Long-term potassium balance on field, farm and country levels

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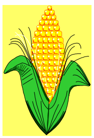
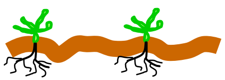
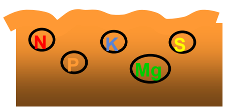
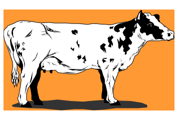
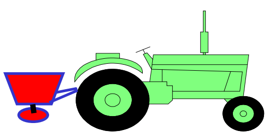
Determination of adequate fertilizer supply

1. Nutrient demand of plants
2. +/- Correction of soil nutrient level
3. + sustainable effects of nutrients
4. – Nutrients available from organic fertilizers

   = Nutrient demand from mineral fertilizers
5. – Limitation by the economic optimum
6. – Environmental restrictions

   = Recommended fertilizer supply

How to calculate a fertilizer recommendation for sustainable plant nutrition ?

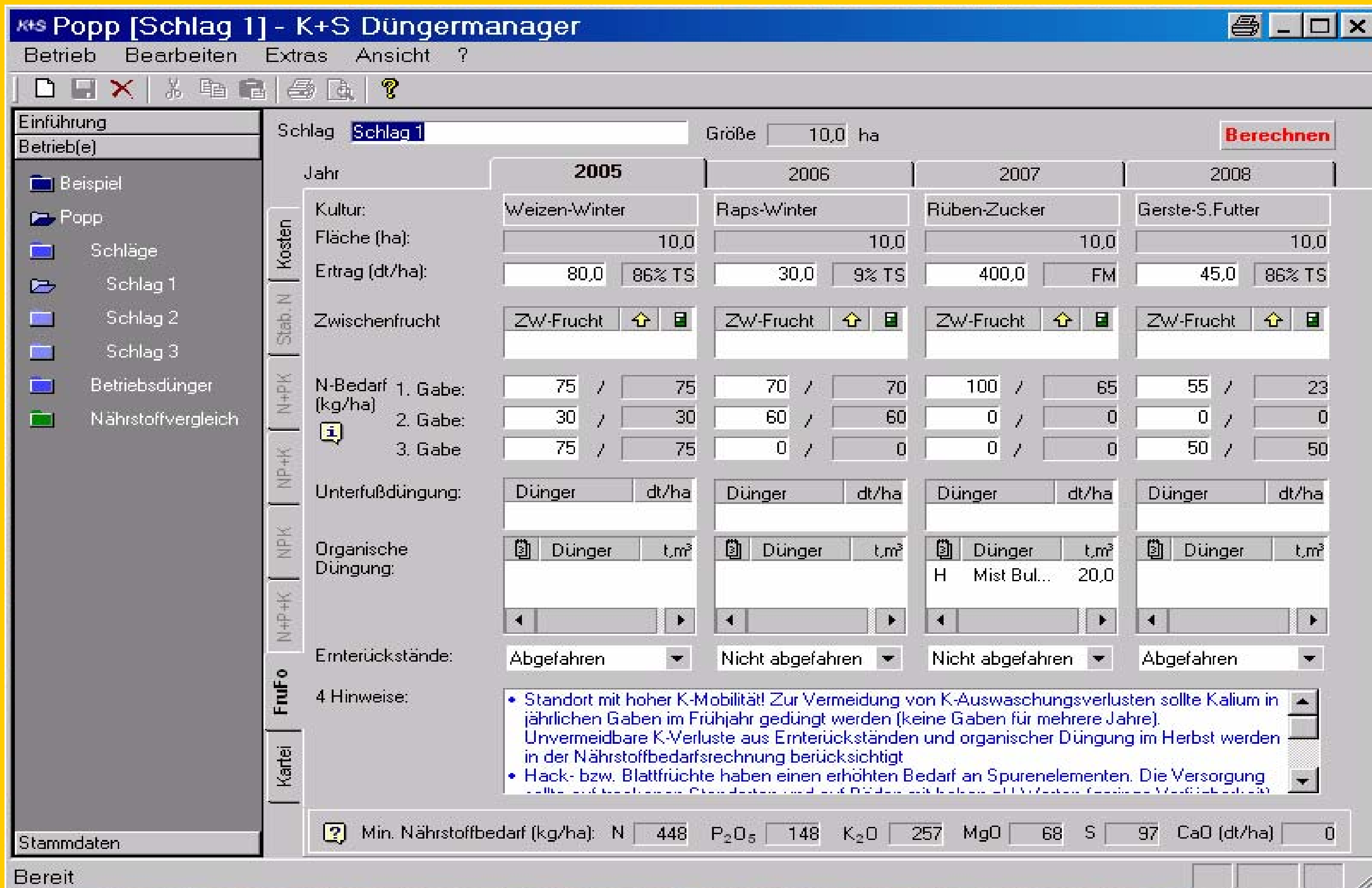
	add or subtract	Factors to consider	Example	Amount of nutrients (kg/ha)				
				N	*P_2O_5*	*K_2O*	*MgO*	*S*
		**Total nutrient uptake**	**Production of 4.5 mt/ha hybrid maize**	100	50	113	18	18
	-	**Plant residues** (roots, leaves, stalks)	**Plant nutrients recycled**	-	14	90	9	-
	+	**Soil fertility** (nutrient content in the soil for P, K, Mg & Ca)	***Removal:***	100	36	23	9	18
	-		e.g. high in P (factor 0.5) and low in K (factor 2.5)	100	18	63	9	18
	-	**Organic manures** (slurry, farmyard manure, compost, sewage sludge)	**Application of 2.5 mt/ha cow dung**	14	10	16	3	1
	=	**Remaining requirement to be supplied as mineral fertilizer**	**Amount of nutrients applied as mineral fertilizer**	**86**	**8**	**47**	**6**	**17**

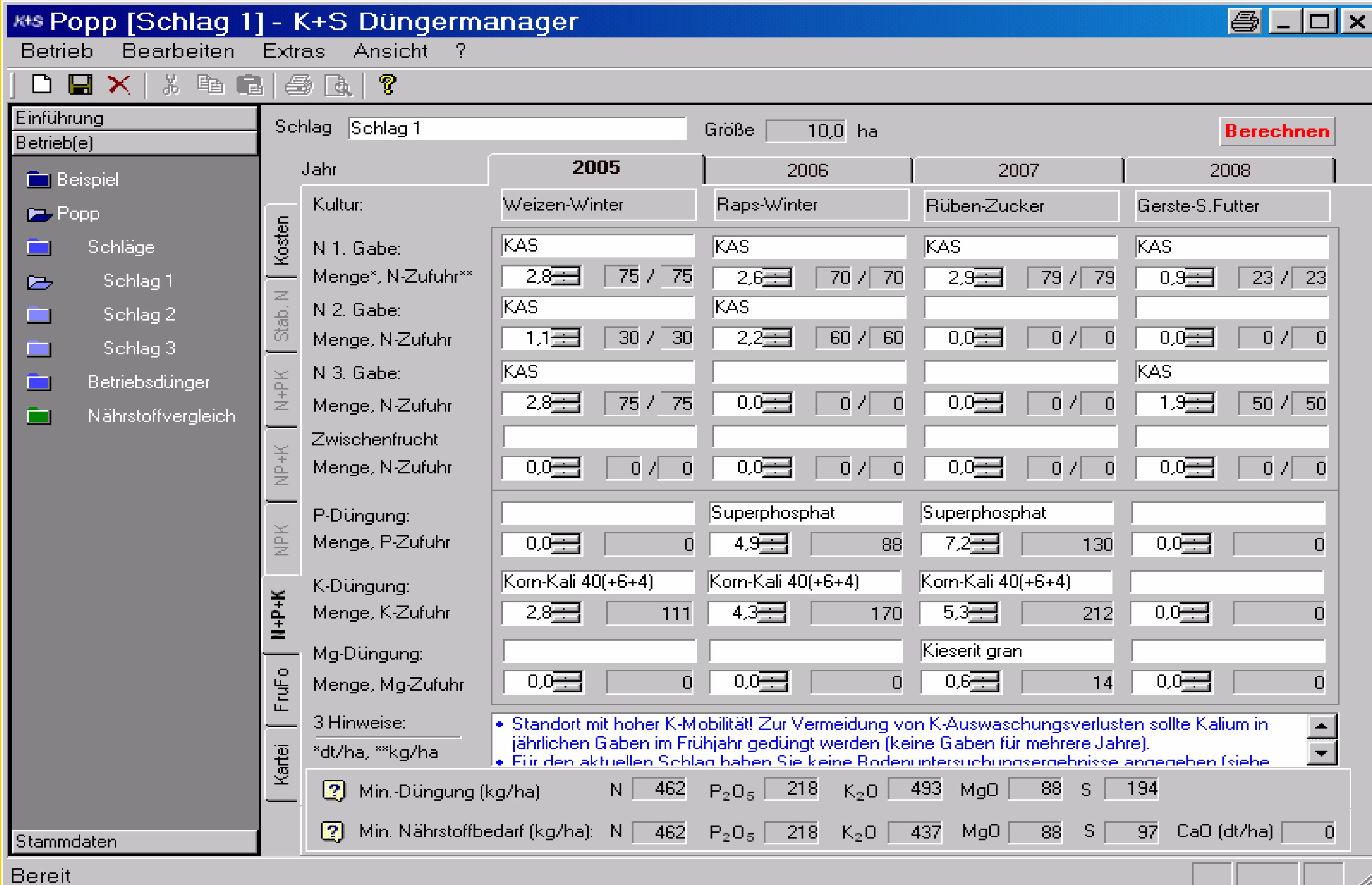
10 important parameters for fertilizer recommendations

