Future prospects for the use of micronutrients in sustainable agriculture

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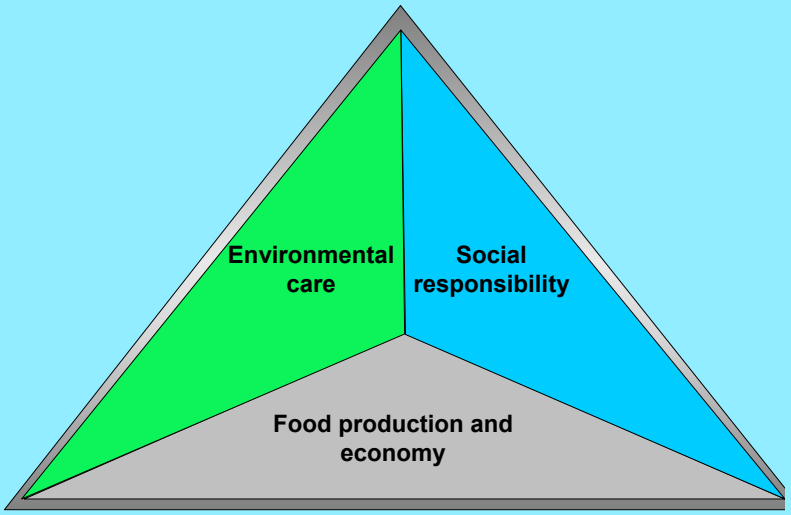
Sustainable land management

Sustainable land management is a system which "simultaneously maintains or enhances production, reduces the production risk, protects the potential of natural resources and prevent degradation of soil and water quality, be economically viable and be socially acceptable."

(Smyth and Dumanski, 1993)

Sustainable Development: Agenda 21
Ecological, Social and Economical Aspects Go Hand in Hand



Source: United Nations

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Social responsibility

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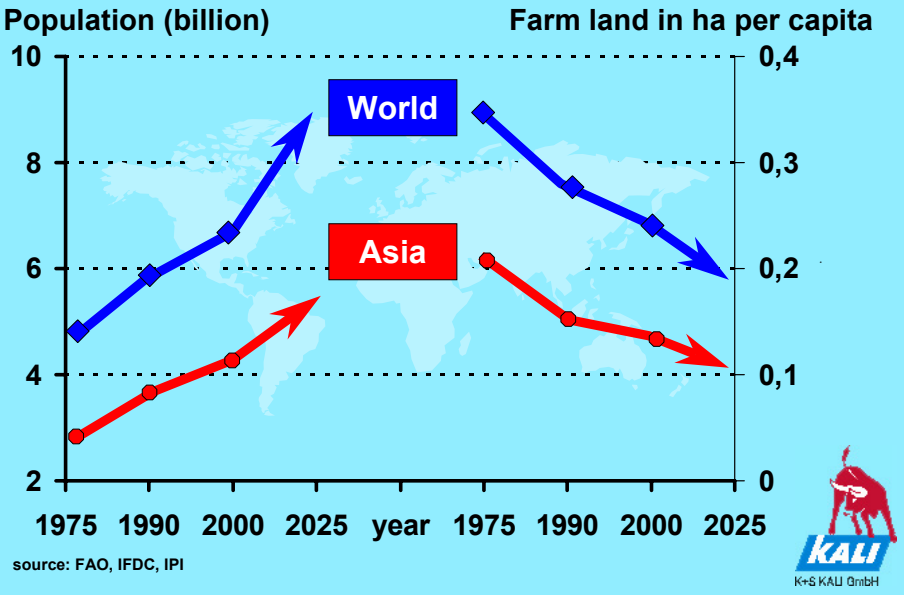
Population Growth and available Land



