MINERAL NUTRITION OF MAIZE, PRODUCED FOR BIO ETHANOL

THE HUNGARIAN CASE-STUDY

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The fuel ethanol issue in Brasil

(Keresztessy, 2008)

1930's	**First to use bioethanol as fuel for cars**
1973-75	**National Ethanol Programme (Proalcool)**
2000	**Almost 50% of car petrol based fuel is bioethanol, made from sugar cane**

The fuel ethanol issue worldwide

1988 International Panel in Climate Change (UN–WMO)

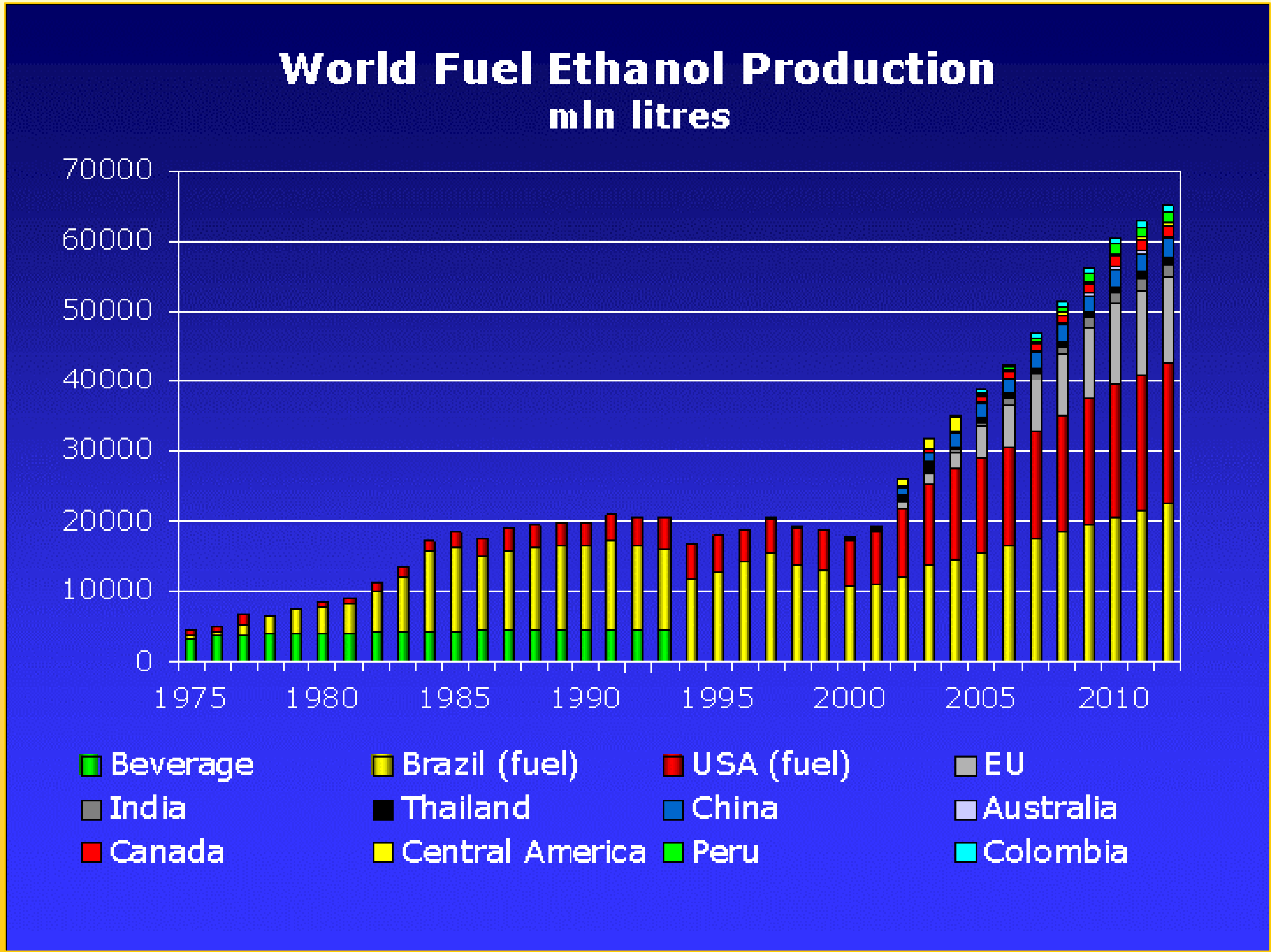
1992 Earth Summit, Rio de Janeiro
Greenhouse gas emission must be reduced

1997 Kyoto Protocol
Between 2008 to 2012, aims 5% reduction of greenhouse gas emission, compared to the 1990 emission values

2002 Production of fuel ethanol has started to increase sharply so that to reduce greenhouse gas emission

Changes in world fuel ethanol production

(Berg, 2004)

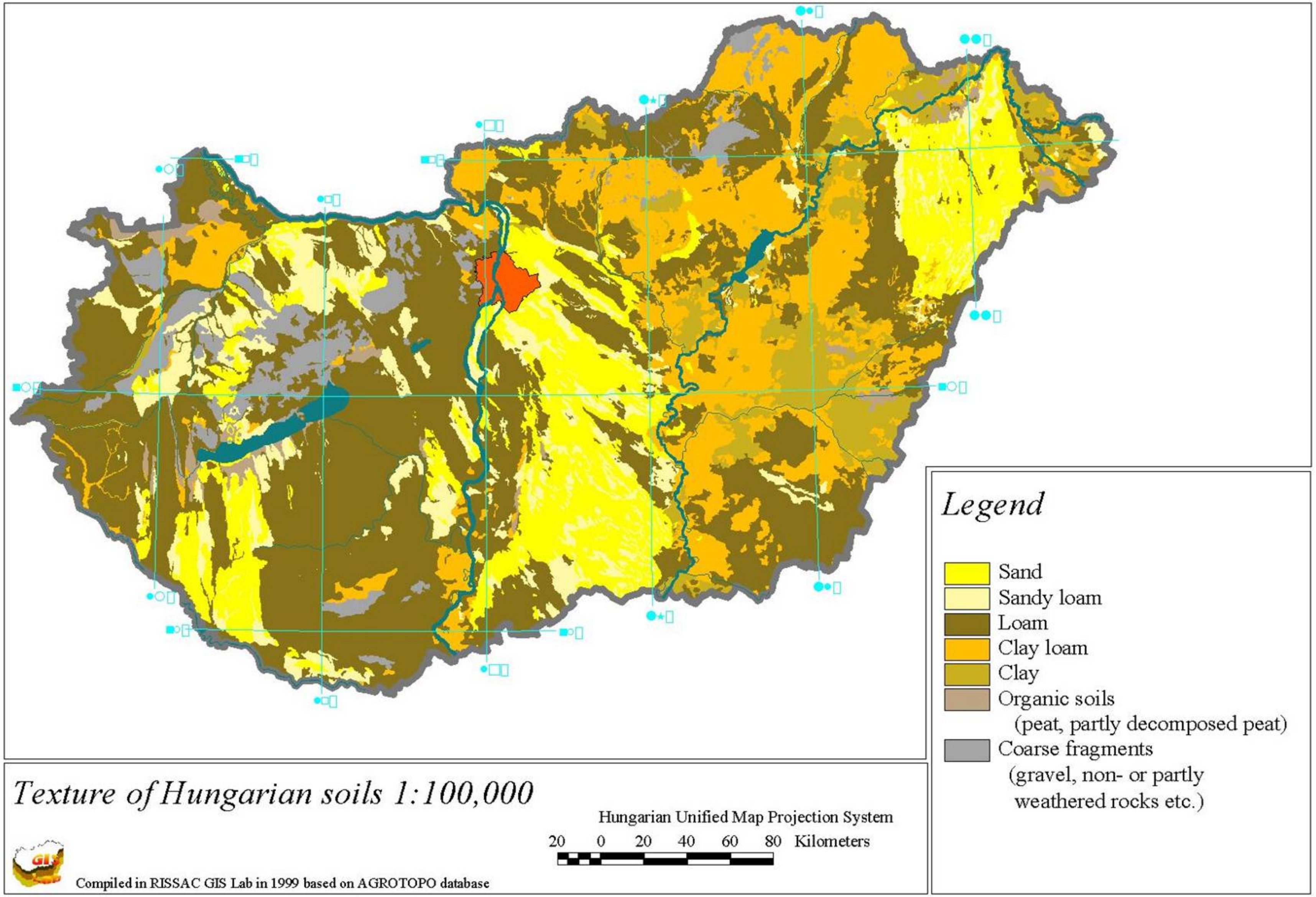


Distribution of world fuel ethanol production in 2007

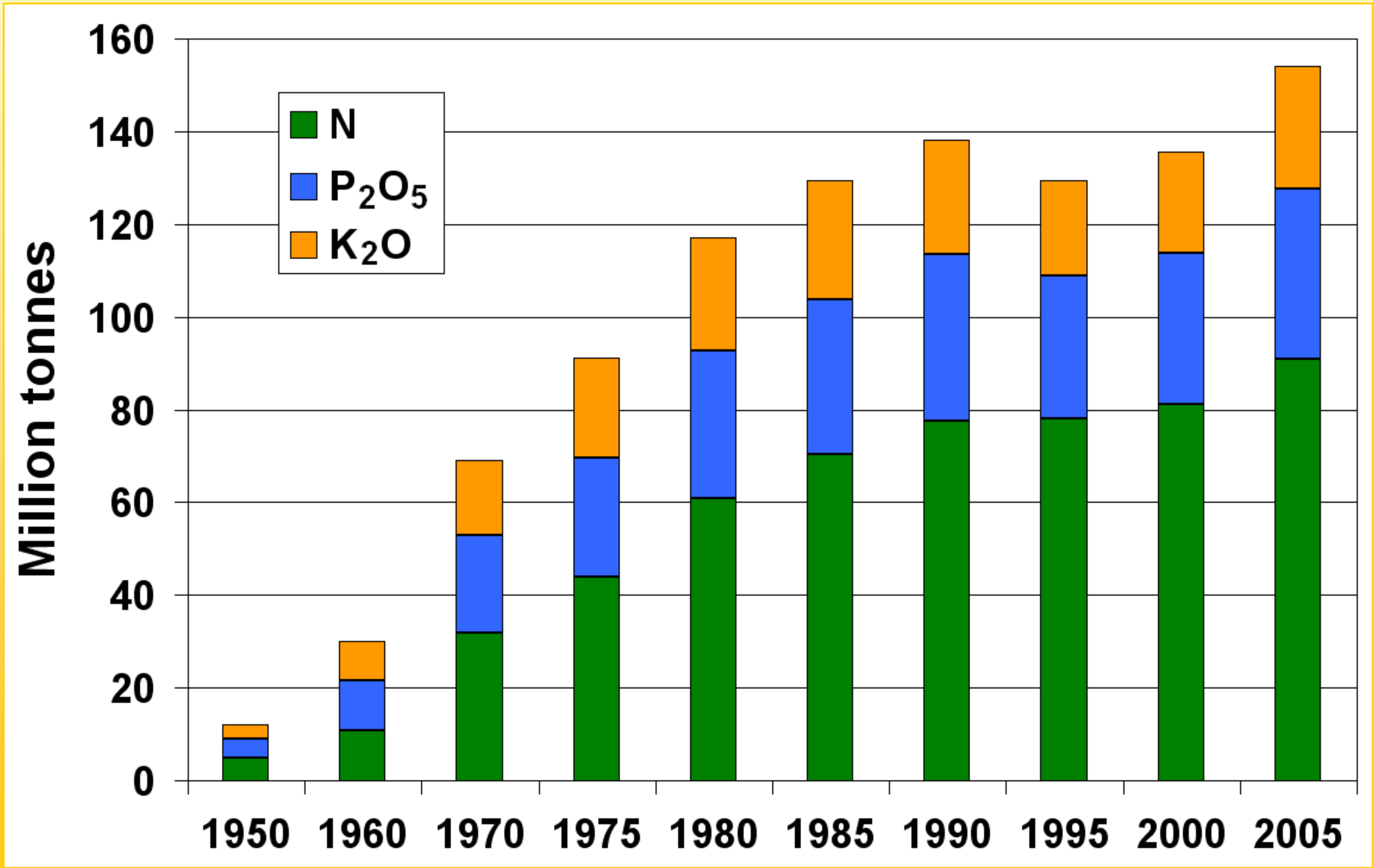
(Potori, 2008)

