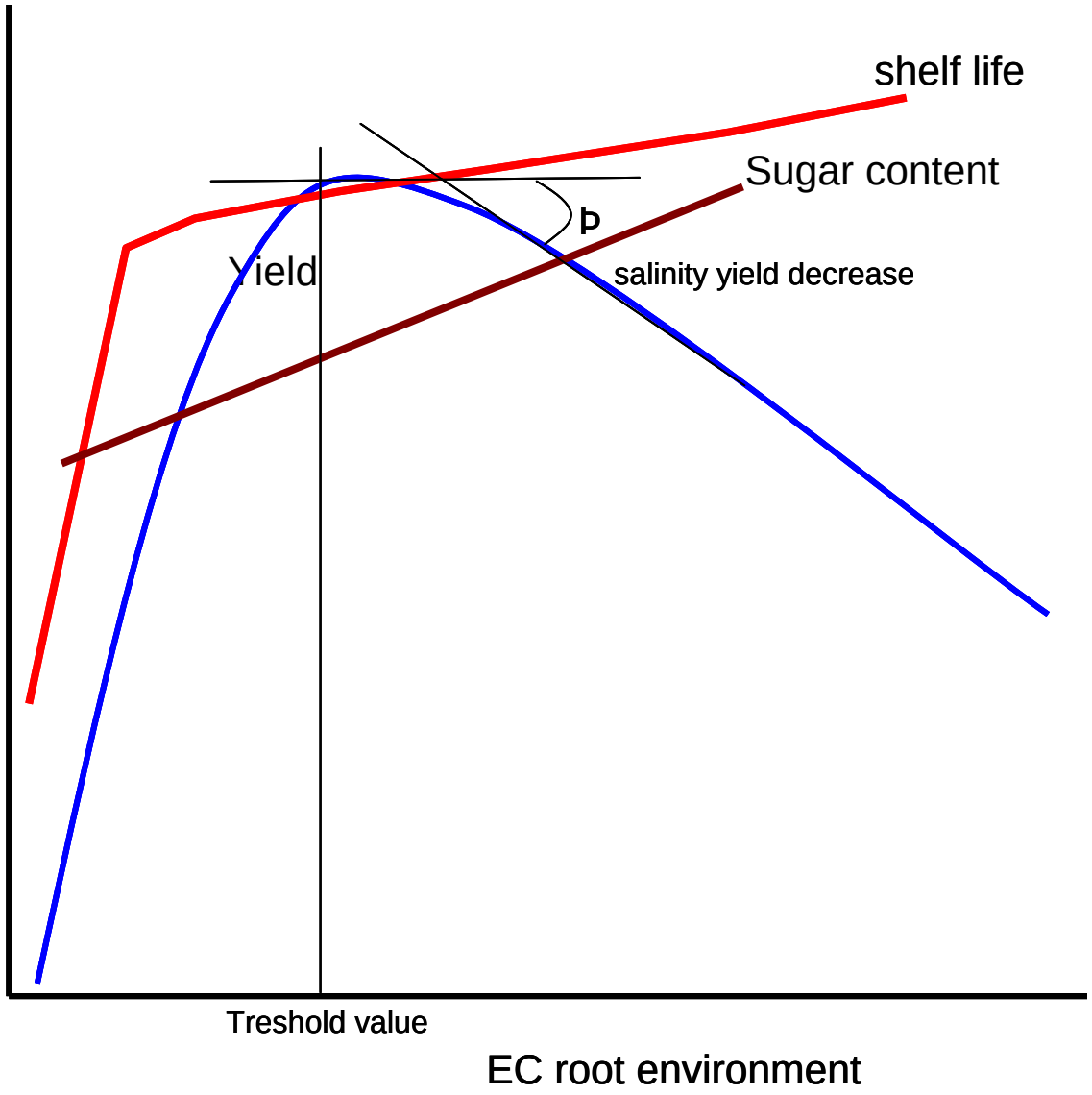
