

What is a virtual plant good for?

Nándor Fodor

RISSAC of HAS, Budapest

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Crop Simulation Models

Modeling the most important interdependences and processes of the atmosphere-soil-plant system

Description of processes:
functions, differential equations and complex algorithms...
implemented in a software

Crop Simulation Models

Required data:

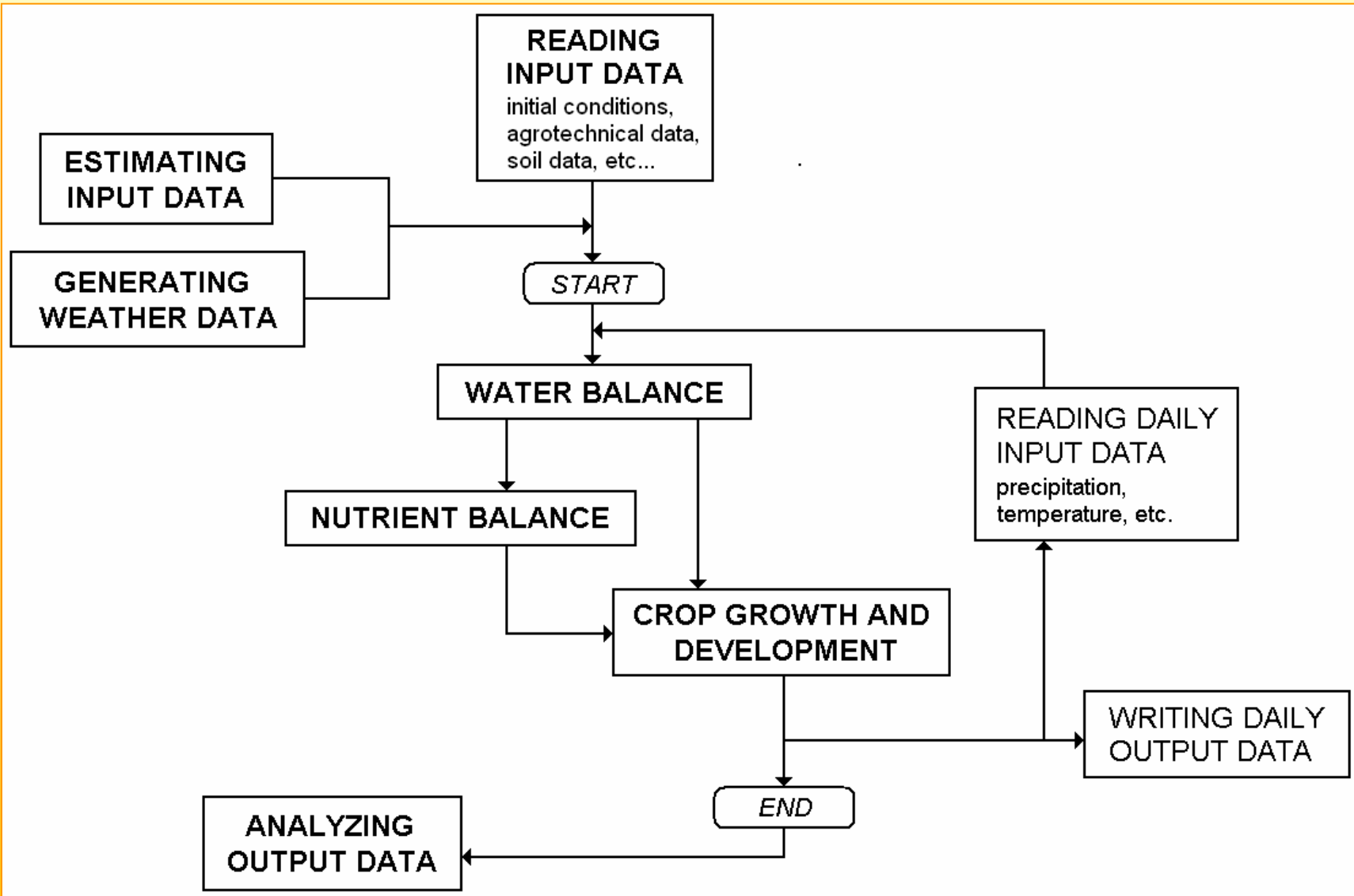
Parameters: physical, chemical and biological
characterization of the system:
DUL, pH, T_{base} ...