source: FAO, IFDC, IPI

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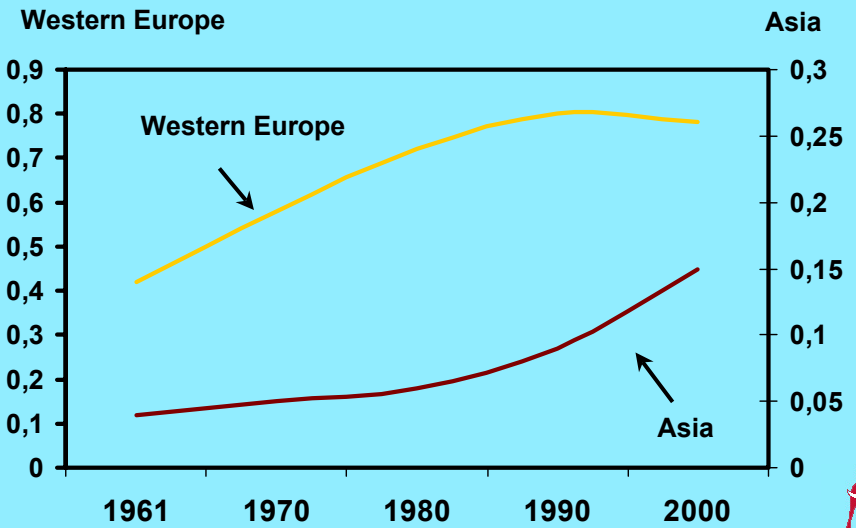
Diet changes in selected Regions
(Ratio meat : cereals for food)



source: FAO, IFPRI

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Environmental

care

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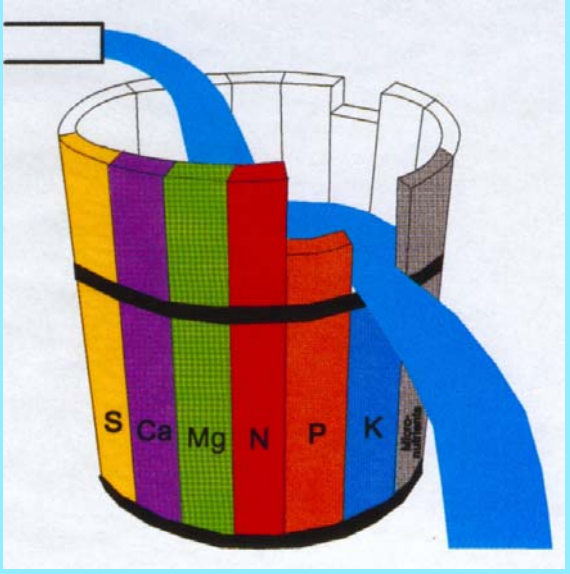
Optimum Nutrient Supply – The Law of Minimum



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Inherent constraints to productivity: World soil resources and their major limitations

(% of total land affected)

Region	Drought	Mineral stress*	Shallow depth	Water excess	Perma-frost	No serious limitation
North America	20	22	10	10	16	22
Central America	32	16	17	10	-	25
South America	17	47	11	10	-	15
Europe	8	33	12	8	3	36
Africa	44	18	13	9	-	16
South Asia	43	5	23	11	-	18
N. & C. Asia	17	9	38	13	13	10
Southeast Asia	2	59	6	19	-	14
Australia	55	6	8	16	-	15
World	28	23	22	10	6	11

*Nutrient deficiencies or toxicities

Source: FAO/Unesco soil map of the world

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Reasons for micronutrients deficiencies

- increased nutrient demands from intensive cropping and high yields

-enhanced production of crops on marginal soils with low levels of micronutrients

-increased use of high analysis fertilizers with low amount of micronutrient „contamination“

- loss of micronutrients by erosion or leaching

- unfavourable conditions for micronutrient uptake (pH redox potential, bioavailability)

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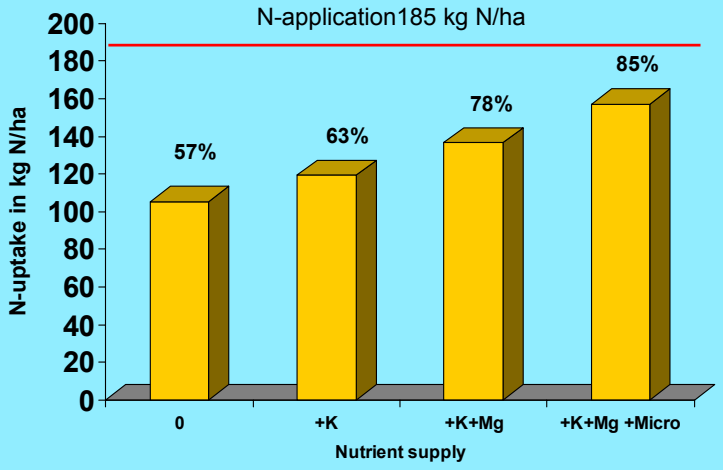
Impact of balanced fertilization on the N uptake of winter wheat