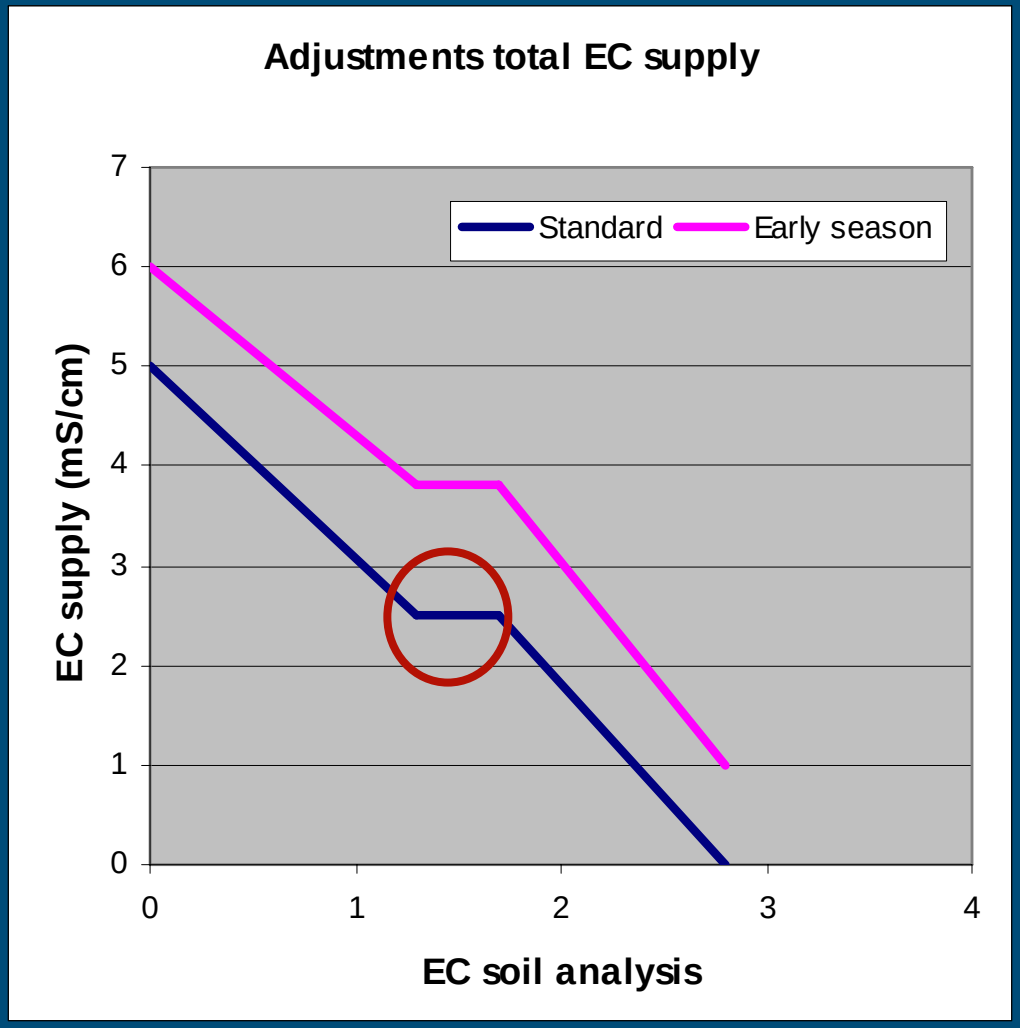
EC management