Initial conditions: *water content ...*

Boundary conditions: *met. data ...*

Agro-technical conditions: *planting ...*

Crop Simulation Models



Crop Simulation Models

Beginnings during the Cold War:
Give a 'better' estimate for the volume of winter wheat production of the SU

Problem #1: *slow hardware*

Year	Processor	Run time
1993	286	>8 hour
2005	P4	27 sec
2007	AMD Opteron	4 sec

Crop Simulation Models

**Problem #2: *fix software* »
*cumbersome development***

$$DM = 2.1 \cdot \frac{GR \cdot (1 - e^{c \cdot LAI})}{PD} \cdot \min(S_1, S_2, \dots)$$

Problem #3: *lack of data*

- » **Weather Generator**
- » **Soil Par. Estimator**

What are the Crop Simulation Models good for?

**Education: virtual crop production
competition**

**Research: extrapolating the results of
experiments in space & time**

**Practice: irrigation control,
search for adaptation
strategies for sustainable
agriculture**

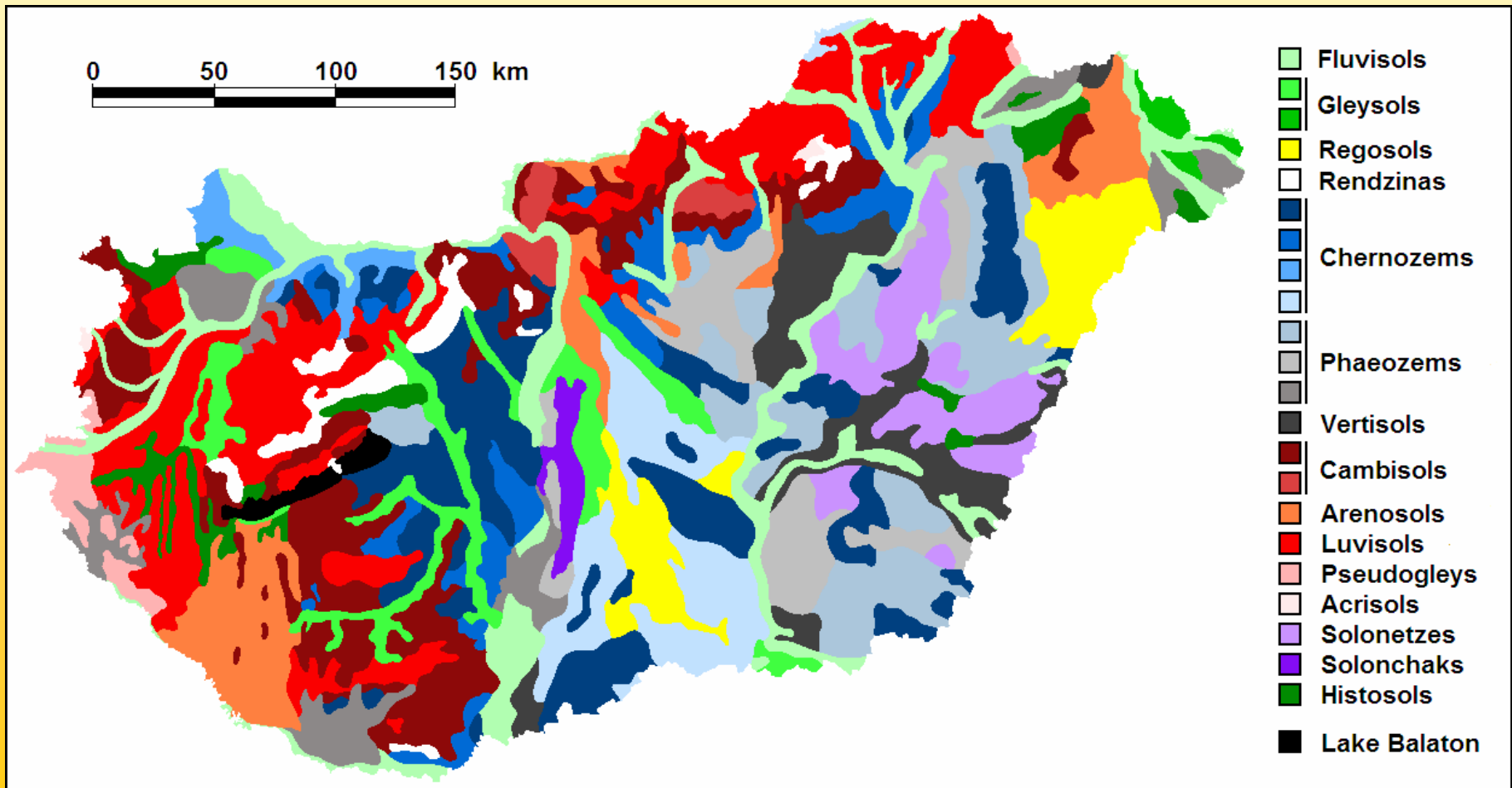
Extrapolating experiment results in space & time