USA	24,5 billion litres
Brasil	19,7 billion litres
EU	1,85 billion litres
China	1,6 billion litres
Canada	0,6 billion litres
Total	49,5 billion litres

Soil textures of Hungary

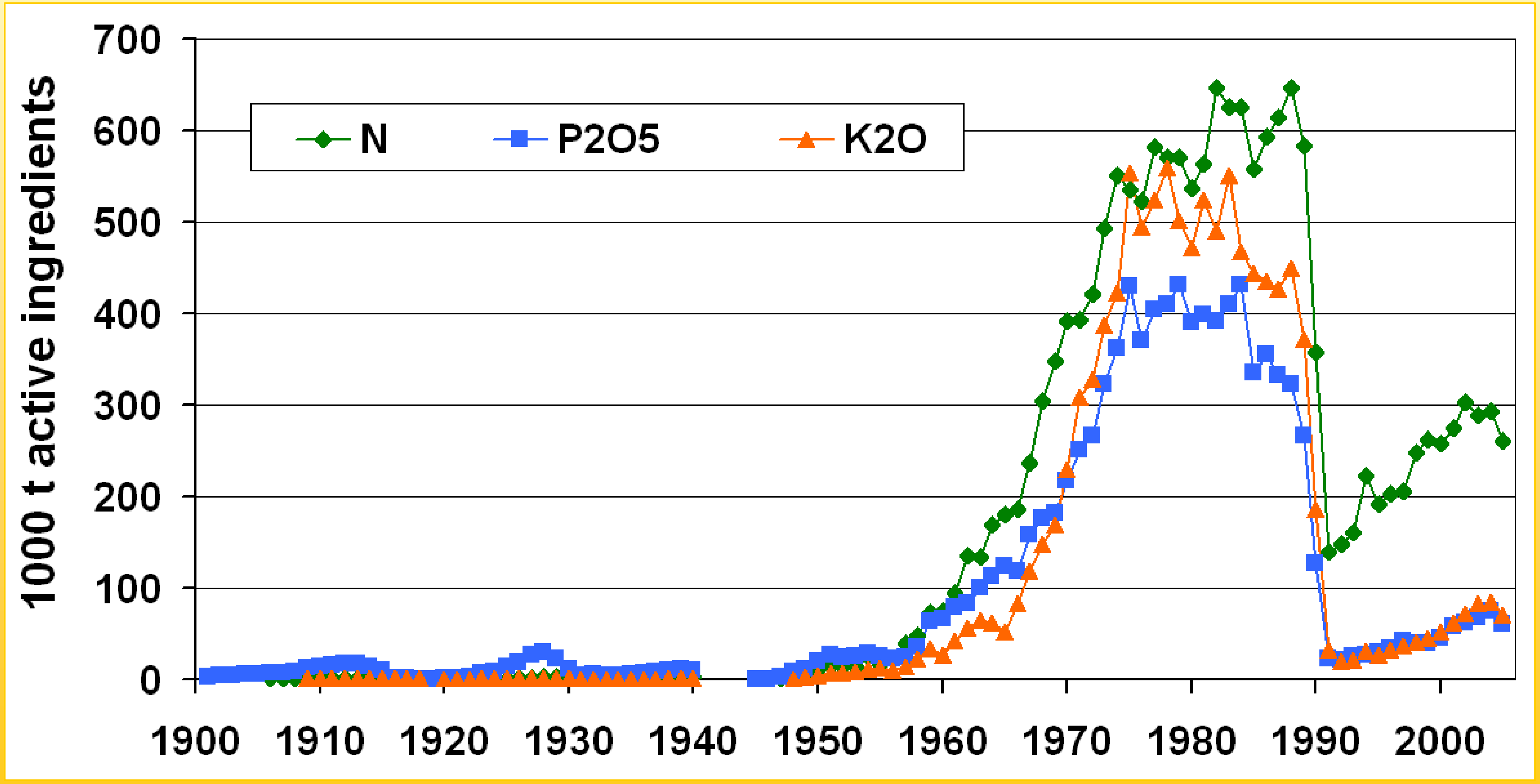


World NPK fertilizer consumption, million tonnes of N-P_2O_5-K_2O, 1950-2005 (FAO+IFA Statistics)

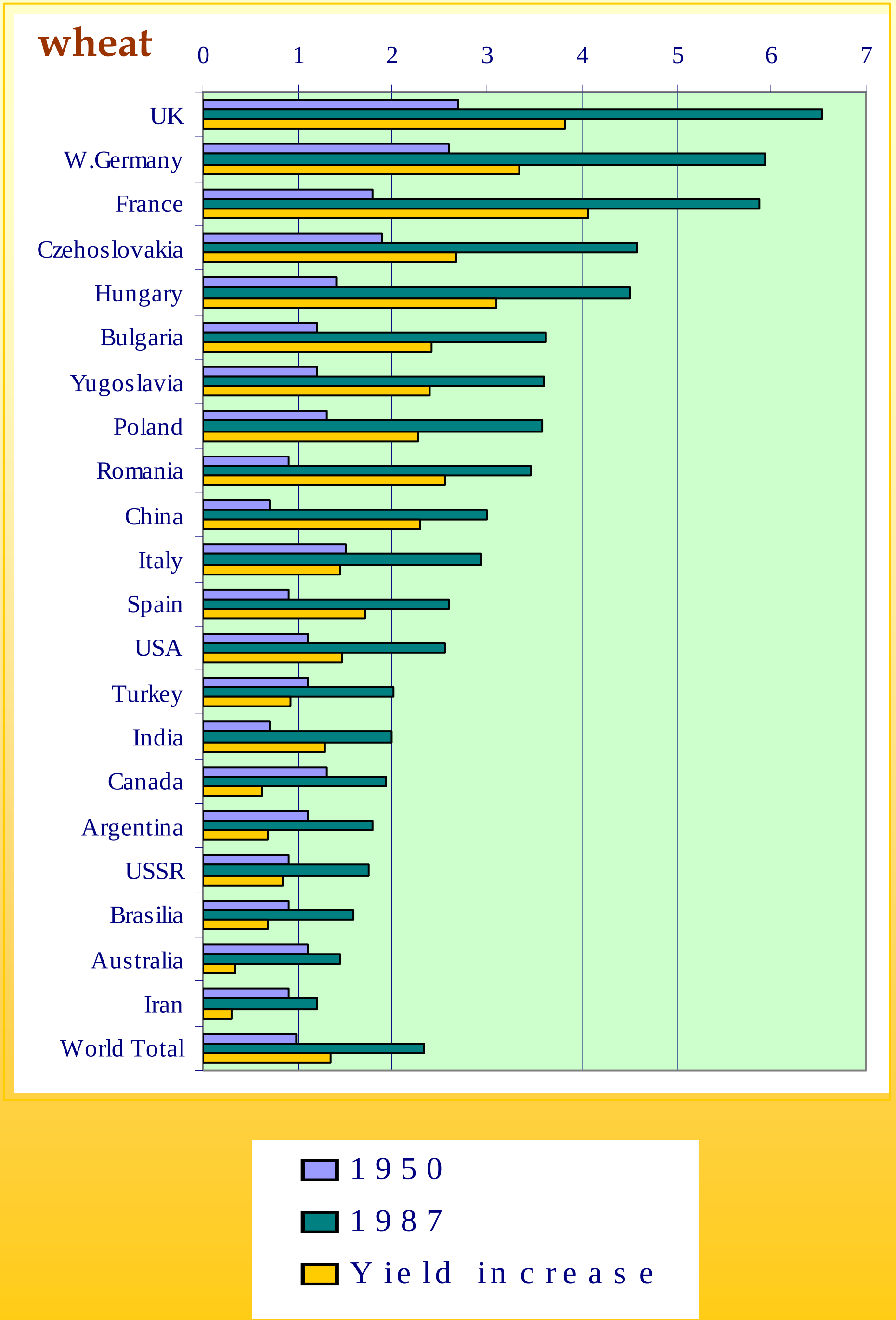


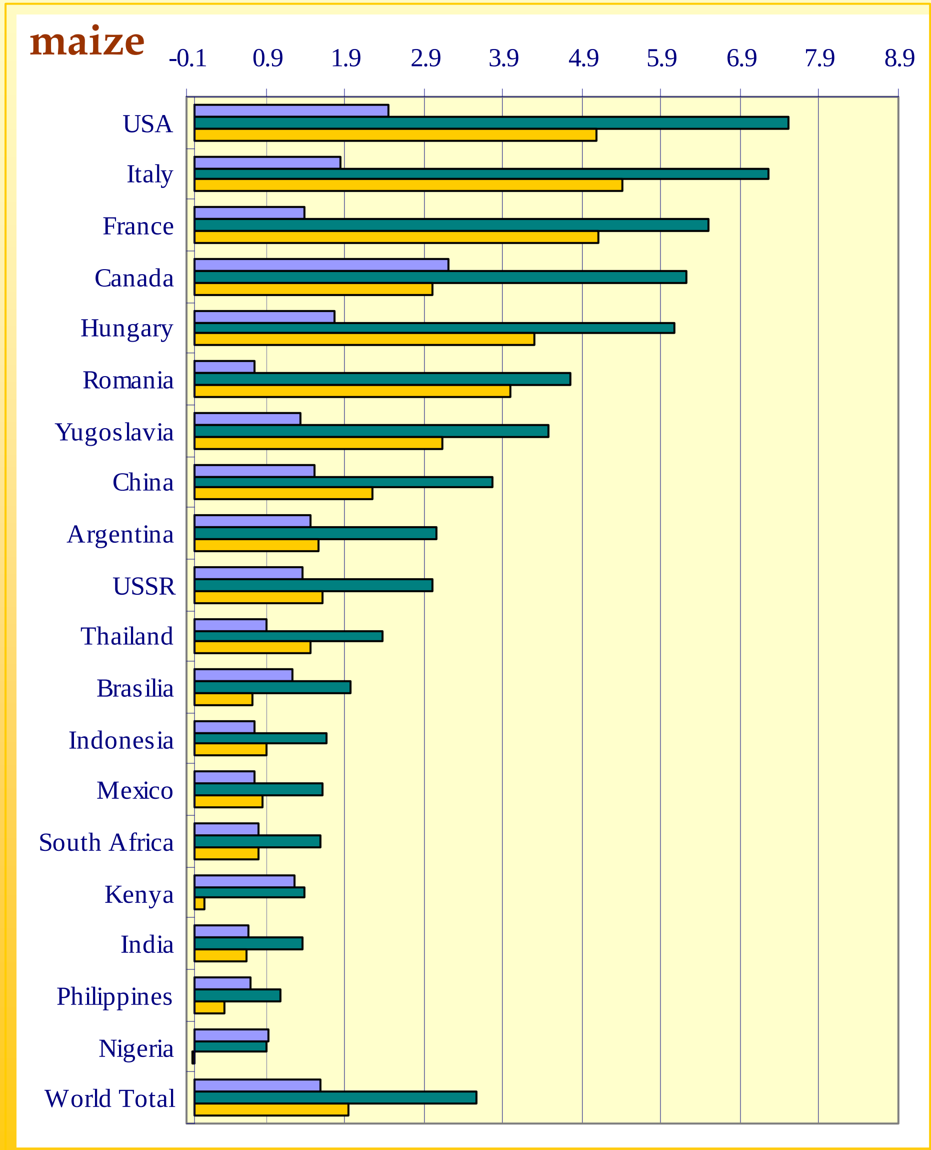
Fertilizer consumption in Hungary, 1901-2005