- Nutrient requirement of the crop
- Cropping intensity (expected yield)
- Soil/climatic conditions
- Form of production (rainfed, irrigated, etc.)
- Nutrient supply by crop residues and organic manure

- Total amount of nutrients to be applied (in kg/ha N, P_2O_5 + K_2O)
- Number, timing and form of applications
- Amount of nutrients per applications
- NPK Fertilizer type/formula to be used

- @ Fertilizer rate to be applied (in kg/ha)


Popp [Schlag 1] - K+S Düngermanager
Betrieb
Bearbeiten
Extras
Ansicht
?
Einführung
Betrieb(e)
Beispiel
Popp
Schläge
Schlag 1
Schlag 2
Schlag 3
Betriebsdünger
Nährstoffvergleich
Stammdaten
Schlag
Schlag 1
Größe
10,0
ha
Berechnen
Jahr
2005
2006
2007
2008
Kosten
Stab. N
N+PK
NP+K
NPK
N+P+K
FruFo
Kartei
Kultur:
Weizen-Winter
Raps-Winter
Rüben-Zucker
Gerste-S.Futter
Fläche (ha):
10,0
10,0
10,0
10,0
Ertrag (dt/ha):
80,0
86% TS
30,0
9% TS
400,0
FM
45,0
86% TS
Zwischenfrucht
ZW-Frucht
ZW-Frucht
ZW-Frucht
ZW-Frucht
N-Bedarf (kg/ha)
1. Gabe:
75 / 75
70 / 70
100 / 65
55 / 23
2. Gabe:
30 / 30
60 / 60
0 / 0
0 / 0
3. Gabe
75 / 75
0 / 0
0 / 0
50 / 50
Unterfußdüngung:
Dünger
dt/ha
Dünger
dt/ha
Dünger
dt/ha
Dünger
dt/ha
Organische Düngung:
Dünger
t,m³
Dünger
t,m³
Dünger
t,m³
H
Mist Bul...
20,0
Dünger
t,m³
Ernterückstände:
Abgefahren
Nicht abgefahren
Nicht abgefahren
Abgefahren
4 Hinweise:
• Standort mit hoher K-Mobilität! Zur Vermeidung von K-Auswaschungsverlusten sollte Kalium in jährlichen Gaben im Frühjahr gedüngt werden (keine Gaben für mehrere Jahre).
Unvermeidbare K-Verluste aus Ernterückständen und organischer Düngung im Herbst werden in der Nährstoffbedarfsrechnung berücksichtigt
• Hack- bzw. Blattfrüchte haben einen erhöhten Bedarf an Spurenelementen. Die Versorgung
Min. Nährstoffbedarf (kg/ha):
N 448
P2O5 148
K2O 257
MgO 68
S 97
CaO (dt/ha) 0
Bereit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10,0
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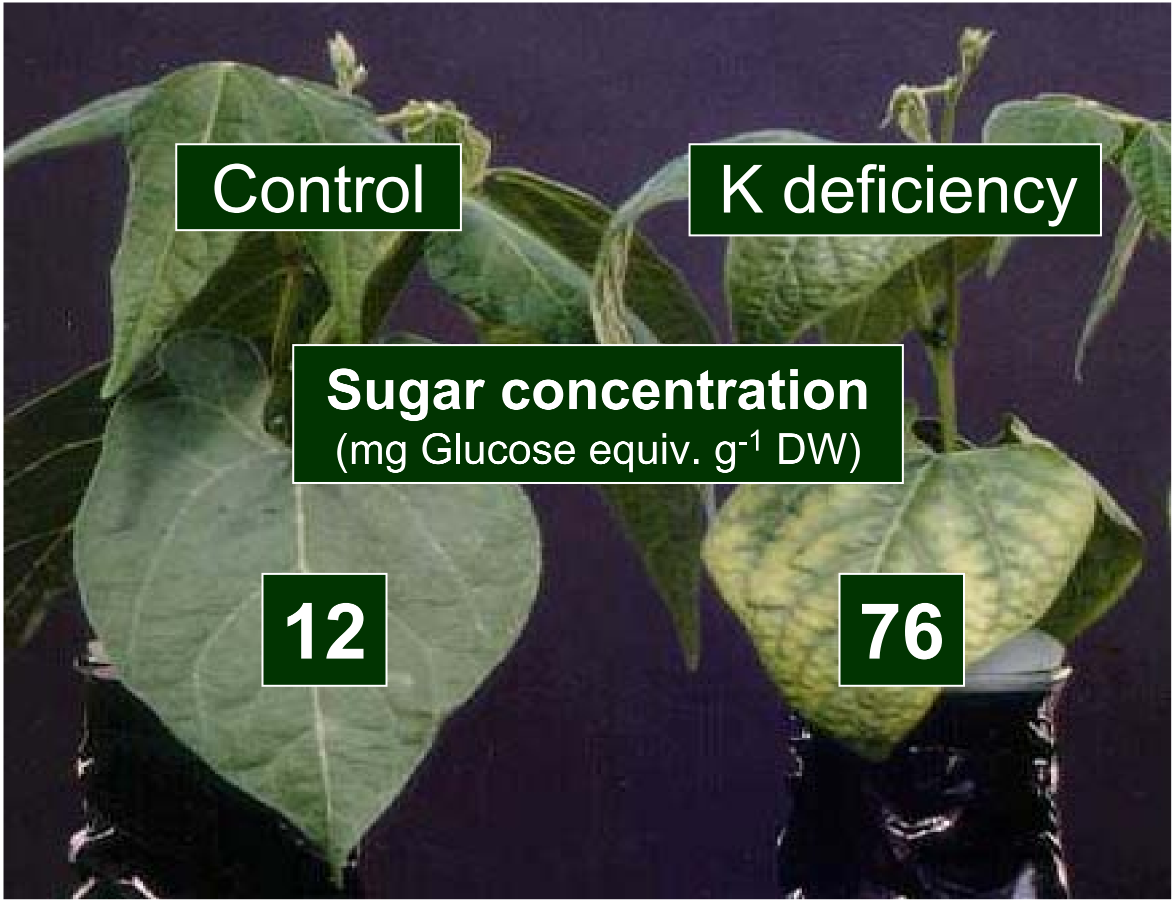
Jahr
2005
2006
2007
2008
Kosten
Stab. N
N+PK
NP+K
NPK
N+P+K
FruFo
Kartei
Kultur:
Weizen-Winter
Raps-Winter
Rüben-Zucker
Gerste-S.Futter
N 1. Gabe:
KAS
Menge*, N-Zufuhr**
2,8 75 / 75
2,6 70 / 70
2,9 79 / 79
0,9 23 / 23
N 2. Gabe:
KAS
Menge, N-Zufuhr
1,1 30 / 30
2,2 60 / 60
0,0 0 / 0
0,0 0 / 0
N 3. Gabe:
KAS
Menge, N-Zufuhr
2,8 75 / 75
0,0 0 / 0
0,0 0 / 0
1,9 50 / 50
Zwischenfrucht
Menge, N-Zufuhr
0,0 0 / 0
P-Düngung:
Superphosphat
Menge, P-Zufuhr
0,0 0
4,9 88
7,2 130
0,0 0
K-Düngung:
Korn-Kali 40(+6+4)
Menge, K-Zufuhr
2,8 111
4,3 170
5,3 212
0,0 0
Mg-Düngung:
Kieserit gran
Menge, Mg-Zufuhr
0,0 0
0,0 0
0,6 14
0,0 0
3 Hinweise:
*dt/ha, **kg/ha
• Standort mit hoher K-Mobilität! Zur Vermeidung von K-Auswaschungsverlusten sollte Kalium in jährlichen Gaben im Frühjahr gedüngt werden (keine Gaben für mehrere Jahre).
Min.-Düngung (kg/ha) N 462 P2O5 218 K2O 493 MgO 88 S 194
Min. Nährstoffbedarf (kg/ha): N 462 P2O5 218 K2O 437 MgO 88 S 97 CaO (dt/ha) 0
Bereit