Nitrate profiles at Nagyhörcsök, Hungary

Extrapolating experiment results in space & time

Prospective effects of climate change

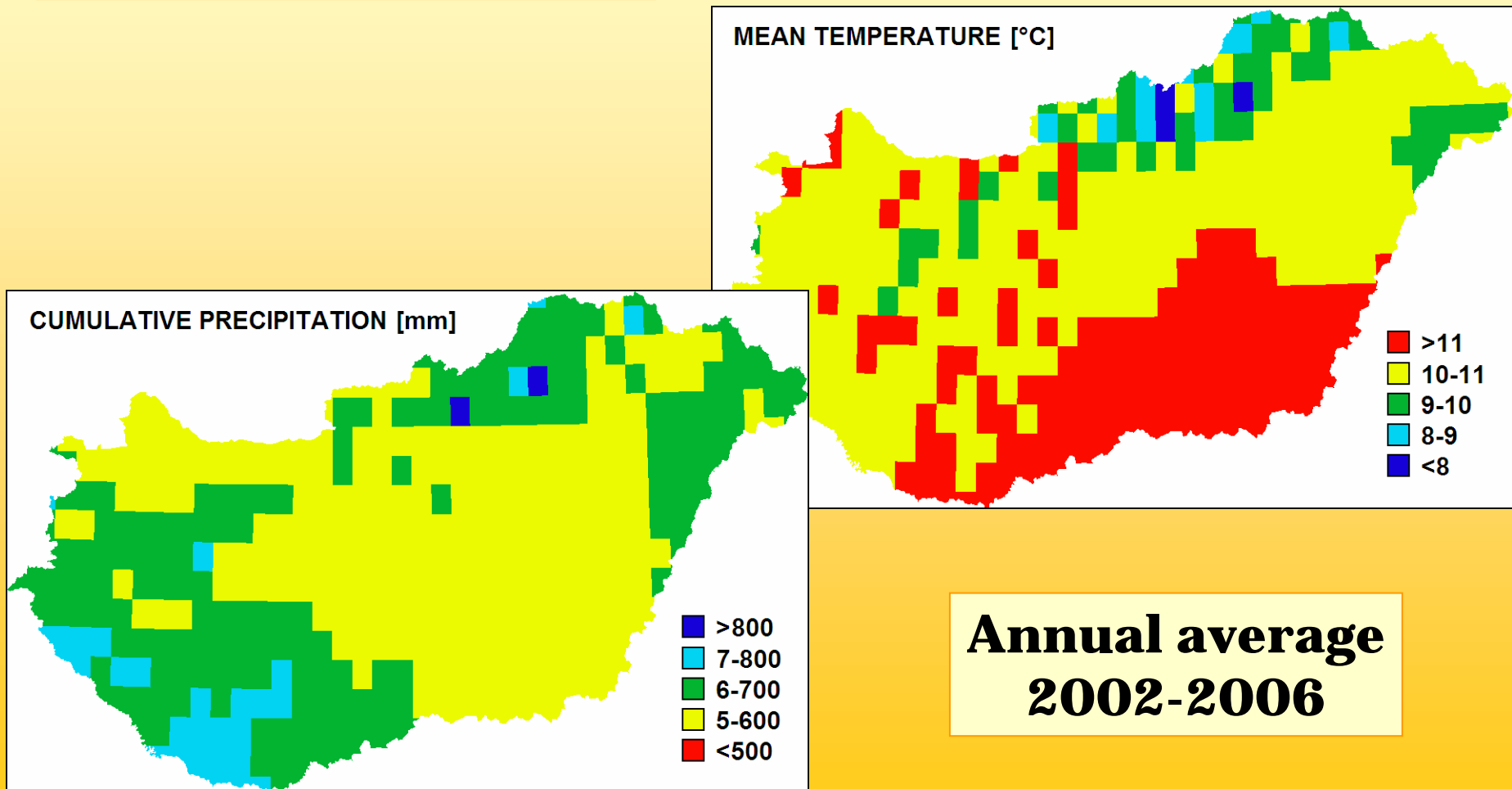
Soil data...