(Csathó and Radimszky, 2007)



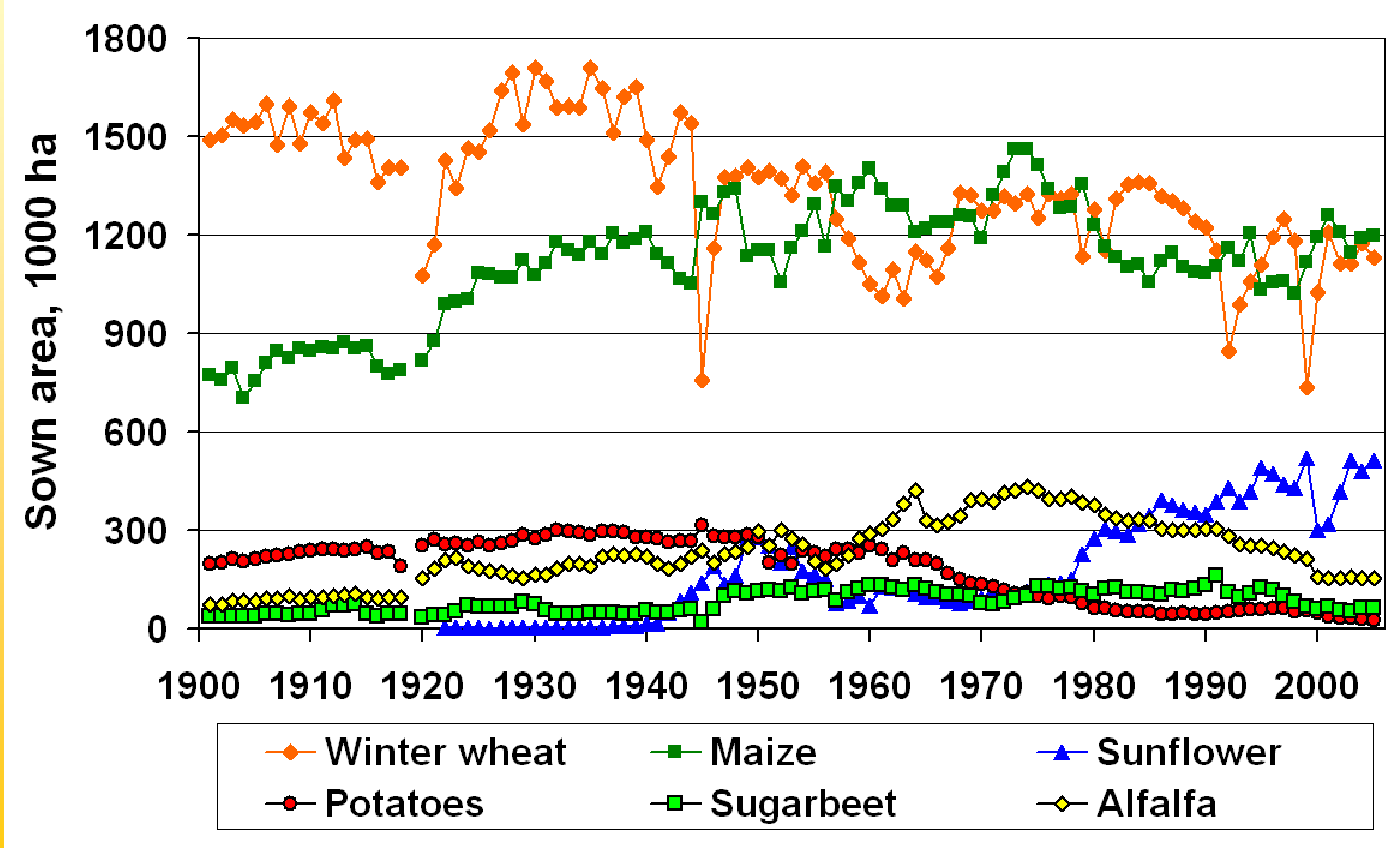
Yield increases in main producer countries, 1950 –1987





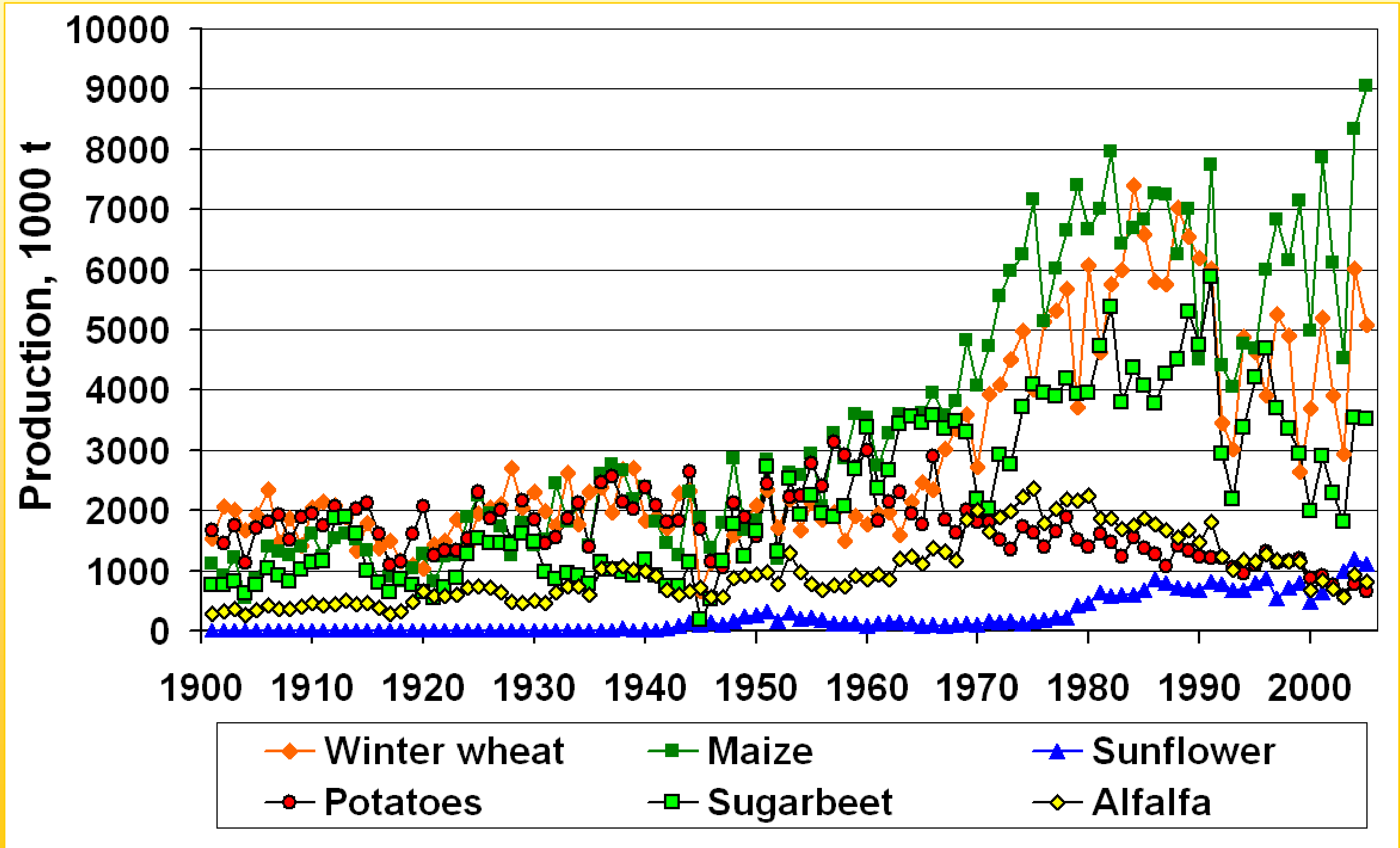
Sown area of main crops in Hungary, 1901-2005

(Csathó and Radimszky, 2007)



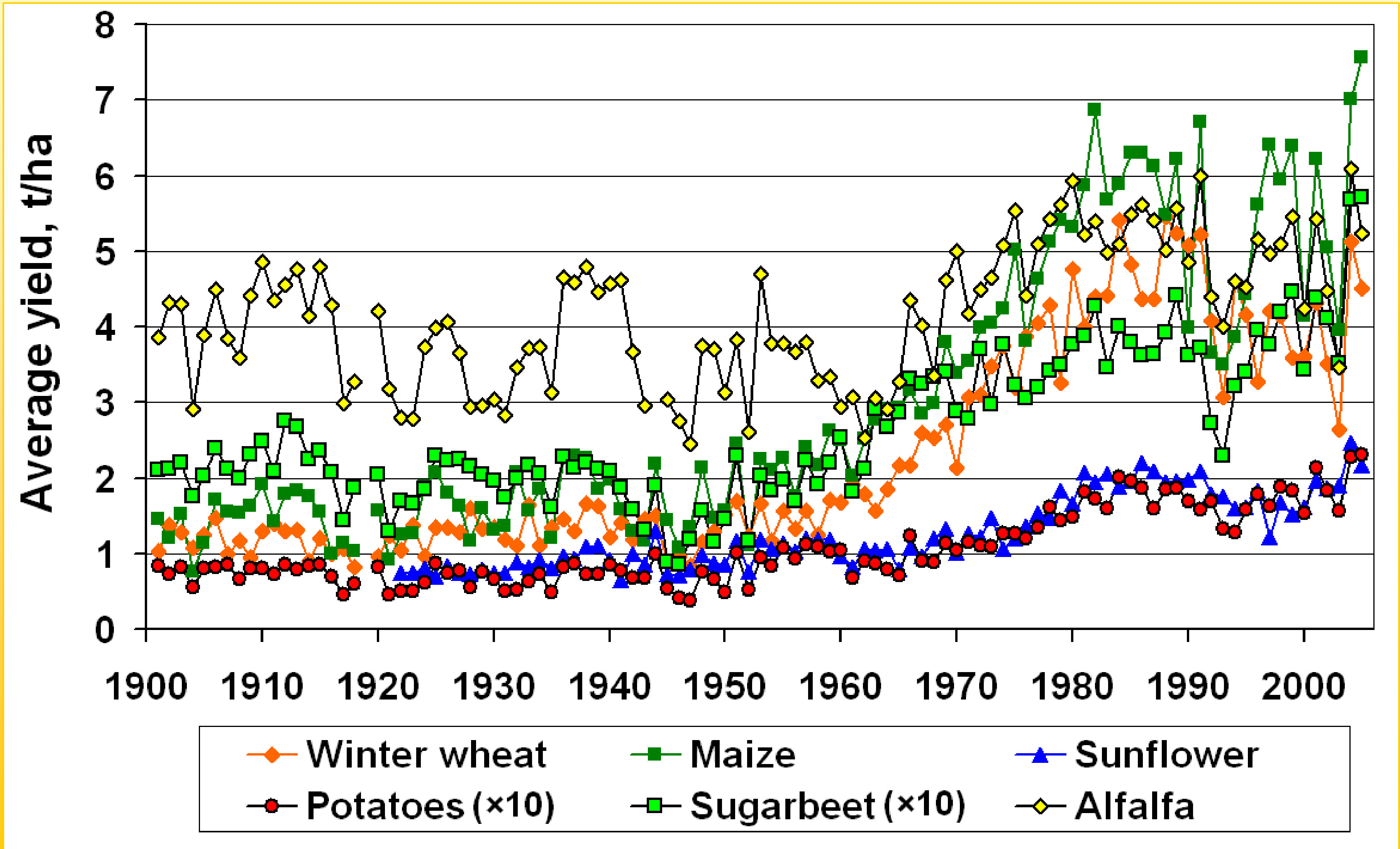
Total production of main crops in Hungary, 1901-2005