- Soil EC
- Water quality



Recommendation Supply



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EC value fertilisers

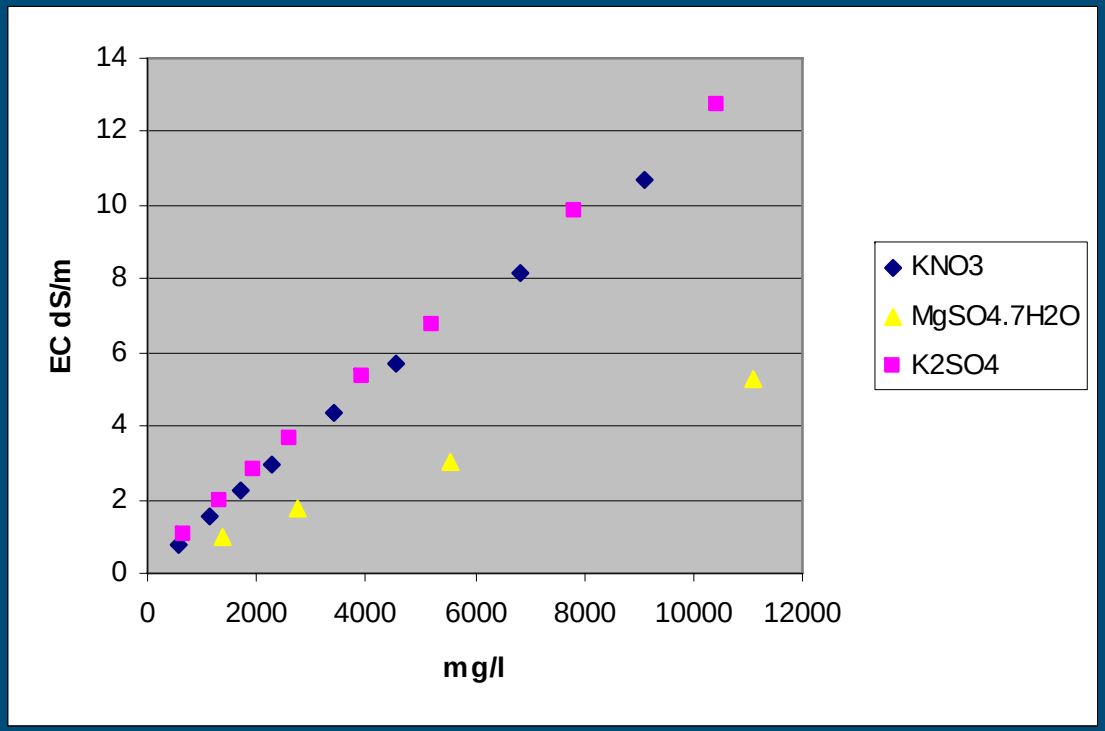

Figure 15.2 Relationship between concentrations of KNO_3, K_2SO_4 and $MgSO_4.7H_2O$ (mg l^{-1}) and the EC (dS m^{-1}) of the solution.

pH management

- pH soil determined by:
  - $CaCO_3$ content
  - Clay / loam content
  - Al and Fe oxides
  - Organic matter
- pH root zone determined by
  - Plant activity
  - Microorganisms

pH rhizosphere

- NH_4 : NO_3 ratio

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N form	Soil				Young leaves	
					Bismut	
	$CaCO_3$	pH	Ca	Mg	Fe	Mn
100% NO_3	3.6	7.4	0.8	0.4	0.8	0.25
75% NO_3 and 25% NH_4	2.7	6.6	1.2	0.5	0.83	0.35
50% NO_3 and 50% NH_4	2	6.3	2.7	0.8	0.91	1.13
75% NO_3 and 25% urea	3.4	7.1	1	0.4	0.82	0.24
50% NO_3 and 50% urea	3.2	7	1.2	0.4	0.81	0.29

Effect of N form on carbonate, the pH Ca and Mg

and the concentration Mn and Fe in young gerbera leaves (mmol kg-1 dry matter).

Sonneveld and Voogt 1990

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Fertigation

- Over-irrigation cause N-loss

Tuning supply and demand

The fertigation model

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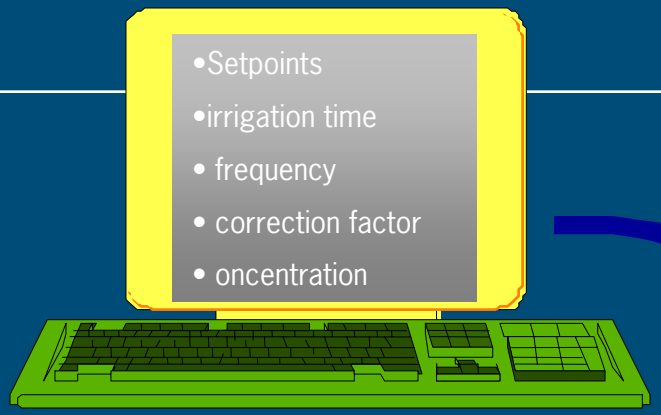
Aim

- Avoidance vertical flow of water
- Supply to crop demand
  - Water supply adjusted to water uptake
  - Nutrient supply attuned to crop growth

- **fertigation** model
  - **Ferti**lisation uptake model
  - Irri**gation** transpiration model