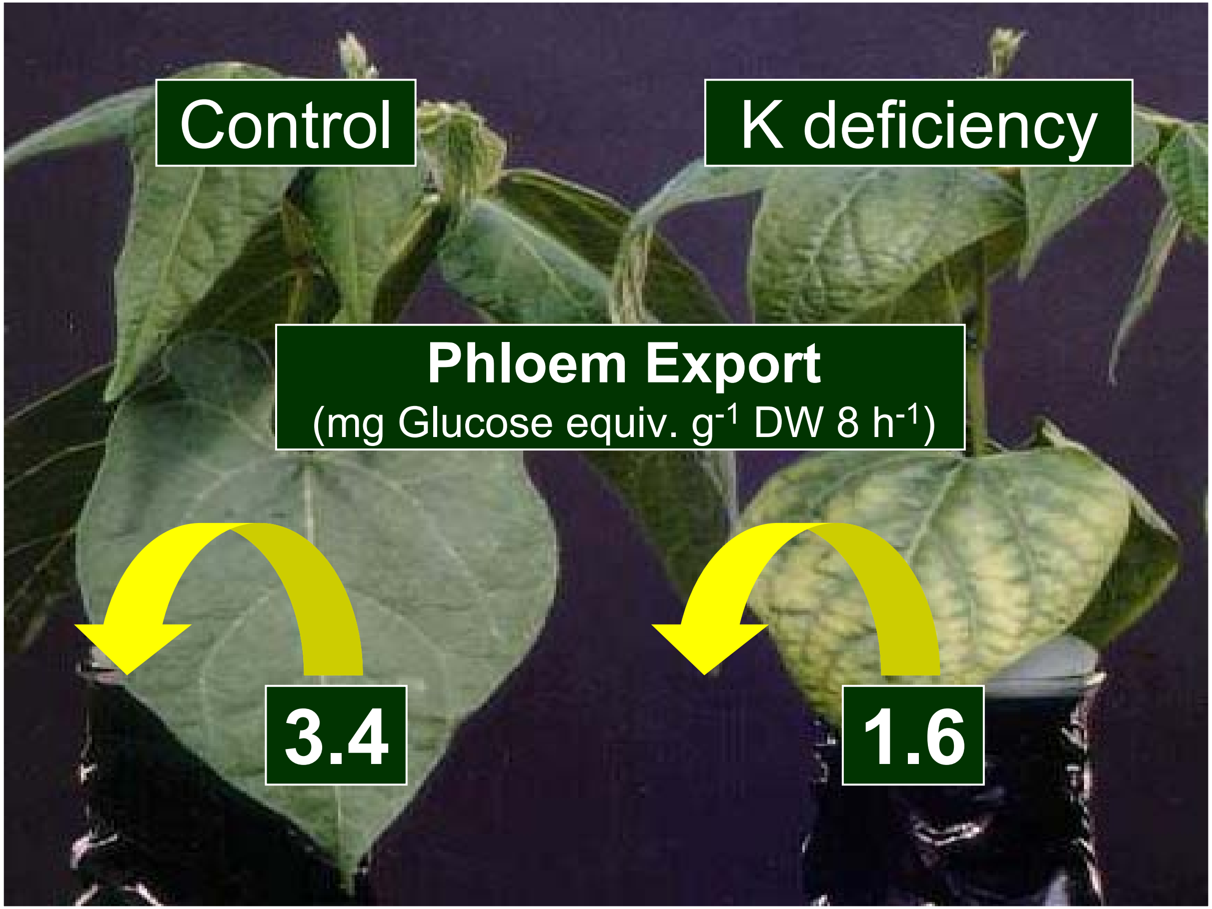
Possibilities of K to influence the soil fertility

- Stability of soil structure due to possible changes in the mineral clay compound.
- Long-term regulation of the soil water content and hence of the efficiency of water.
- Nitrogen supply of plants via ammonium and therefore on the N efficiency of plants
- Valuation of soil K reserves for a maintaining security of K supply

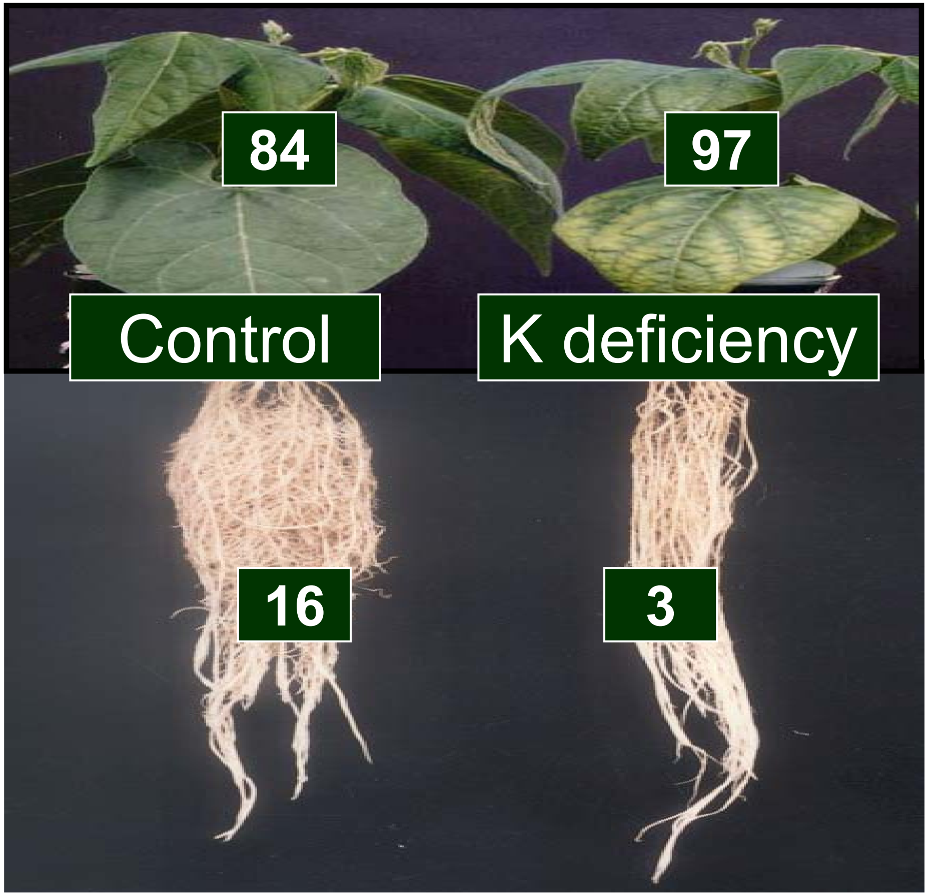
Accumulation of sugars in K deficient leaves