(Csathó and Radimszky, 2007)



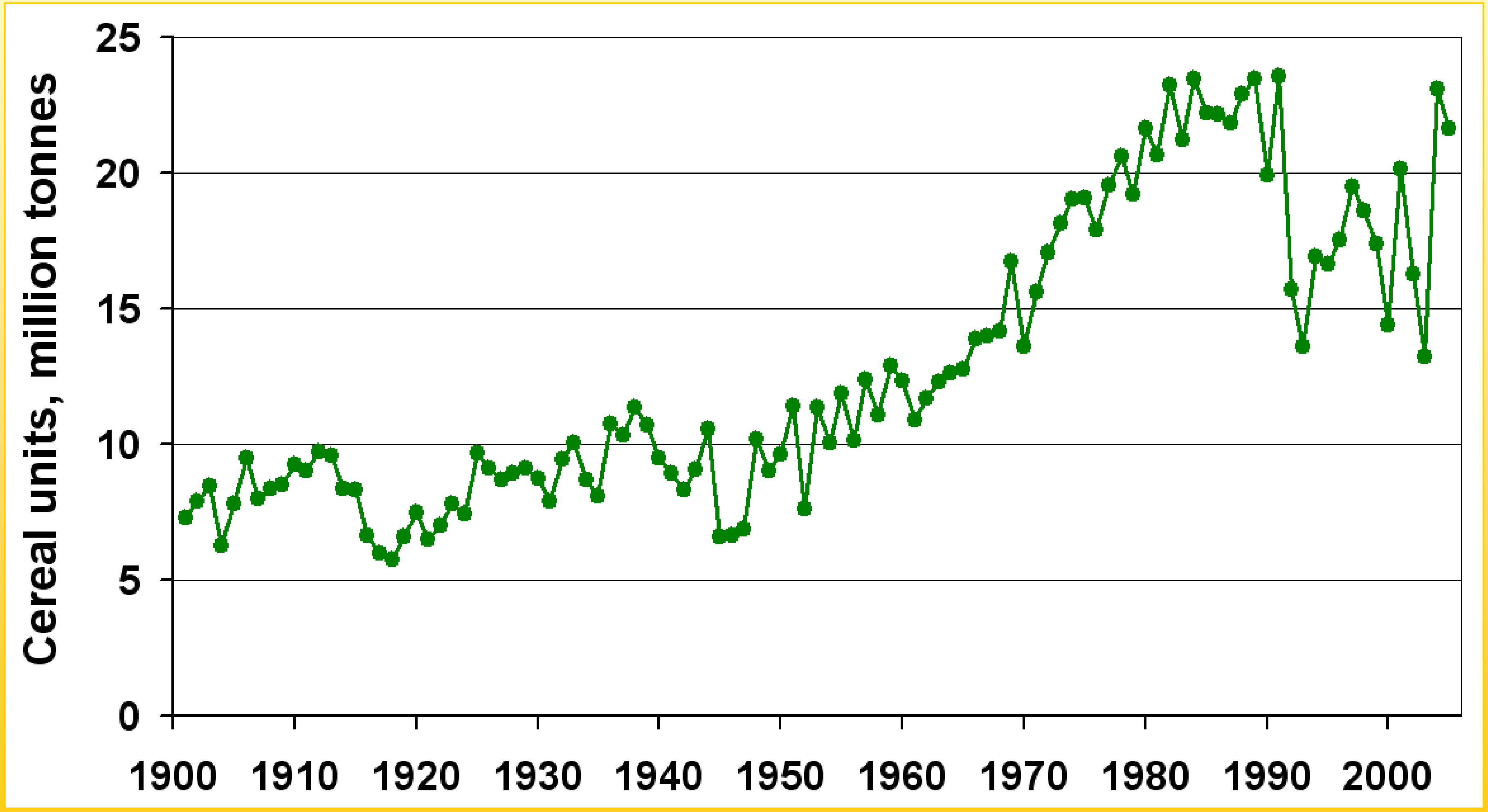
Average yields of main crops in Hungary, 1901-2005

(Csathó and Radimszky, 2007)



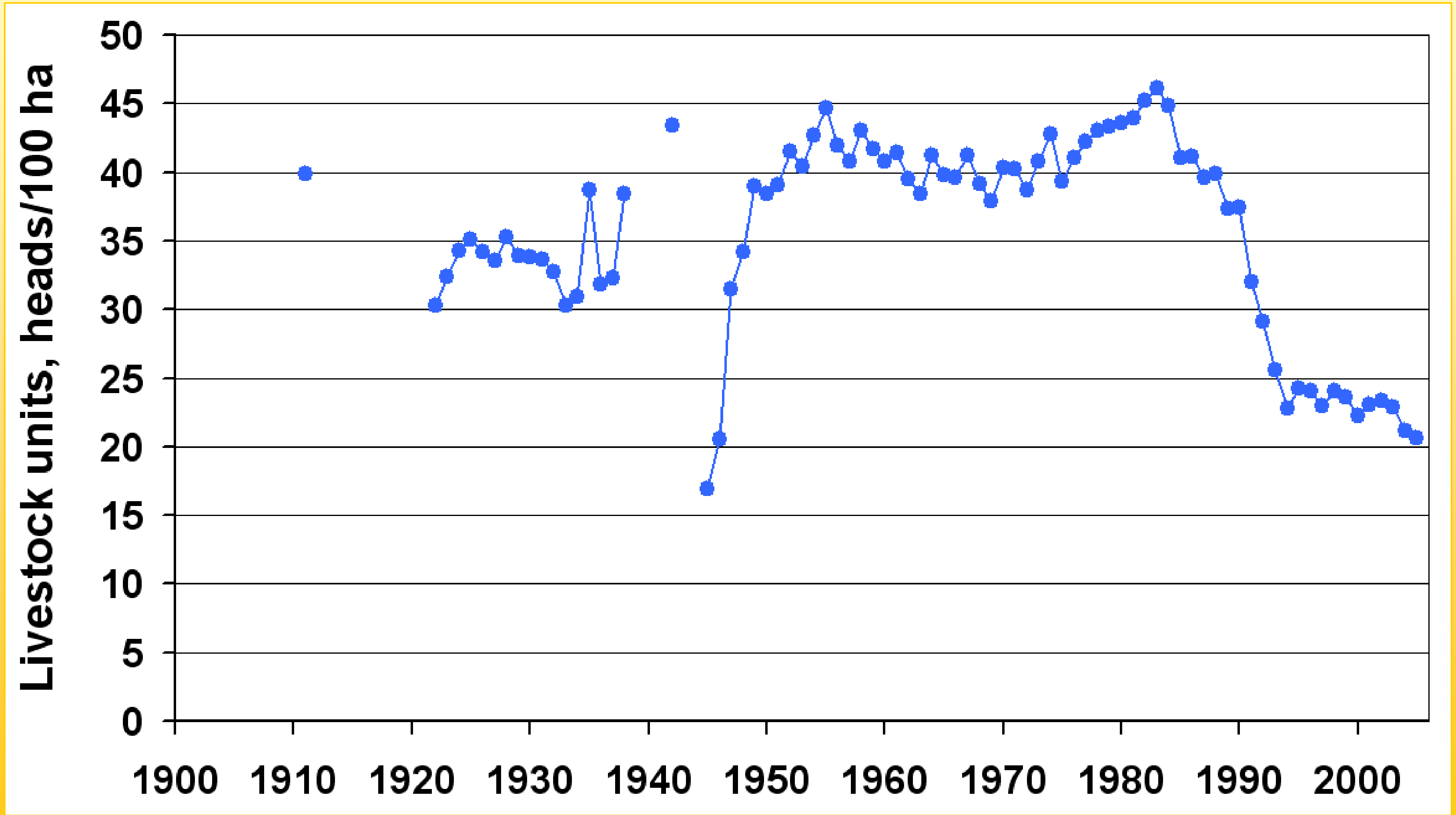
Total crop production in Hungary, in cereal units, 1901-2005

(Csathó and Radimszky, 2007)