Extrapolating experiment results in space & time

Prospective effects of climate change

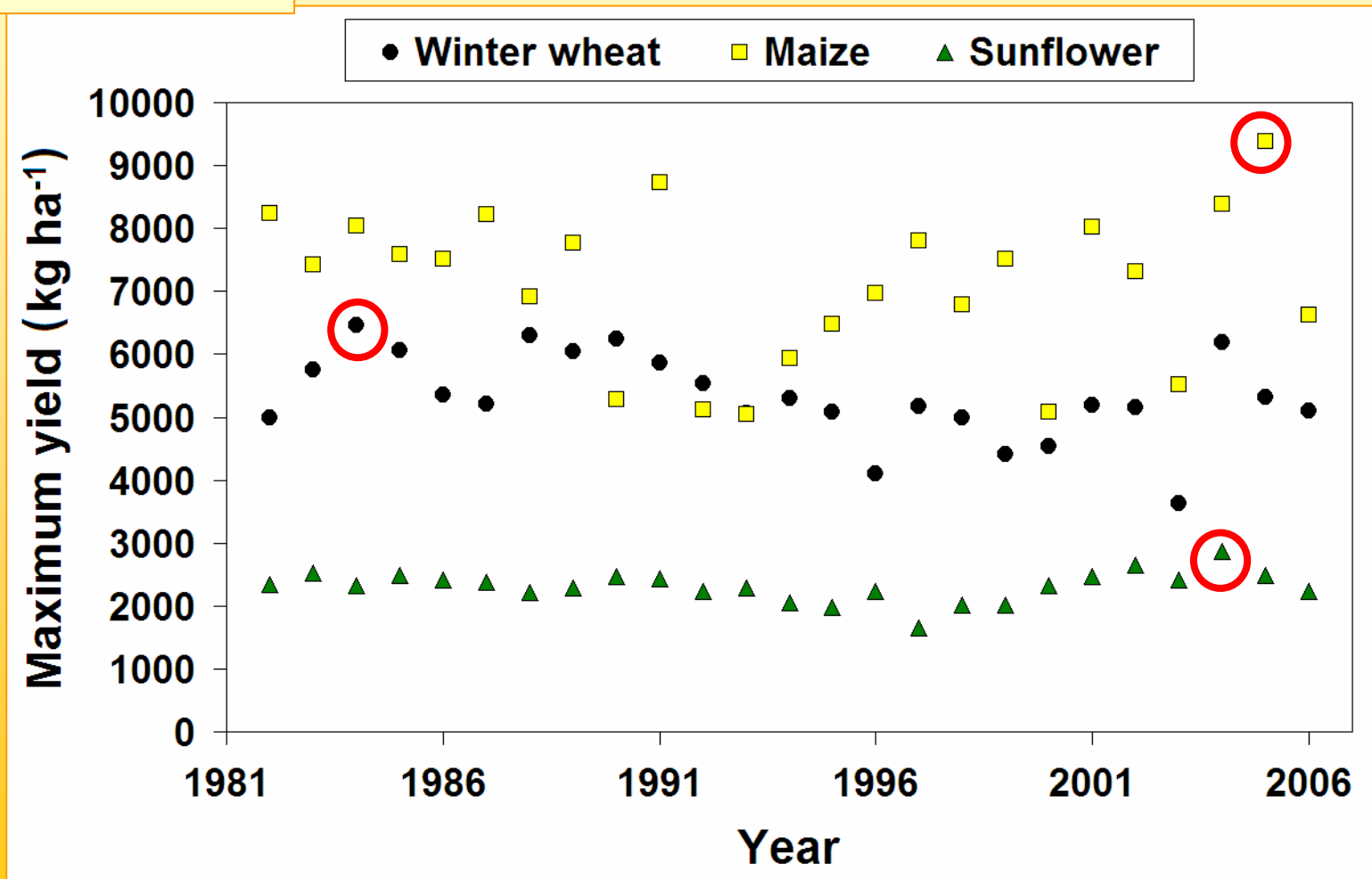
Meteorological data...