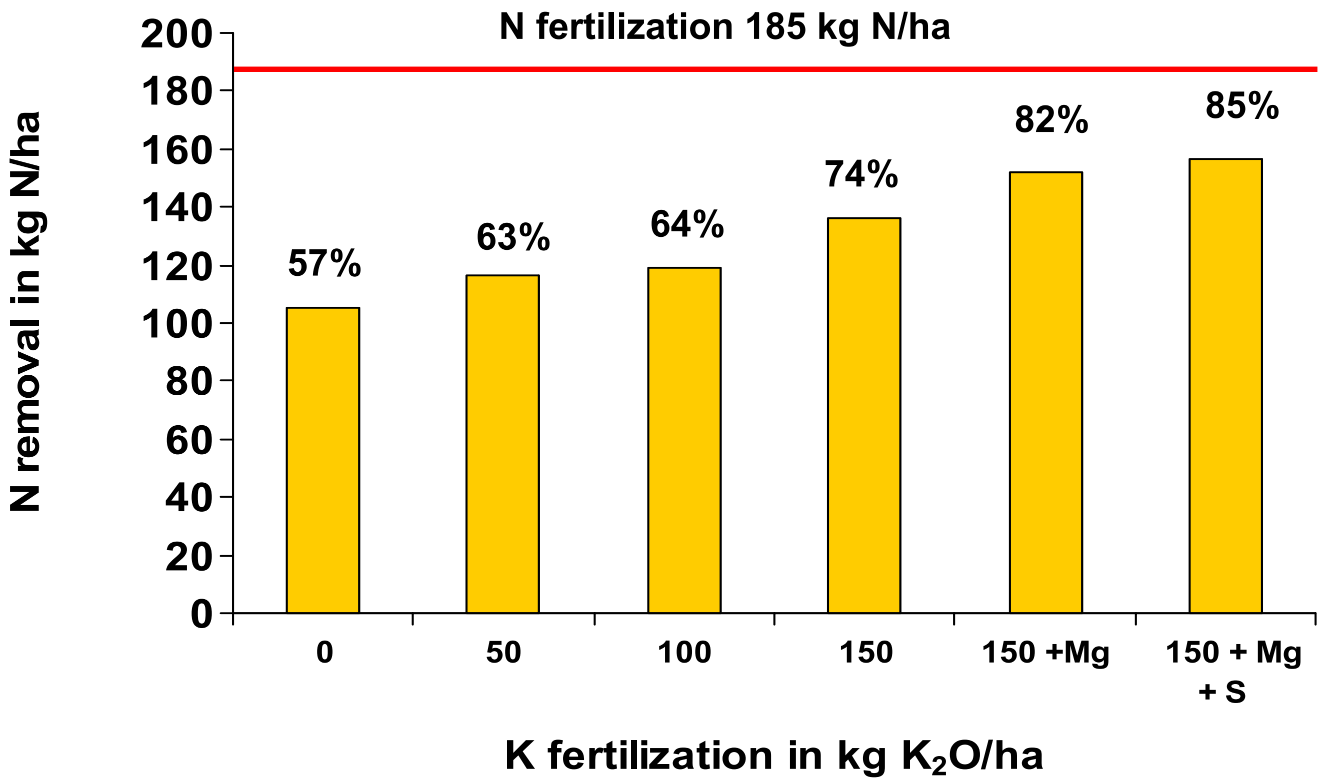
Decrease of sugar export under K deficiency



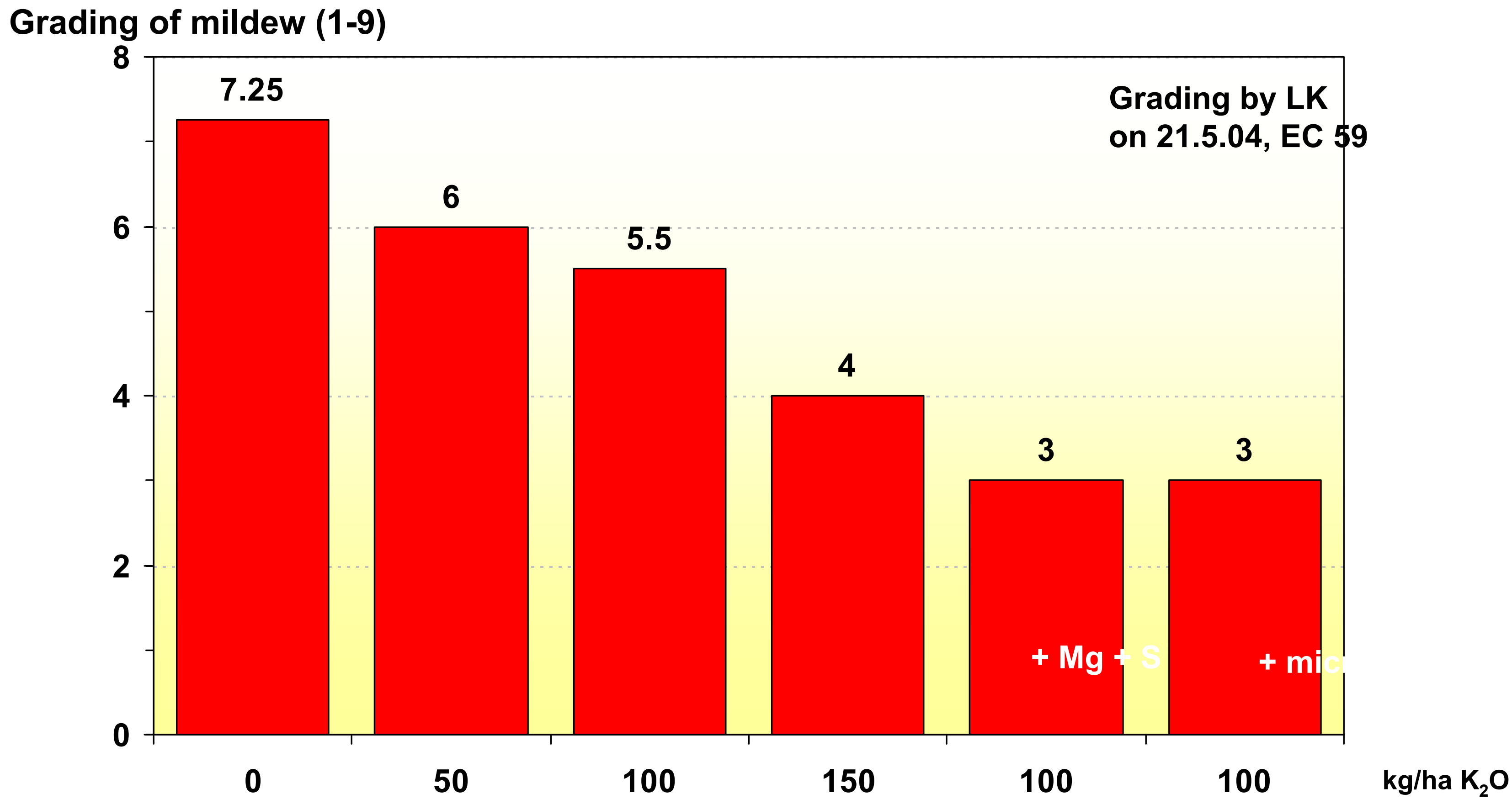
Relative distribution of carbohydrates between shoot and roots (%)