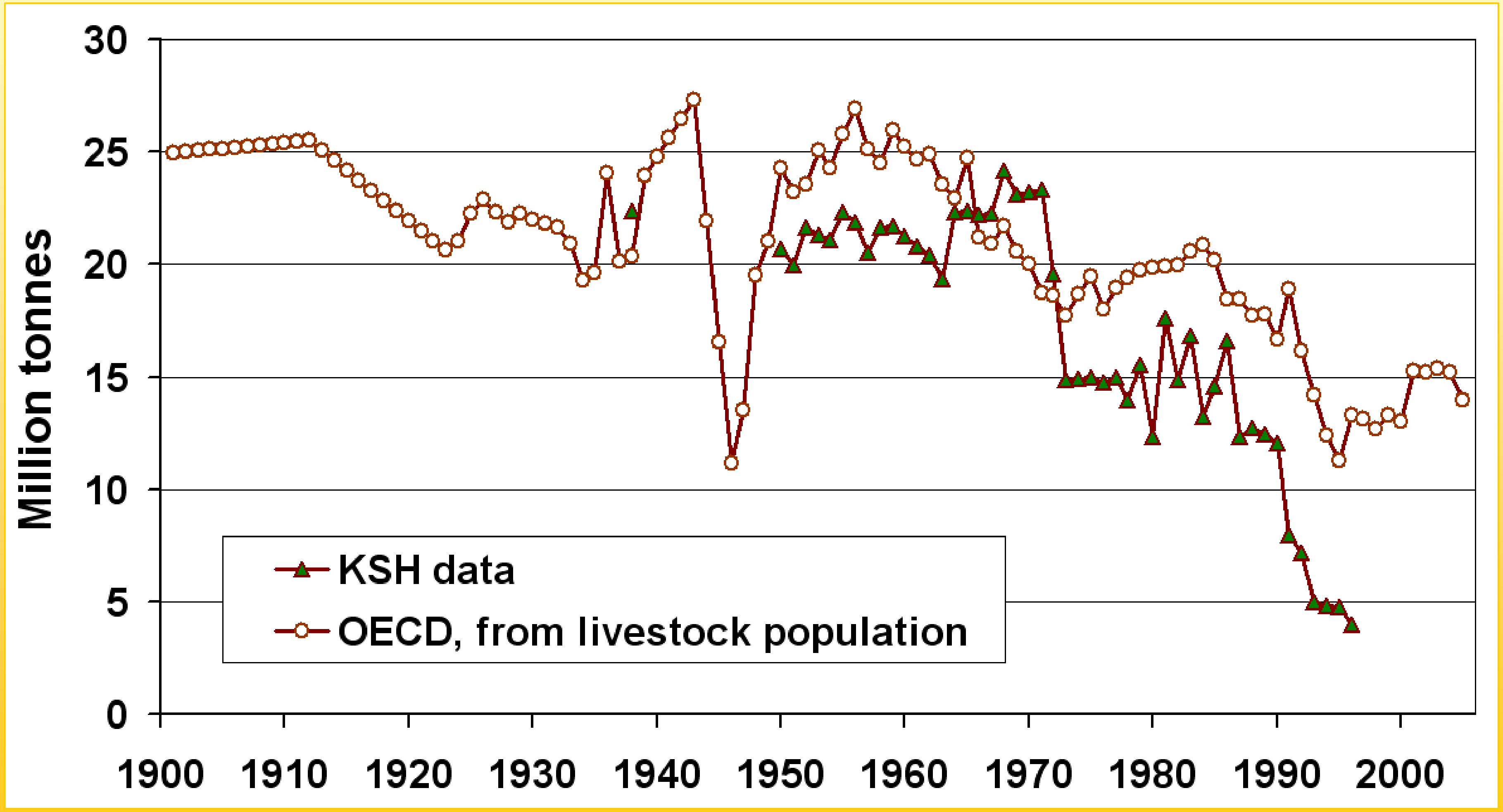
Livestock number in Hungary, 1901-2005

(Csathó and Radimszky, 2007)



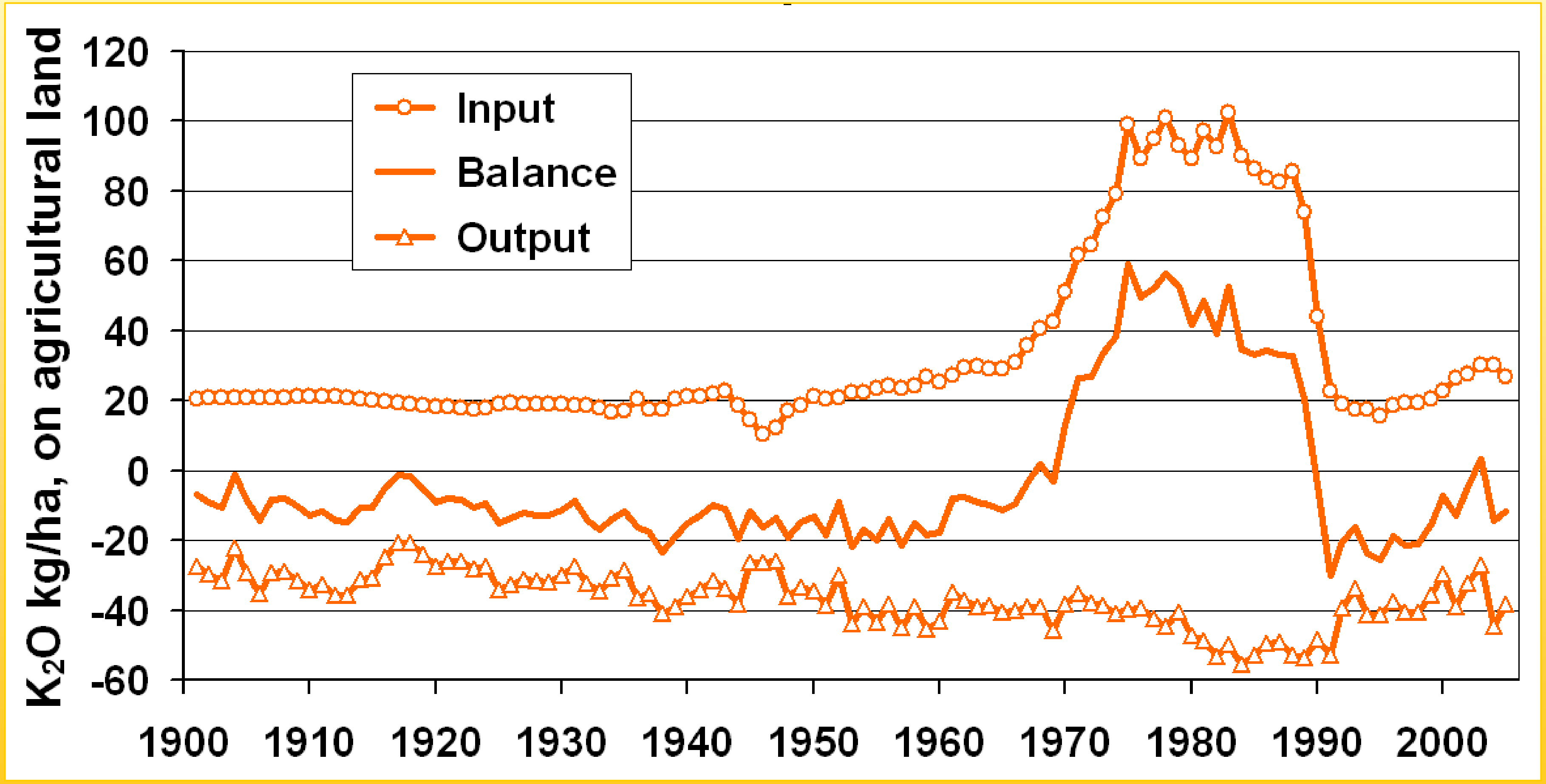
Farmyard manure application in Hungary, 1901-2005

(Csathó and Radimszky, 2007)



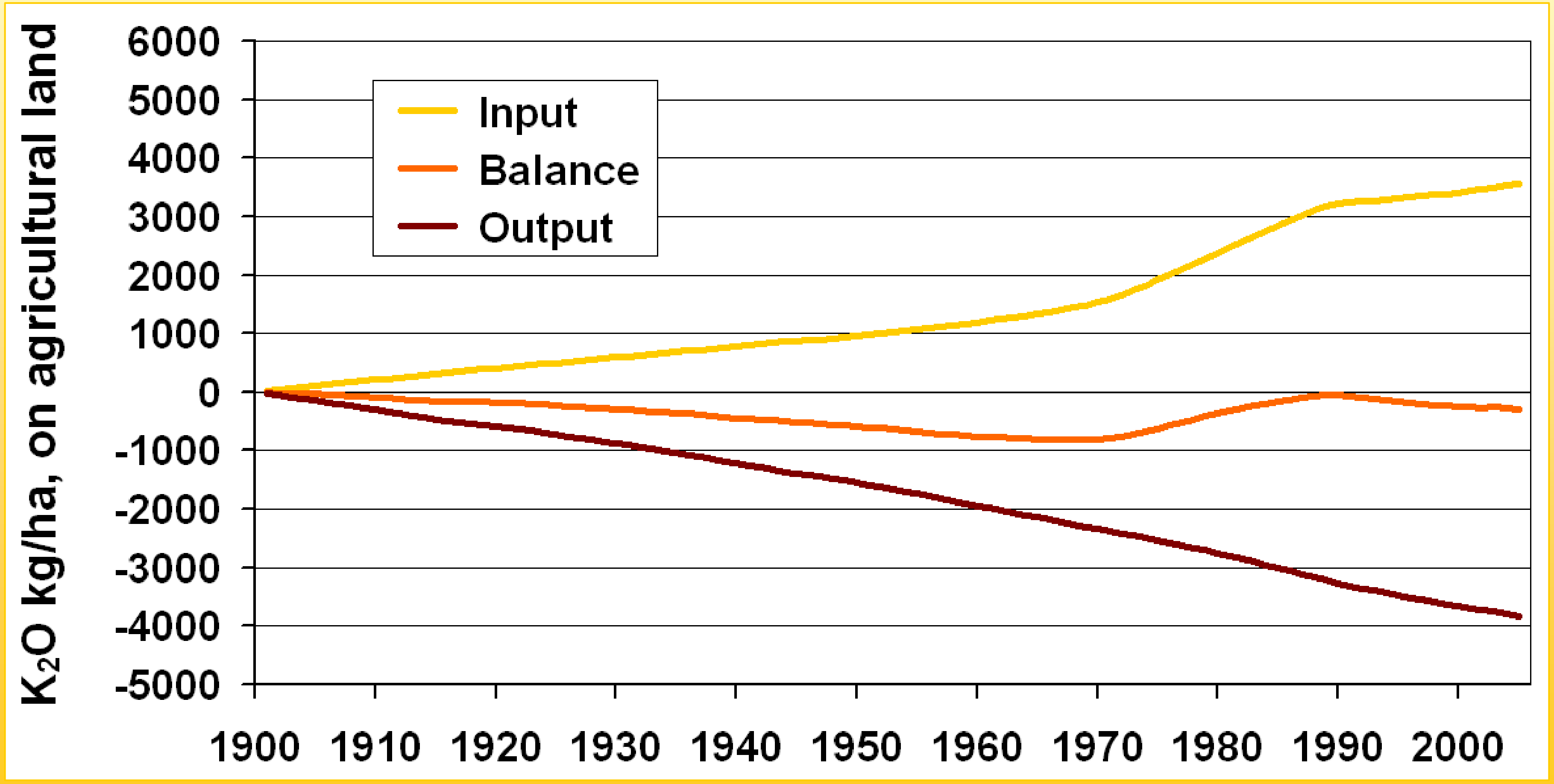
Yearly potassium balances in Hungarian agriculture, 1901-2005

(Csathó and Radimszky, 2007)