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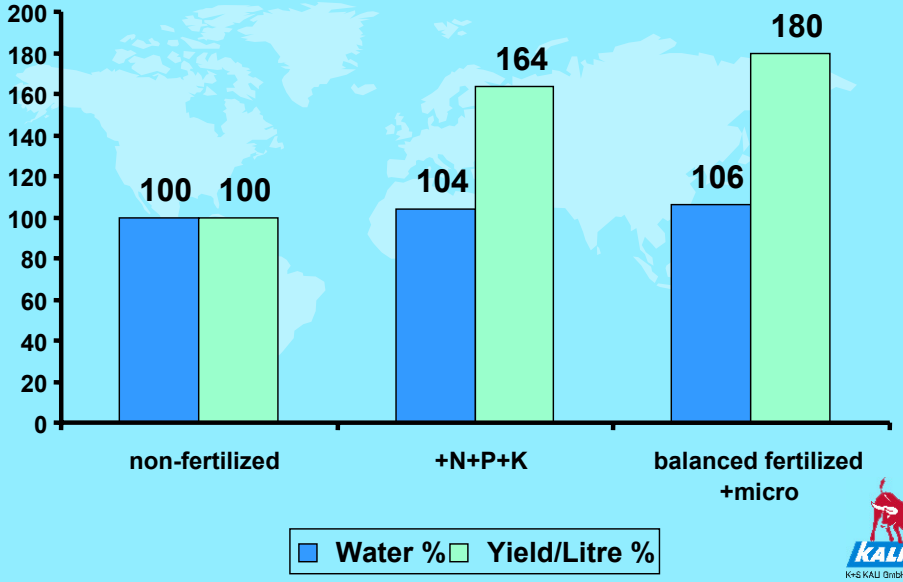
Water Efficiency of Crops subject to Fertilization



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Food production and economy

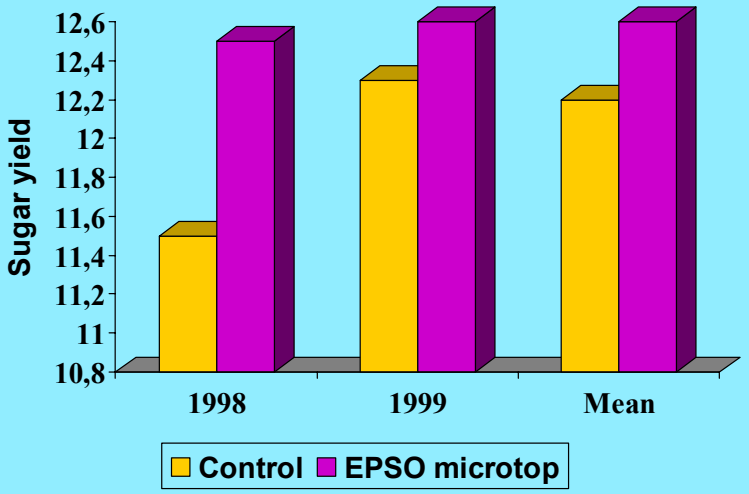
Fertilization experiment: Application of B and Mn in sugar beets

Field experiment at 7 sites in 2 years

Treatments:

1. Control	without micronutrients application
2. EPSO microtop	2 applications (0,25 kg B and Mn foliar application) end of July)

Impact of foliar application of B and Mn on the sugar yield of sugar beets in t/ha in 2 years