Effect of different rates of K and Mg on the uptake of N in triticale



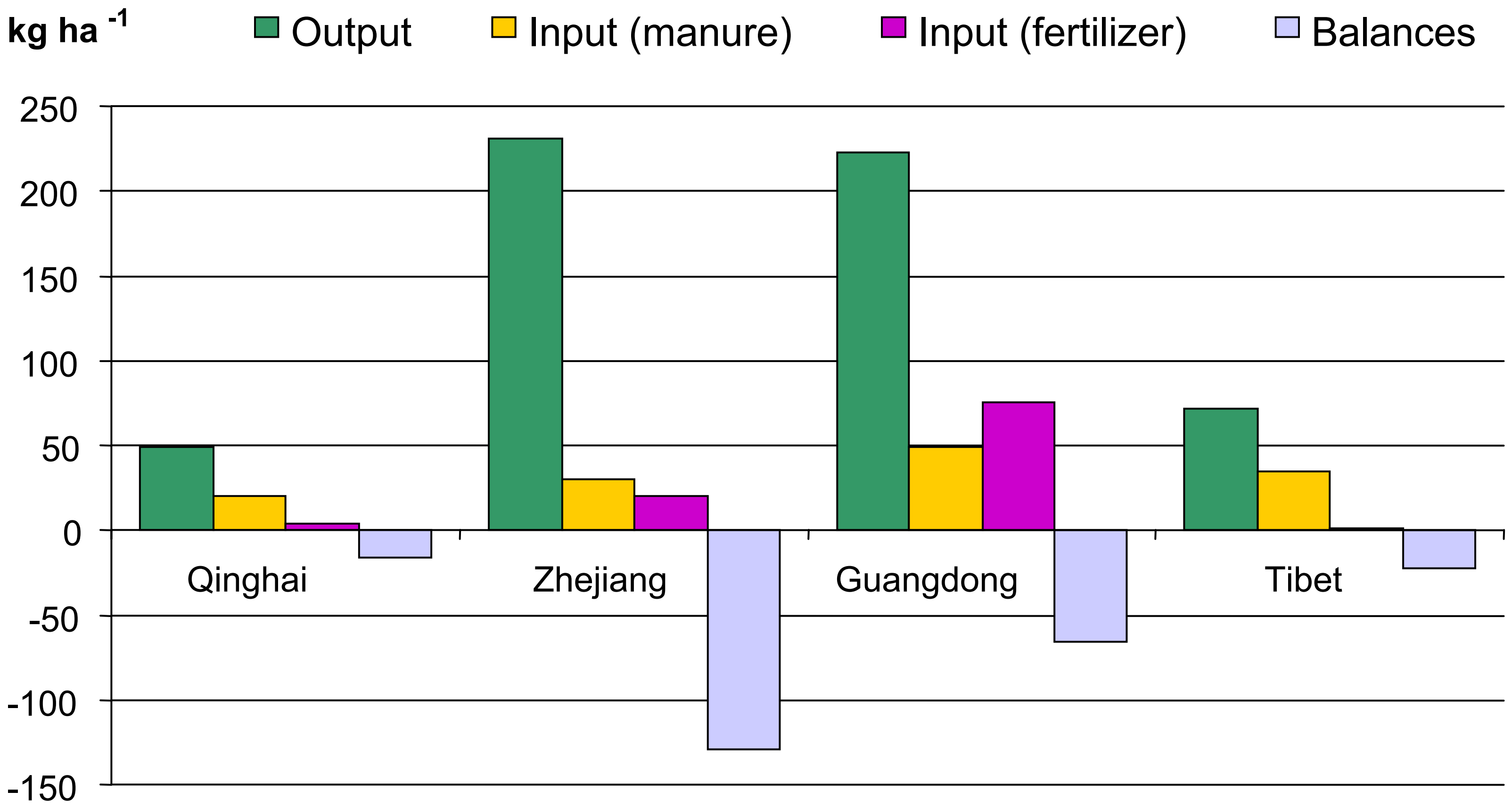
Influence of different rates of K on resistance of winter barley against powdery mildew
- Füchtorf, Germany, 2004 -



Source: Orlovius 2004

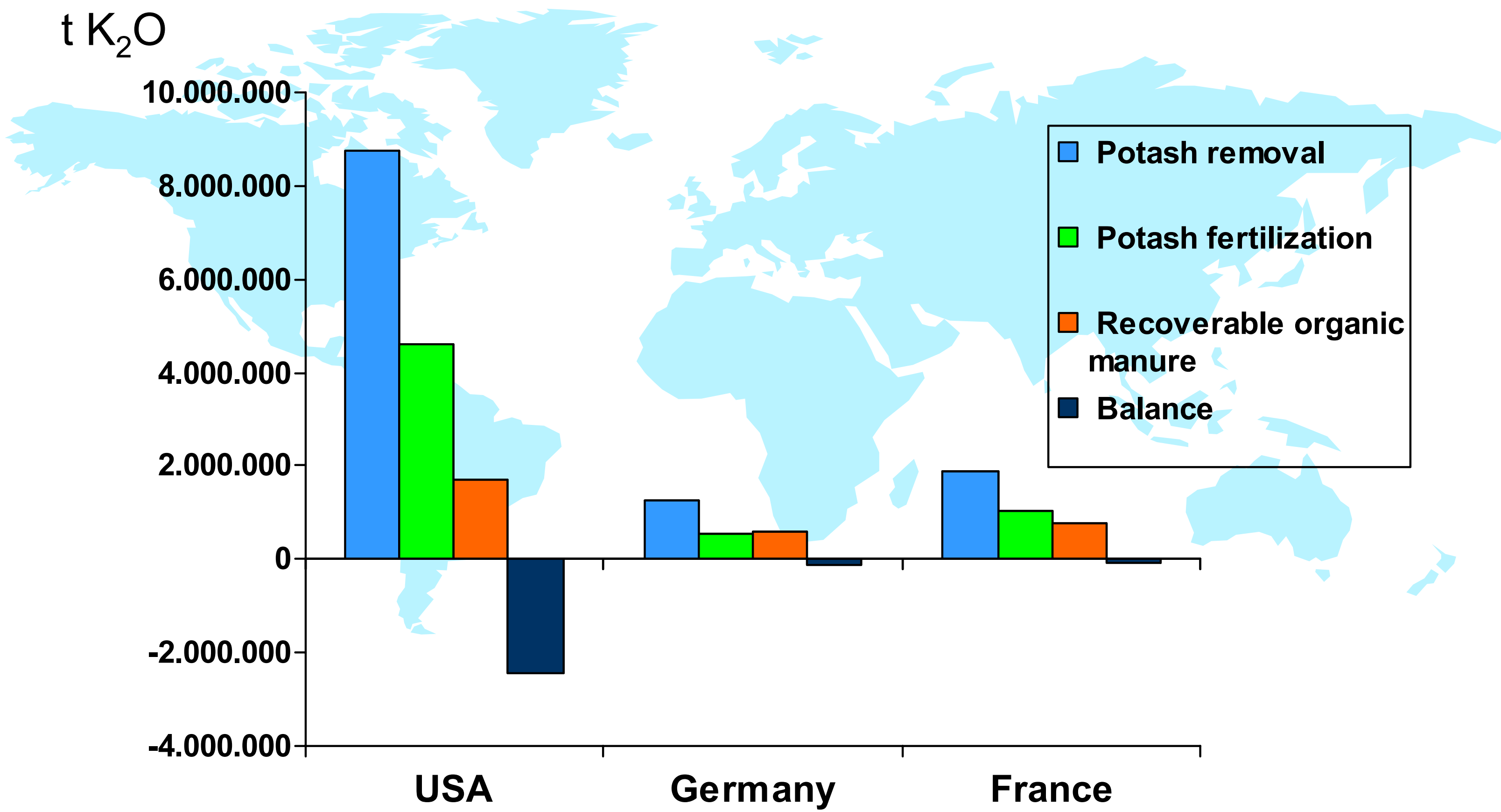
Potassium balance
on
country level

Potassium input/output balances and fertilizer and manure inputs and application rates for Chinese provinces in 1996