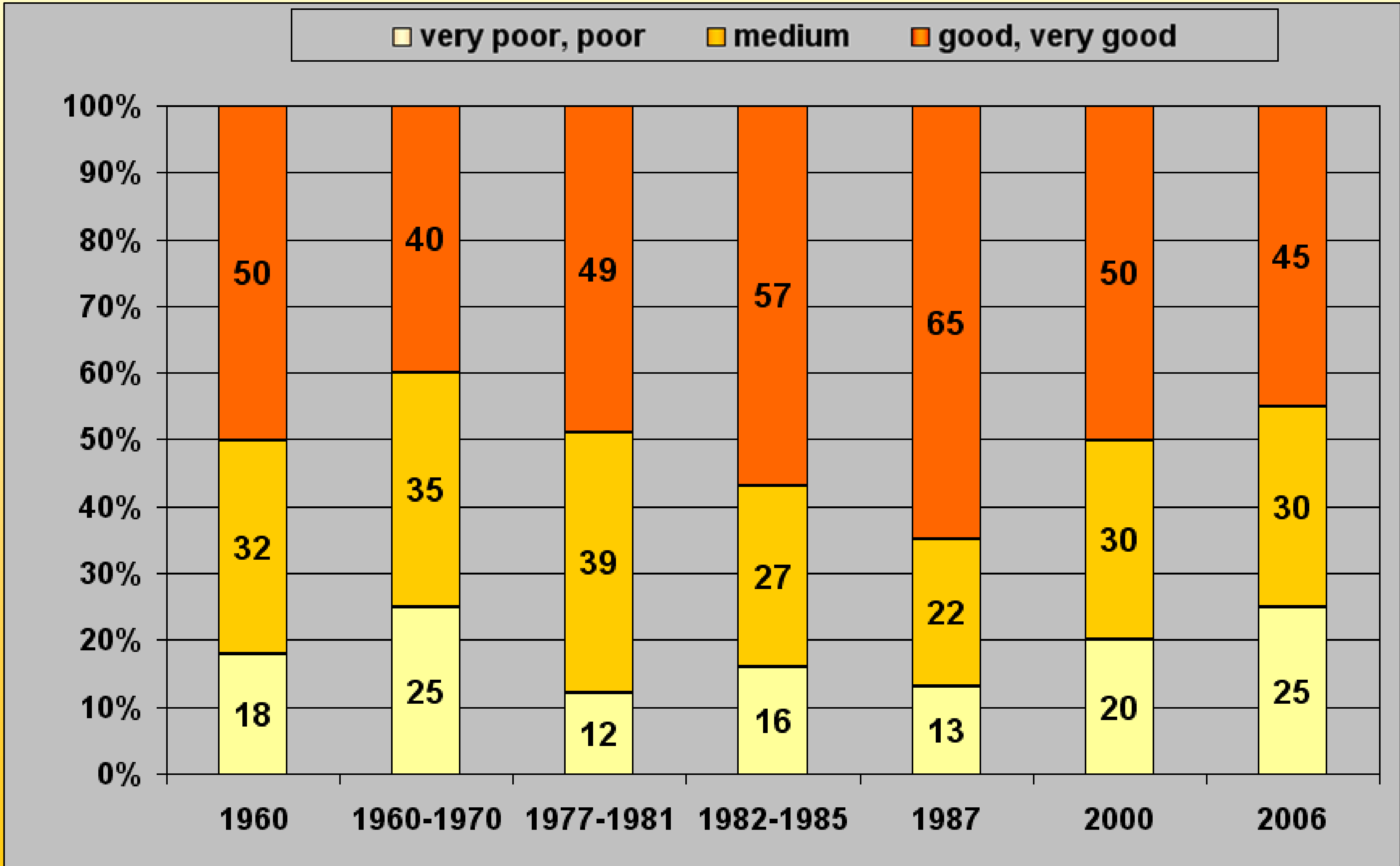


Cumulative potassium balance in Hungarian agriculture, 1901-2005

(Csathó and Radimszky, 2007)

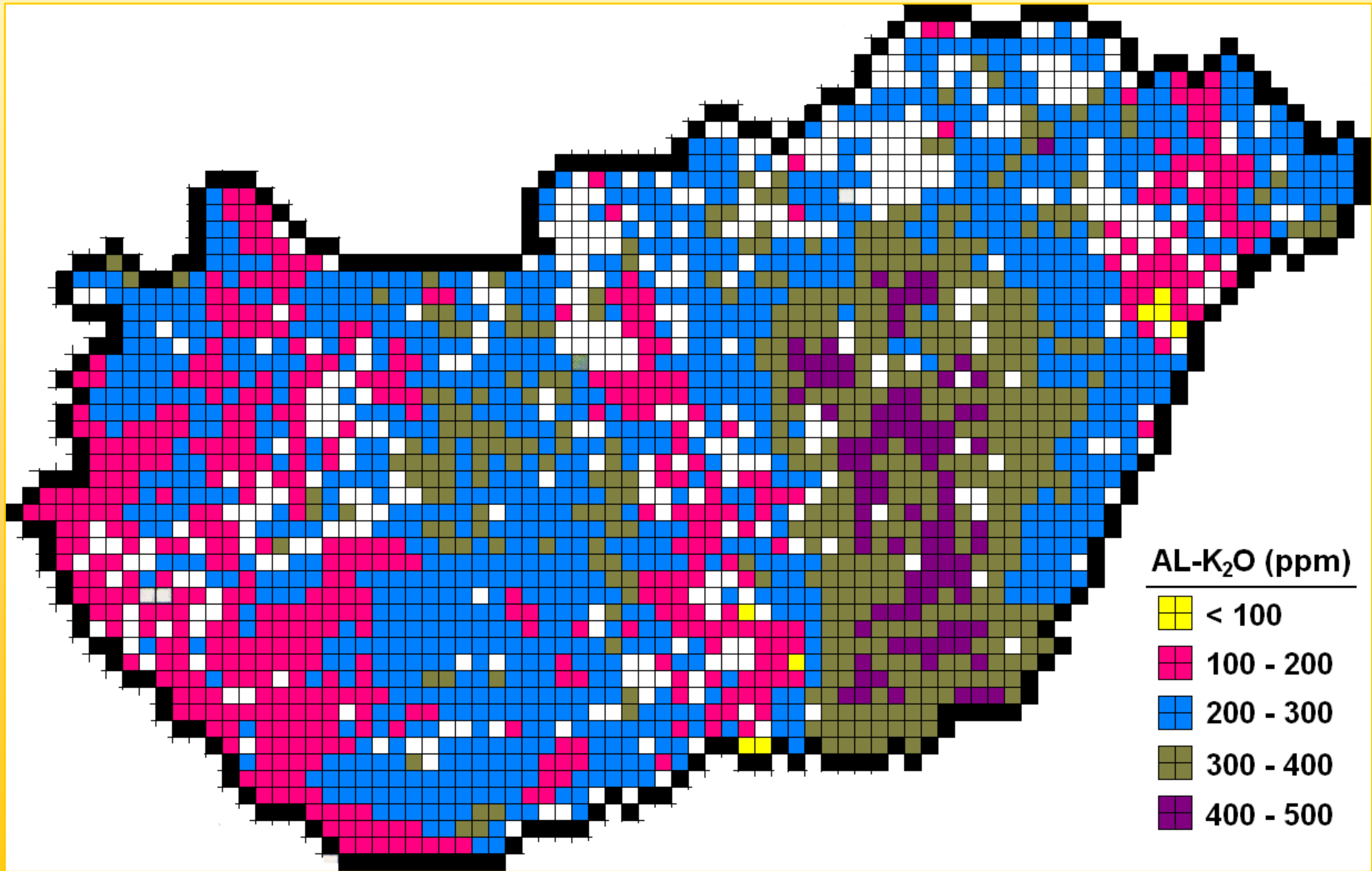


Changes in the K supply of Hungarian soils, 1960-2006



Distribution of Hungarian soils according to their AL-K_2O mg/kg content,

(Baranyai et al. 1987)



The recommended N, P_2O_5 and K_2O kg/ha doses are calculated according to the formula:

$$F = (Ye \times Sy \times M) \pm C$$

where...

F	**recommended N, P_2O_5 and K_2O kg/ha doses,**
Ye	**the expected yield level,**
Sy	**“specific nutrient contents”, [kg/t], depending on the expected yield level,**
M	**multiplication factor, depending on the soil nutrient supply categories,**
C	**fertilizer dose correcting factors (type of pre-crop, aboveground plant residues remaining on the field, previous farmyard manure application, etc.).**

Comparison of the philosophies of intensive (MÉM NAK) and sustainable, environmentally friendly (RISSAC-RIA) fertiliser recommendation systems

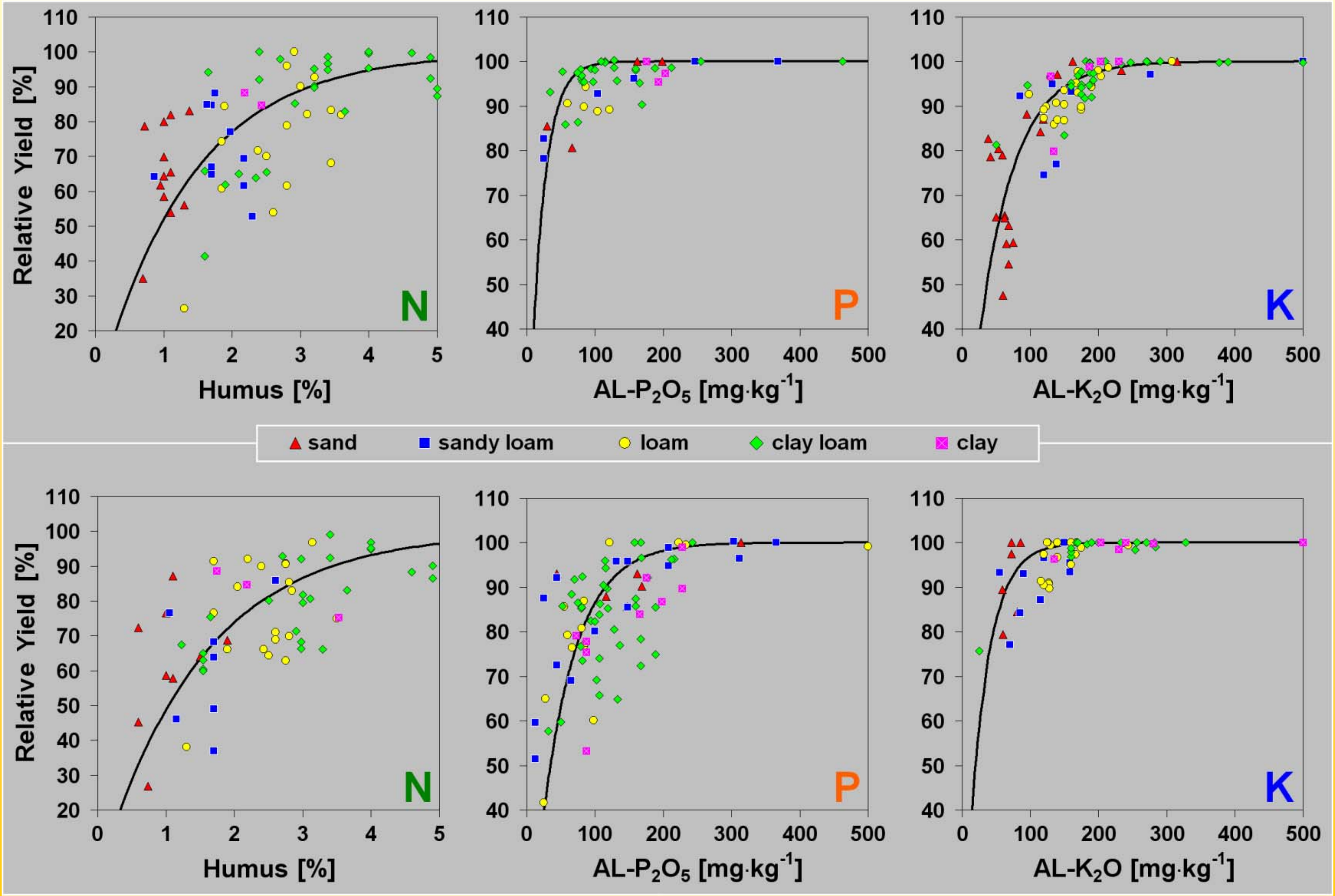
Principles for intensive plant nutrition (MÉM NAK 1979)