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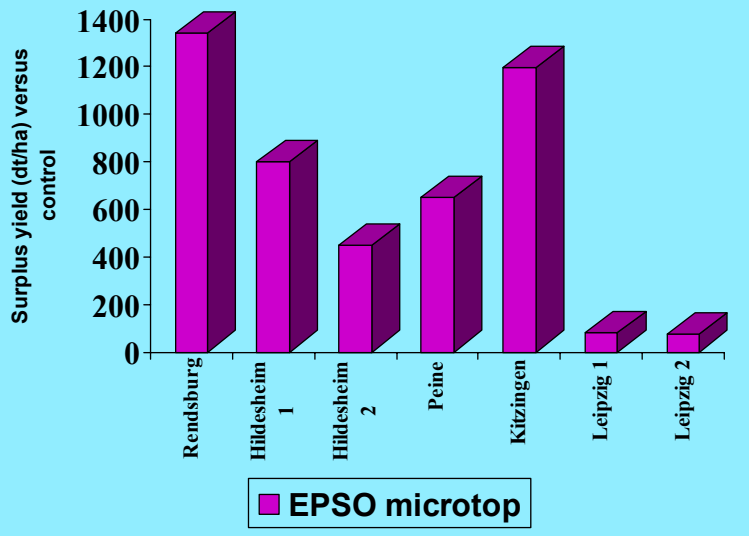
Impact of B and Mn application on the sugar beet yield at 7 sites in 1998



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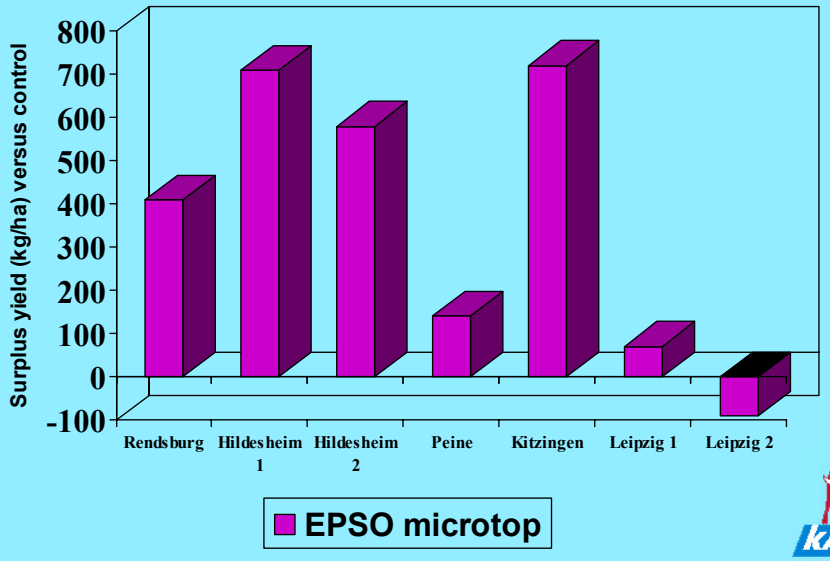

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Questions:

1. Correlations between the surplus yields and the concentrations of B und Mn in the soil?

2. Effect of micronutrient application on the B and Mn leaf concentrations?

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Correlations between the surplus yields and the concentrations of B und Mn in the soil?

Coefficient of correlation R^2

B	1998	0,16
	1999	0,12
Mn	1998	0,39
	1999	0,17

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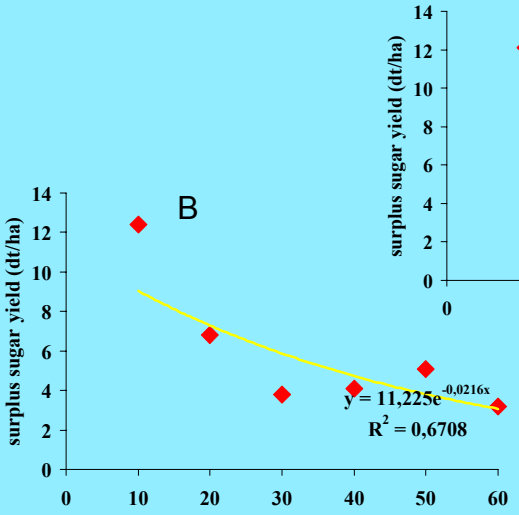
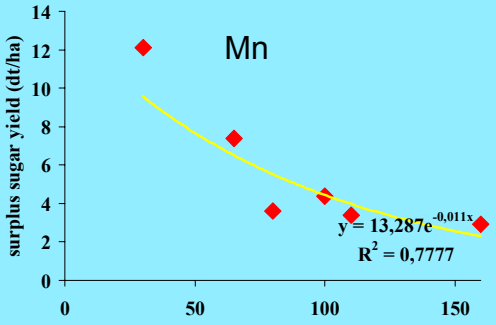
Influence of Mn and B application on sugar beet yield versus Mn- und Bor concentration in the leaves (1998)