Fertigationmodel



OUTPUT

INPUT

radiation

heating temperature

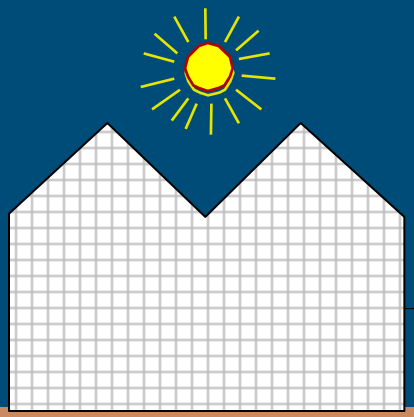
airtemperature

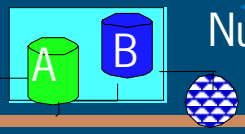
plantsize

Irrigation

quantity

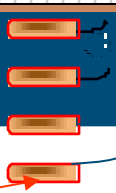
frequency





Nutrient supply unit

pump



Soil moisture content

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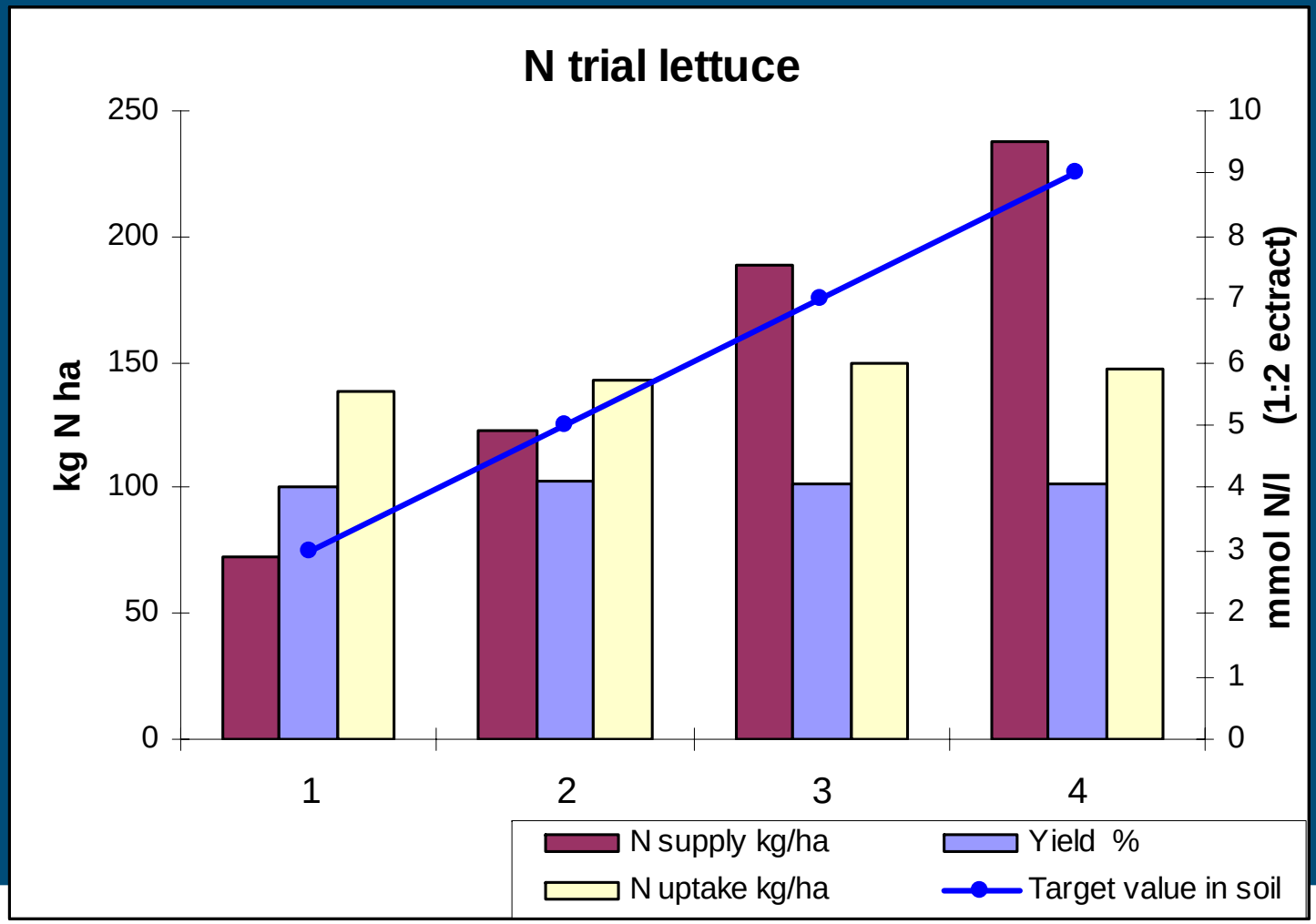
Reduction of N