- Efforts for ***maximum*** yield levels
- Aim is: "***soil*** nutrition”
- Aim is: to achieve and sustain ***good*** to ***very good*** soil PK supply
- ***Quick*** soil PK build-up
- PK fertilisation ***each*** year
- PK fertilisation on ***any*** soil PK supply level
- ***Higher*** limit values for soil nutrient supply categories
- ***Unified*** soil nutrient supply categories
- Highest soil PK supply category: ***very good***
- ***Higher*** specific crop nutrient contents
- Specific crop nutrient contents ***independent*** *of the planned yield level*

Principles for sustainable fertilisation (RISSAC-RIA, 1998)

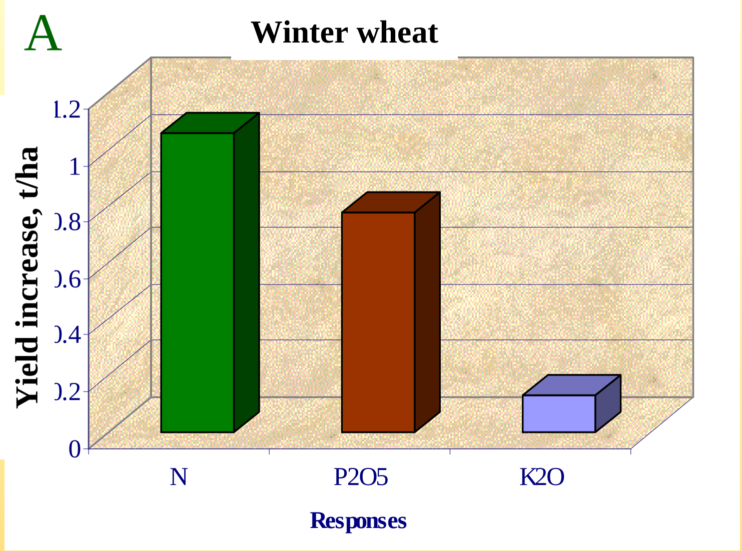
- Efforts for ***economic*** yield levels
- Aim is: "***plant*** nutrition"
- Aim is: to achieve and sustain ***moderate*** to ***good*** soil PK supply
- ***Slow*** soil PK build-up
- PK fertilisation of the ***rotation***
- *PK fertilisation only on* ***moderate*** or ***poor*** soil PK supply levels
- ***Lower*** limit values for soil nutrient supply categories
- Soil nutrient supply categories depending on the two main ***crop groups***
- *Introducing* ***excessive*** *soil PK supply category*
- ***Lower*** specific crop nutrient contents
- Specific crop nutrient contents ***dependent*** *of the planned yield level*

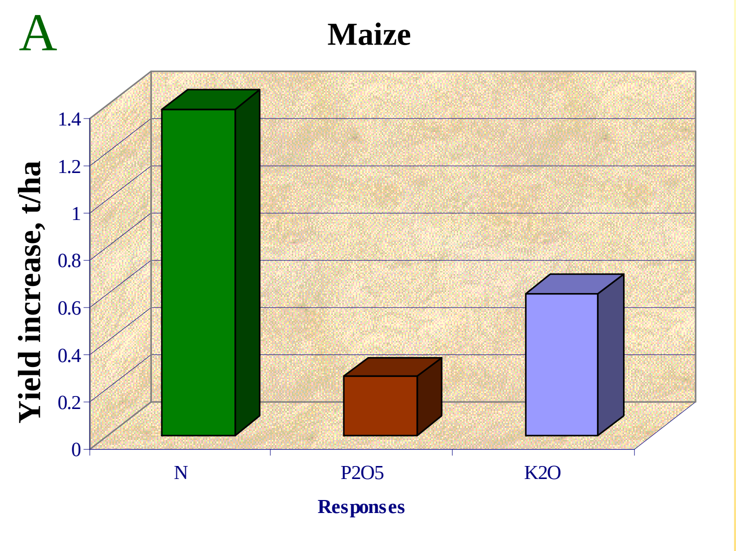
Correlation between NPK supply and responses to NPK fertilization in the database of the Hungarian field trials, 1960-2000 (Csathó, 2005)

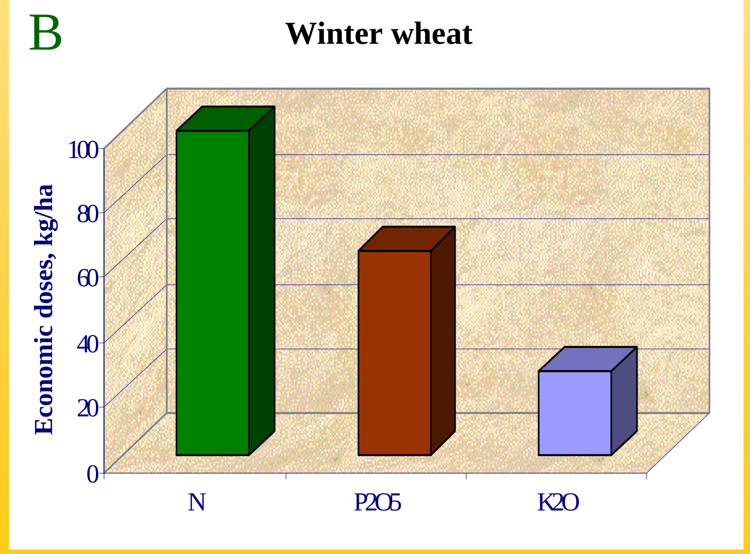


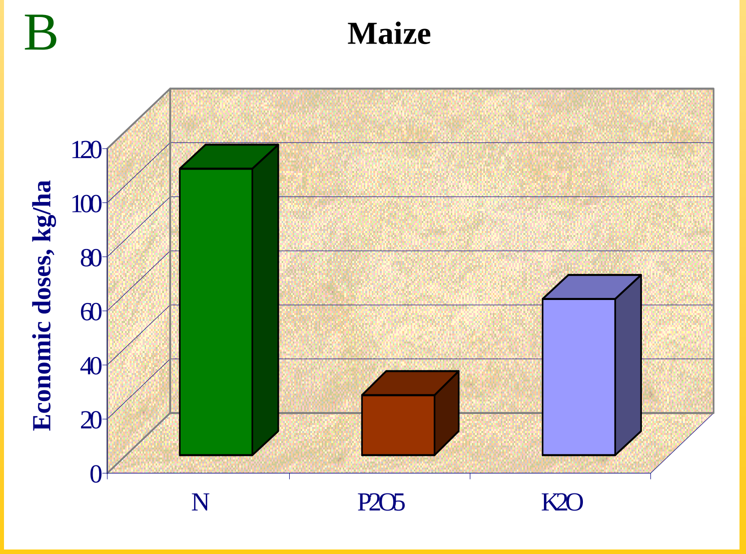
A) Average responses of winter wheat and maize to N-, P-, K application,

B) N, P2O5, K2O doses necessary for economic yields, obtained in the Hungarian field trials









Soil K supply categories depending on soil texture, expressed in AL-K_2O

- K demanding crops -

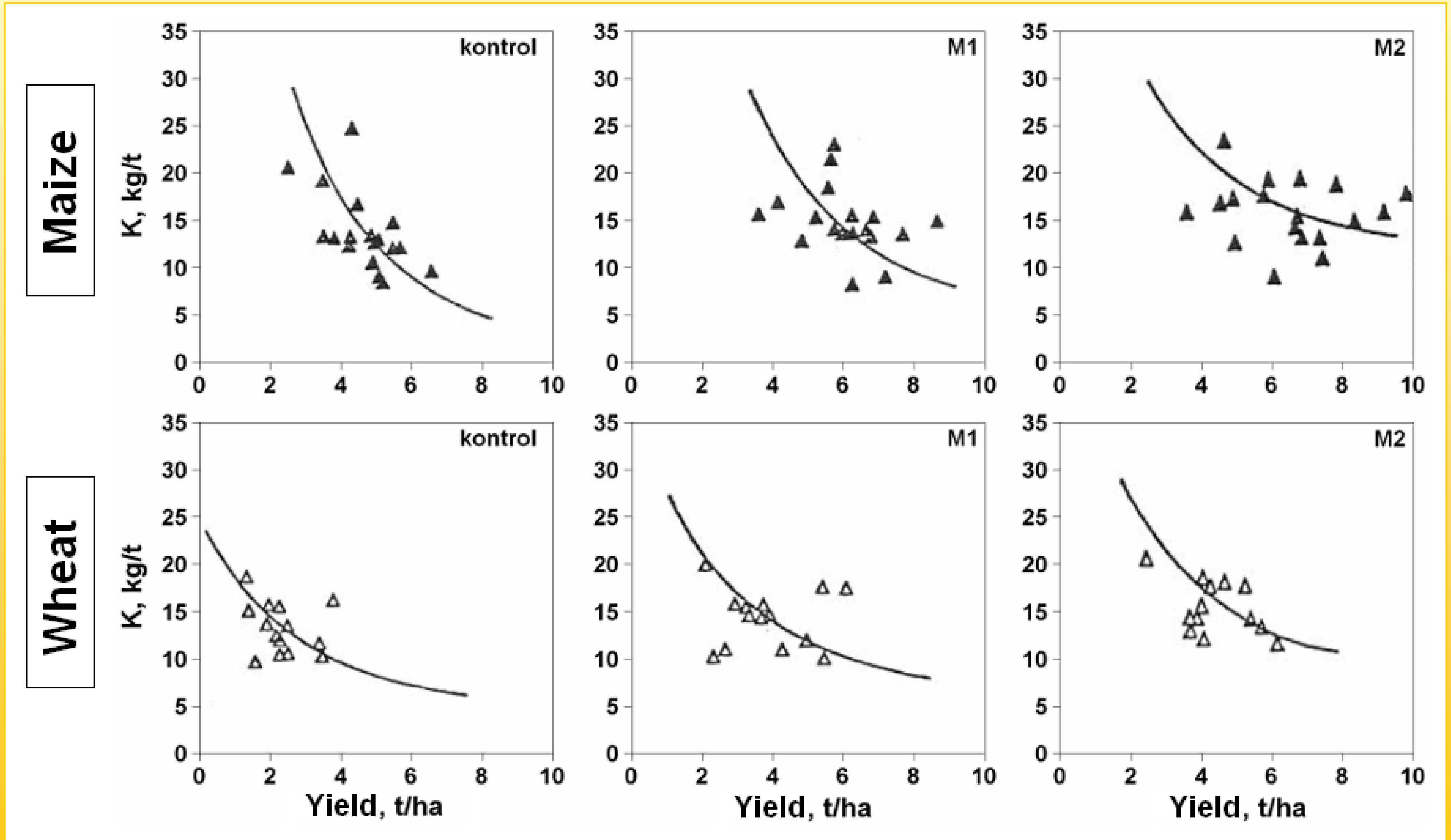
Soil texture	K supply categories (mg/kg AL-K_2O)					
	Very poor	Poor	**Moderate**	Good	Very good	Excessive
Sand	≤ 60	61-90	**91-120**	121-160	161-200	≥201
Sandy Loam	≤100	101-140	**141-170**	171-220	221-270	≥271
Loam	≤120	121-150	**151-180**	181-230	231-290	≥291
Clay Loam	≤130	131-160	**161-190**	191-250	251-310	≥311
Clay	≤140	141-170	**171-200**	201-260	261-320	≥321