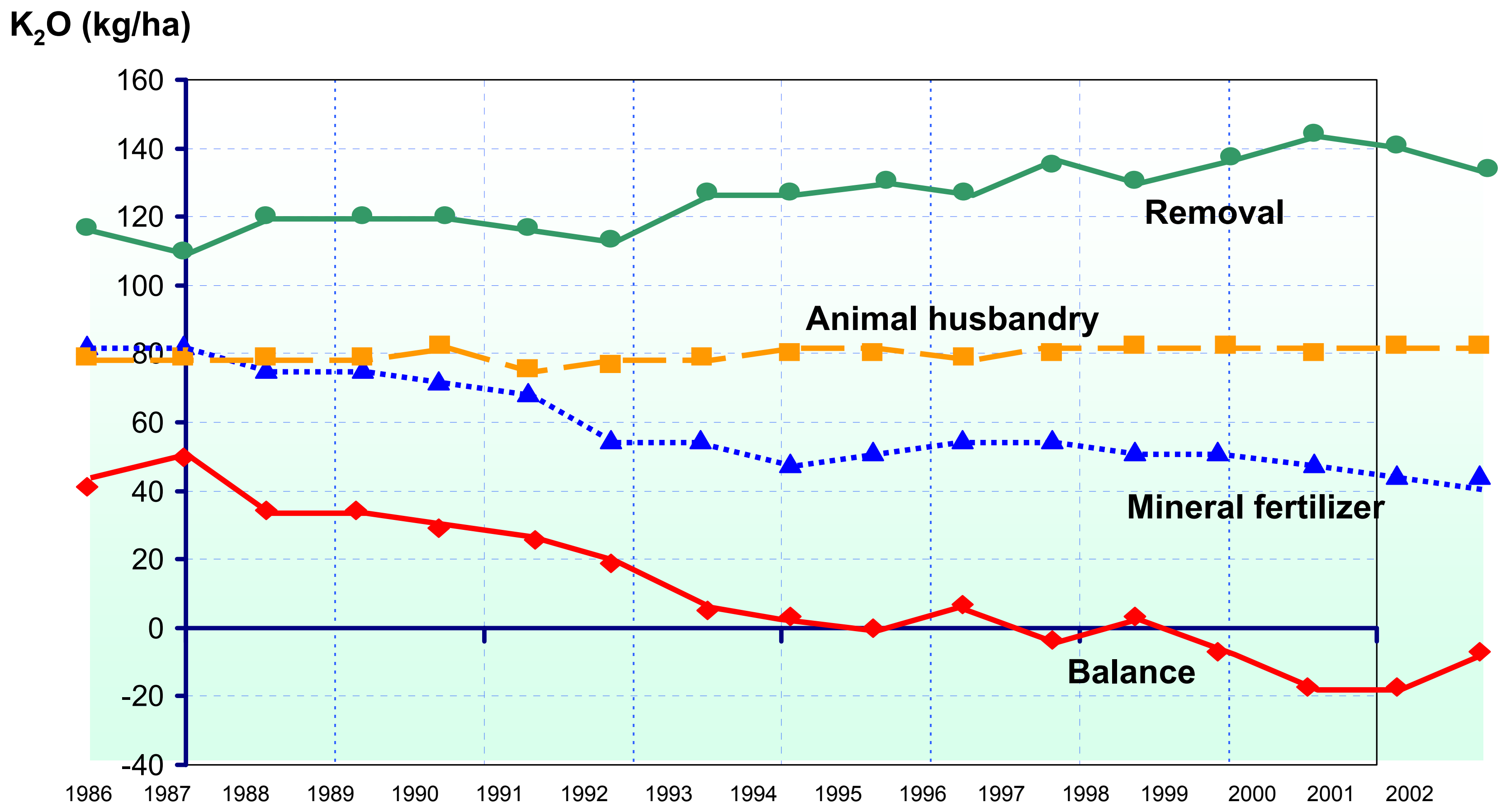
Source: Sheldrick et al., 2002

Potassium balances in USA, Germany and France



Source: PPI, FAO, EFMA, K+S

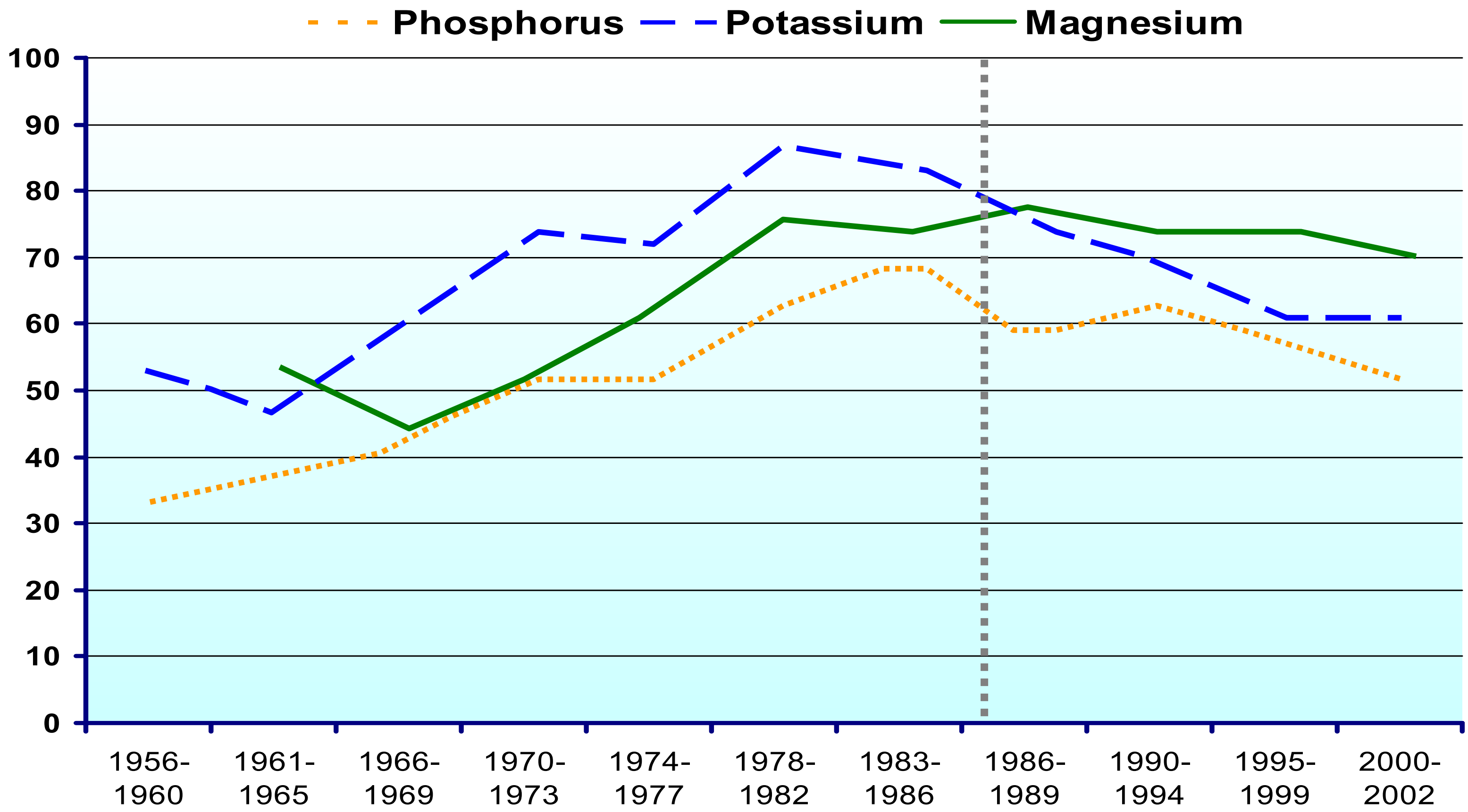
Potassium balance – Lower Saxony, Germany



Source: Baumgärtel, Hannover

Nutritional status of the arable land in the new federal states of Germany (1956 – 2002)

- Nutrition note according to Riem, new valuated after 1987 -



Source: Krause and Herold, 2003

Developing of the nutritional status of the arable land in Thuringia (1986 – 2002)

- share of the nutrient content classes in % -

Nutrient	Content classes	Sampling period 1986 – 1990	Sampling period 2000 - 2002
P	A+B	26	39
	C	25	24
	D+E	49	30
K	A+B	4	21
	C	17	31
	D+E	79	48
Mg	A+B	9	16
	C	12	22
	D+E	79	62

Source: Breitschuh et al., Jena

Potassium balance on farm and field level

Principle and necessary data for balancing of nutrient input and output

- after HEGE, 1997; modified after PÖTSCH, 1998 -

Nutrient application	-	Nutrient removal	=	Nutrient balance
Field/stable basis				
Mineral fertilizer Farmyard manure Symbiotic N bond Mobilisation Deposition	-	Removal by crops Gaseous losses Leaching	=	Soil surface balance
Farm gate basis				
Mineral fertilizer Fodder Life-stock purchase Symbiotic N bond	-	Product sales (Crops and animals)	=	Farm gate balance

Source: Gruber et al., Austria, 2001

Nutrient balances on supply/withdrawal basis of potassium – Farm gate balance

		Conventional farming	Organic farming
INPUT			
Concentrate fodder	kg	3.4	3.9
Mineral fertilizer	kg	10.8	-
∑ INPUT	***kg***	***14.2***	***3.9***
OUTPUT			
Milk	kg	10.8	13.8
Calf	kg	0.1	0.2
∑ Output	***kg***	***10.9***	***14.0***
Farm gate balance	***kg***	***3.3***	***-10.1***