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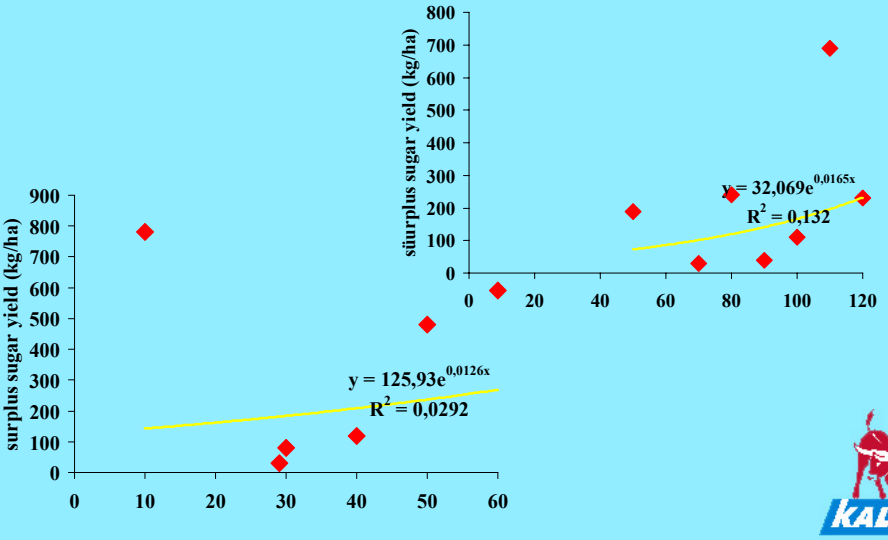

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Nutrient use efficiency: Indicators

Indicators used to determine nutrient use efficiency

Four basic questions must be answered in all assessments of fertilizer use efficiency:

- How much of the nutrients applied are taken up by the crop?
- How much *additional* yield or quality is obtained for each *additional* unit of nutrient uptake?
- To what extent can the crop benefit from the nutrients not recovered by the crop during the period of assessment?
- What is the monetary return from the nutrients applied?

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Indicators which allow answering the following questions

- ***Agronomic efficiency (AE)***
  How much additional yield do I produce for each kg of fertilizer nutrient (FN) applied?
- ***Physiological efficiency (PE)***
  How much additional yield do I produce for each additional kg of nutrient uptake?
- ***Internal efficiency (IE)***
  How much yield is produced per kg fertilizer nutrient (FN) taken up from both fertilizer and indigenous (soil) nutrient sources?
- ***Economic efficiency (EE):***
  How much additional income do I produce for the money invested in nutrient application?

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Summary I

- Use of micronutrients is a key factor for a sustainable land use management
- The effect of micronutrient use is extremly site specific (soil, climatic conditions)
- Soil testing is an inappropriate parameter to detect the micronutrient demand of crops.
- Soil concentrations are good indicators but not viable (to sumptuous and expensive).

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Summary II

- We need other parameters as decision support for micronutrient application
  Micronutrient sensor??
- For sustainable use of micronutrients not only the crop demands are important. Also the social effects and the economic output have to taken into account.
- The development of fertilizers adapted to the site specific conditions is necessary.

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Conclusion

- Sustainable agriculture is based on the five columns:
  - productivity
  - stability
  - protection
  - viability
  - acceptability
- Low micronutrient supply of soils is a major course of unsustainability
- Current management practices further deplete the nutrient status of the soils
- Balanced fertilization is a key factor to improve sustainability, stability and protection
- Viability and acceptability which depends on a large extent on socio-economic factors are at least favoured by balanced fertilization

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Sustainable application rate of fertilizers

1. Micronutrient demand of the crop
2. +/- correction of the Micronutrient status of the soil
3. – Micronutrients available from organic manures

   = Biological demand for nutrients from fertilizers.
4. – Restriction to the economic optimum
5. – Keeping within the legal limit

= **Recommended application rate**