- less K demanding crops -

Soil texture	K supply categories (mg/kg AL-K_2O)					
	Very poor	Poor	Moderate	**Good**	Very good	Excessive
Sand	≤ 40	41-60	61-90	**91-120**	121-160	≥161
Sandy Loam	≤ 80	81-100	101-140	**141-170**	171-220	≥221
Loam	≤100	101-120	121-150	**151-180**	181-230	≥231
Clay Loam	≤110	111-130	131-160	**161-190**	191-250	≥251
Clay	≤120	121-140	141-170	**171-200**	201-260	≥261

Correlation between the yield level and the crop specific K content

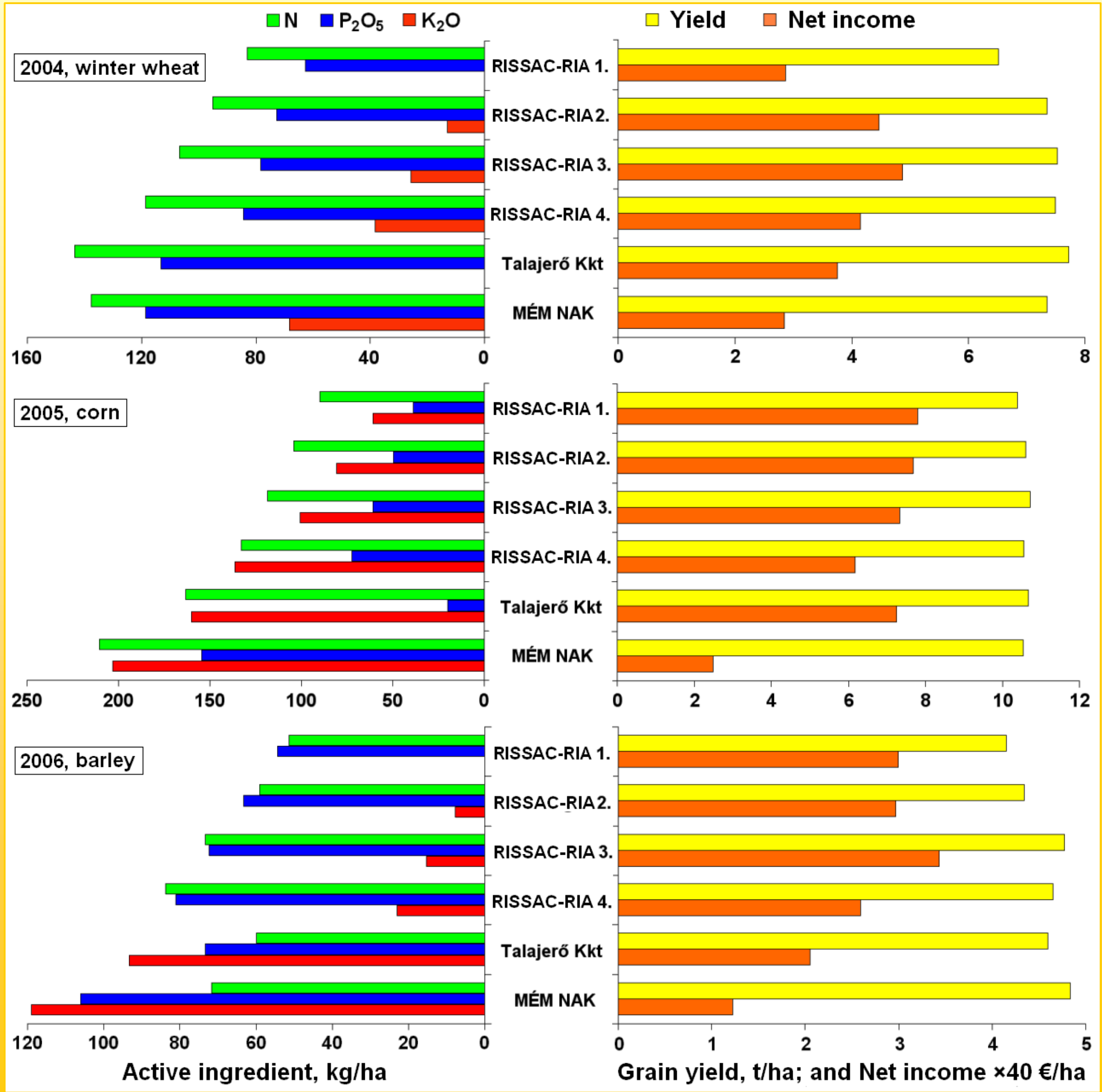
(Árendás, 1998)



Basic characteristics of the soils in the IMPHOS field trials, 2004-2006

ID	IMPHOS-1	IMPHOS-2	IMPHOS-3
Location	Balatonszentgyörgy	Mezőkövesd	Nagyhörcsök
Soil type	brown forest soil	meadow soil	chernozem
Soil texture	sandy loam	clay loam	loam
pH-KCl	6.45	4.49	7.1
$CaCO_3$, %	0	0	3.9
Humus content, %	1.62	3.43	2.95
AL-P_2O_5, mg/kg	107	38	90
AL-K_2O, mg/kg	156	209	167

Recommended NPK doses, yields and net incomes, obtained in the different recommendation systems. IMPHOS trials.



Optimal K doses and factors determining it in the IMPHOS field trials, 2004-2006

Trial	Year	Crop	Expected yield level, t/ha	AL-K2O, mg/kg	K supply category	Pre-crop byproduct incorporated (t/ha)	K dose, K2O kg/ha in the optimal recommendation level	Response to K, yield surplus t/ha
	2004	winter wheat	5.0	156	good	rape straw (3.6)	38	0.03
IMPHOS-1	2005	maize	8.0	156	moderate	wheat straw (7)	88	0.50
	2006	barley	4.8	156	good	corn stem (12.1)	0	0.20
	Mean						***42***	***0.24***
	2004	winter wheat	5.5	209	very good	sunflower stem (6)	0	0
IMPHOS-2	2005	maize	7.0	209	good	wheat straw (11.6)	42	0
	2006	barley	5.0	209	very good	corn stem (10.7)	0	0
	Mean						***14***	***0***
	2004	winter wheat	6.0	167	good	-	20	0.36
IMPHOS-3	2005	maize	10.0	167	moderate	-	94	0.65
	2006	barley	5.5	167	good	-	23	0.29
	Mean						***46***	***0.43***

Differences between recommended N(P)K doses for corn, used

A) for fodder

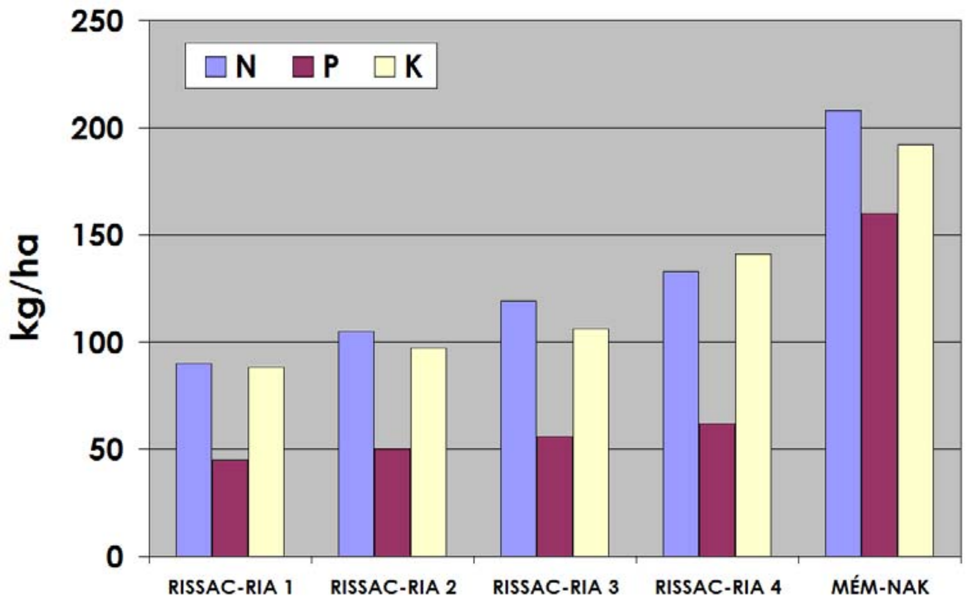
B) for fuel ethanol

Soil data
(Nagyhörcsök, Hungary)

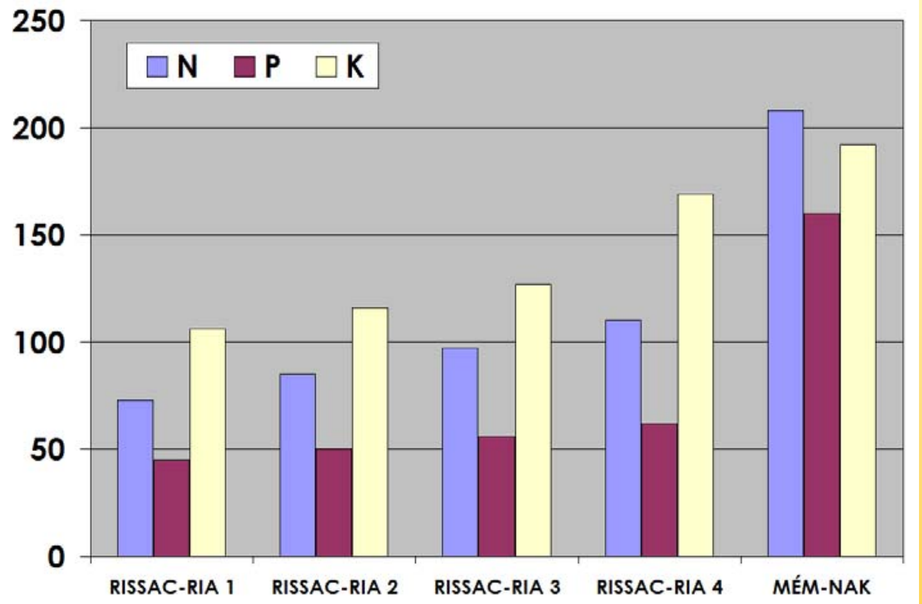
Soil	Value	Supply category
Type	Loam	
Humus	2.5 %	medium
AL-P_2O_5	90 mg/kg	medium
AL-K_2O	167 mg/kg	medium
$CaCO_3$	3.9 %	
pH-KCl	7.1	
Mg-KCl	130 mg/kg	good
EDTA-Zn	0.9 mg/kg	poor
EDTA-Cu	2.2 mg/kg	sufficient
EDTA-Mn	131 mg/kg	sufficient

Recommended N(P)K doses for corn

A) for fodder



B) for fuel ethanol



Thank You!