Source: Gruber et al., Austria, 2001

Nutrient balances on supply/withdrawal basis of potassium – Soil surface balance

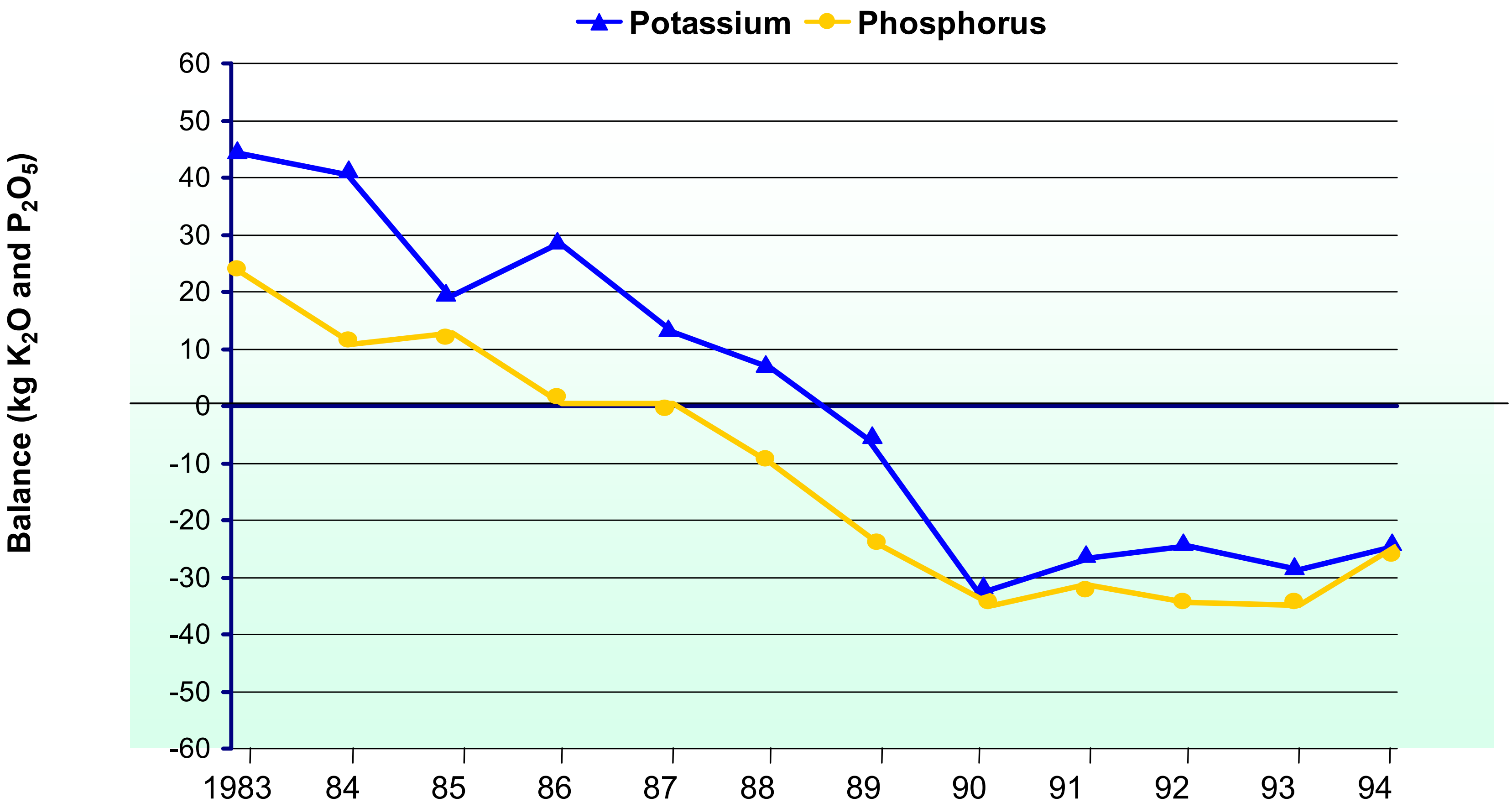
		Conventional farming	Organic farming
INPUT			
Farmyard manure	kg	141.8	179.6
Mineral fertilizer	kg	10.8	-
∑ INPUT	***kg***	***152.6***	***179.6***
OUTPUT			
Removal	kg	165.3	213.6
∑ Output	***kg***	***165.3***	***213.6***
Soil surface balance	***kg***	***-12.8***	***-33.9***

Source: Gruber et al., Austria, 2001

Phosphorus and potassium balances

Crop rotation: sugar beet – winter wheat – winter barley

- Lower Saxony, Germany, mean of 1983-1994 -



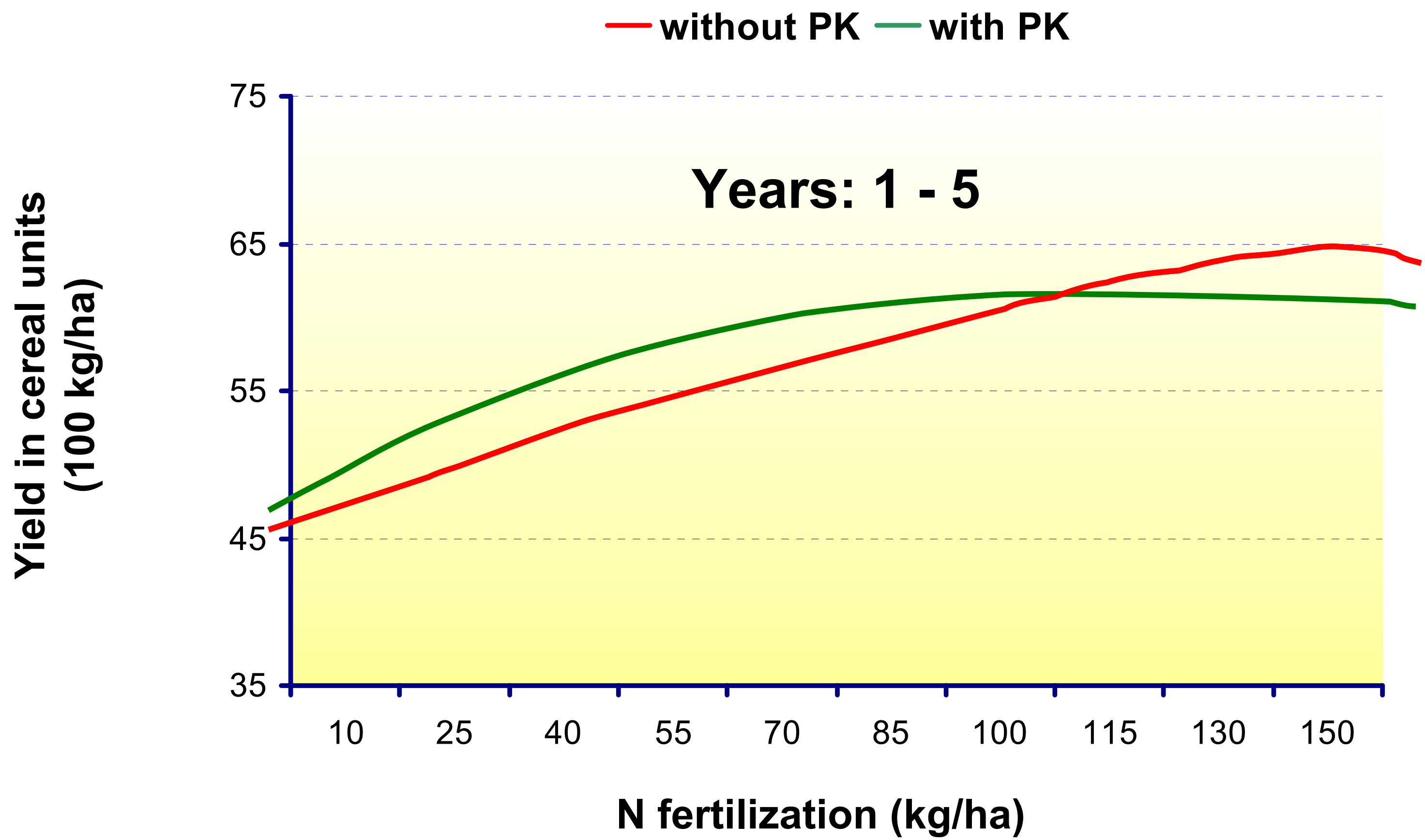
Source: Baumgärtel, Hannover

Recommendation for potassium and phosphorus for crop rotation on loamy soils

Crop rotation	Demand	Harvest residues	Fertilization	Removal	Balance
		Phosphorus, kg P_2O_5/ha			
Sugar beet (50 t)	90	15	190	50	140
Winter wheat (9 t)	90	40	-	72	-72
Winter barley (8 t)	80	15	-	64	-64
Total amount	**260**	**70**	**190**	**186**	**4**
		Potassium, kg K_2O/ha			
Sugar beet (50 t)	350	85	230	125	105
Winter wheat (9 t)	130	210	-	54	-54
Winter barley (8 t)	130	85	-	48	-48
Total amount	**610**	**380**	**230**	**227**	**3**