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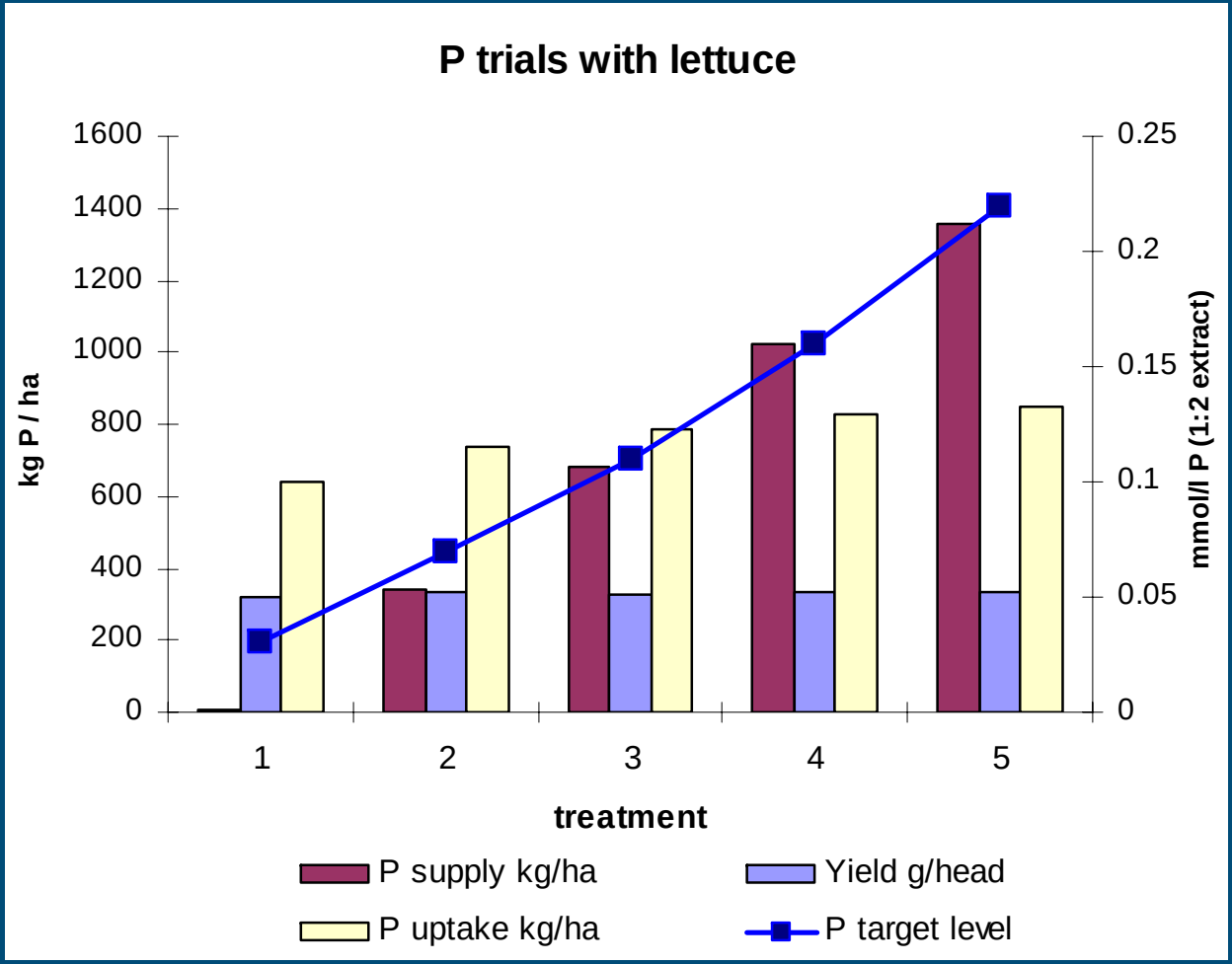
Redcution of P



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Conclusion

- Current fertigation strategy not very sustainable
- Complex hydrology; re-use drainage water not general applicable
- Supply tuned to crop requirement best solution *Fertigation model*
- Further improvements by reduction N and P in soil
- Bottle- necks:
  - High standards for water quality
  - Unequal distribution of water

For those who want to know more….

Cees Sonneveld
Wim Voogt

Plant Nutrition of Greenhouse Crops

Greenhouse cultivation is noted for its high uptake of minerals, consistent climatic conditions, exclusion of natural precipitation and control of salt accumulation. Acknowledging that plant nutrition in greenhouse cultivation differs in many essentials from field production, this volume details specific information about testing methods for soils and substrates in a greenhouse environment. It does so while offering a universally applicable analysis. This is based on the composition of the soil and substrate solutions, methods for the interpretation of tissue tests, and crop responses on salinity and water supply in relation to fertilizer application. Fertilizer additions, related to analytical data of soil and substrate samples, are presented for a wide range of vegetable and ornamental crops. The subject is especially apt now as substrate growing offers excellent possibilities for the optimal use of water and nutrients, as well as the potential for sustainable production methods for greenhouse crops.

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Sonneveld · Voogt

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