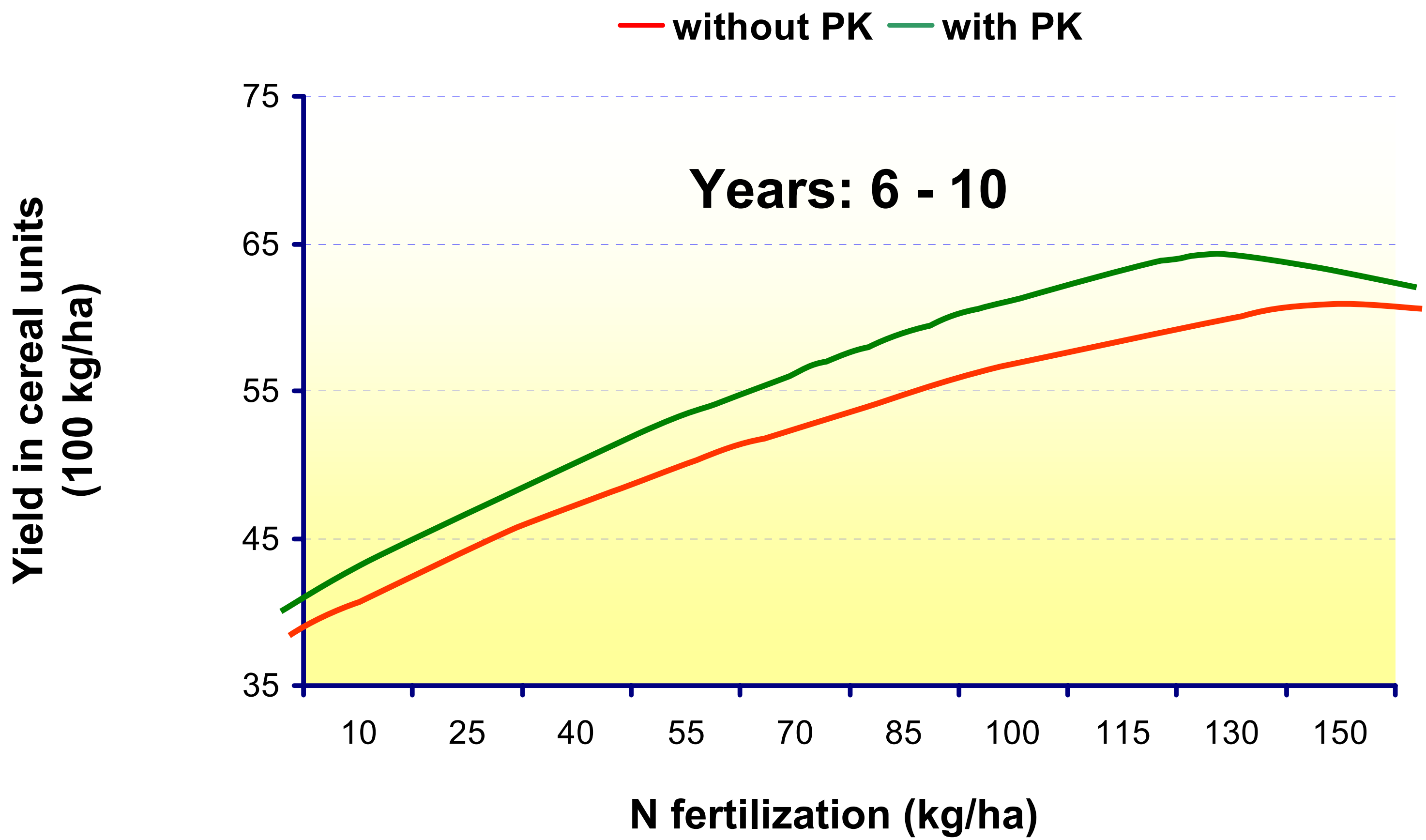
Source: Baumgärtel, Hannover

Yield and N demand in two five-year-periods of a long-term fertilization trial of 10 years with and without PK fertilization - 1st period -



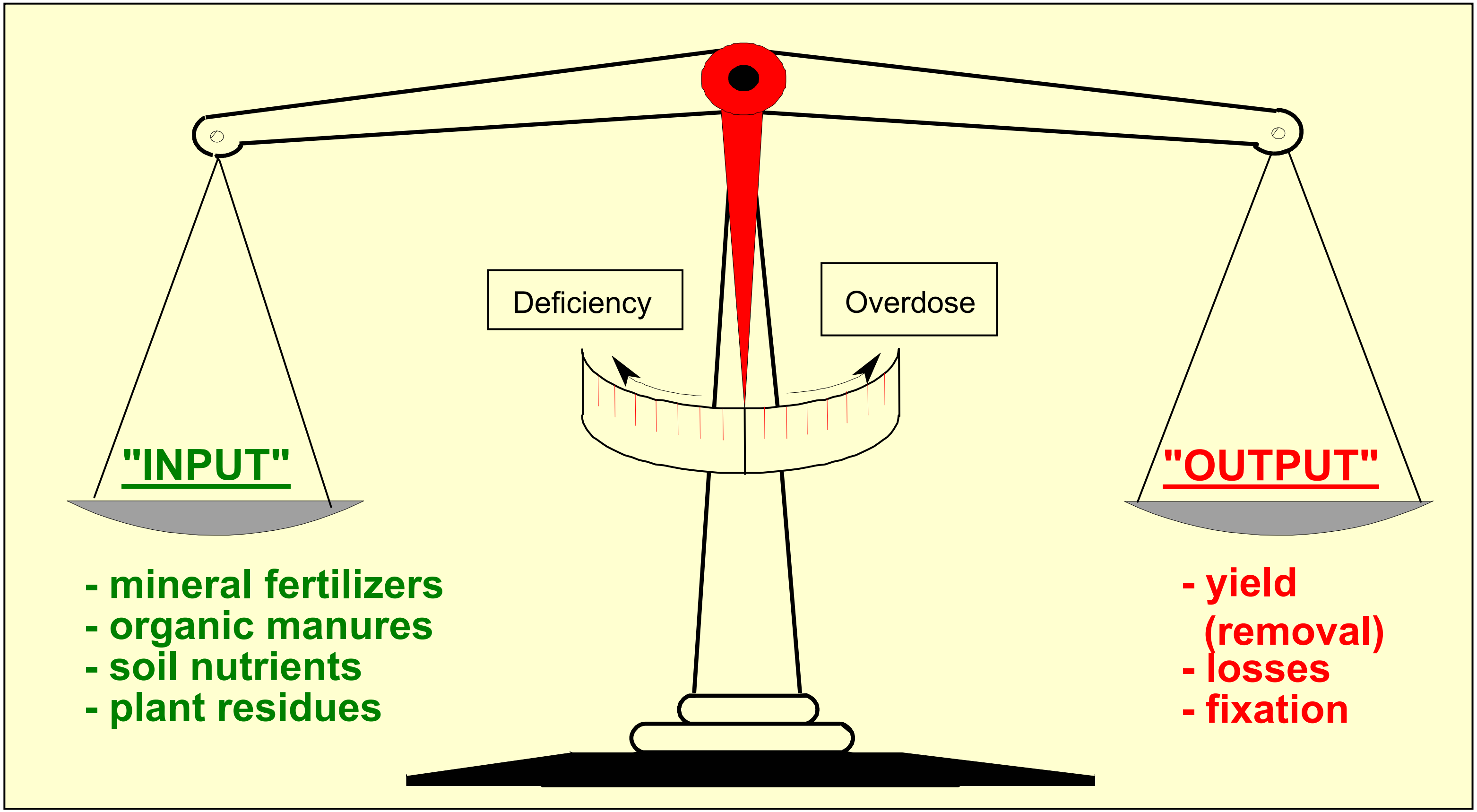
Source: Lorenz, LUFA Oldenburg

Yield and N demand in two five-year-periods of a long-term fertilization trial of 10 years with and without PK fertilization - 2nd period -



Source: Lorenz, LUFA Oldenburg

Balanced plant nutrition by balanced fertilization



Intelligent fertilization

Intelligent fertilization means:

To supply the complete soil – plant system with nutrients –

to keep it constantly efficient.


Thank you !
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