Extrapolating experiment results in space & time

Prospective effects of climate change

Plant data...



Extrapolating experiment results in space & time

Prospective effects of climate change

Estimated scale of climate change by 2100

Parameter	Mathematical operation	Winter	Spring	Summer	Autumn
Temperature (°C)	Add	3.2	2.3	2.8	2.7
Precipitation (mm)	Multiply	1.11	1.04	0.91	0.99
CO ₂ (ppm)	Fix value			557	

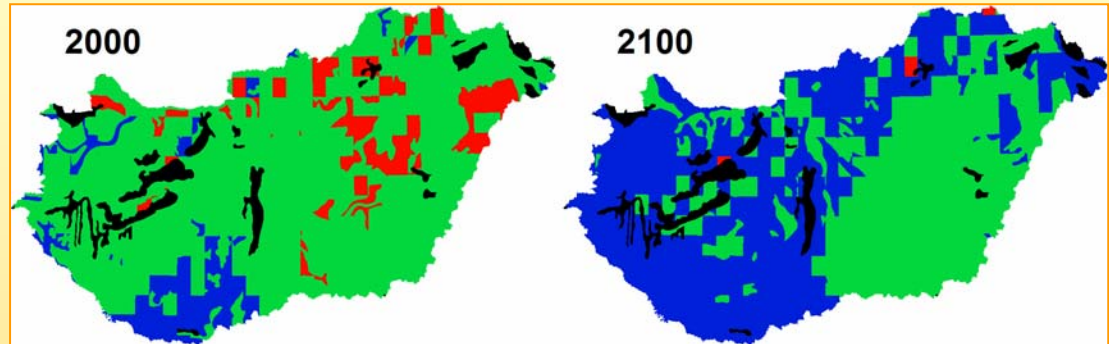
Extrapolating experiment results in space & time

Prospective effects of climate change

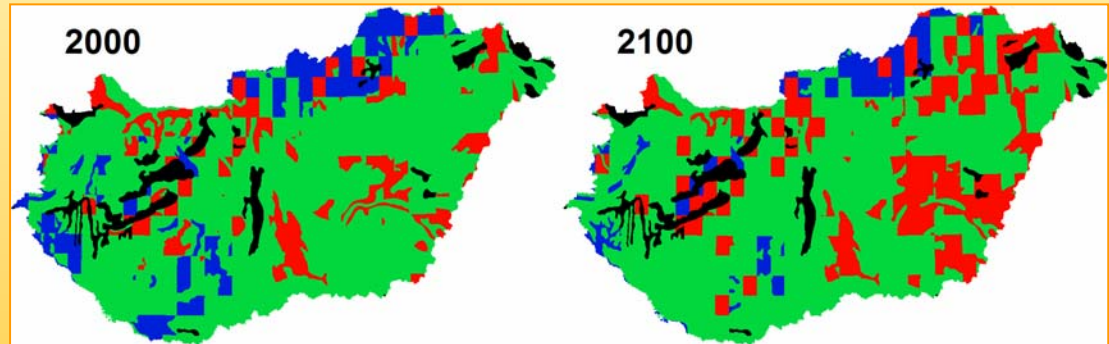
Yield

below average
average
above average

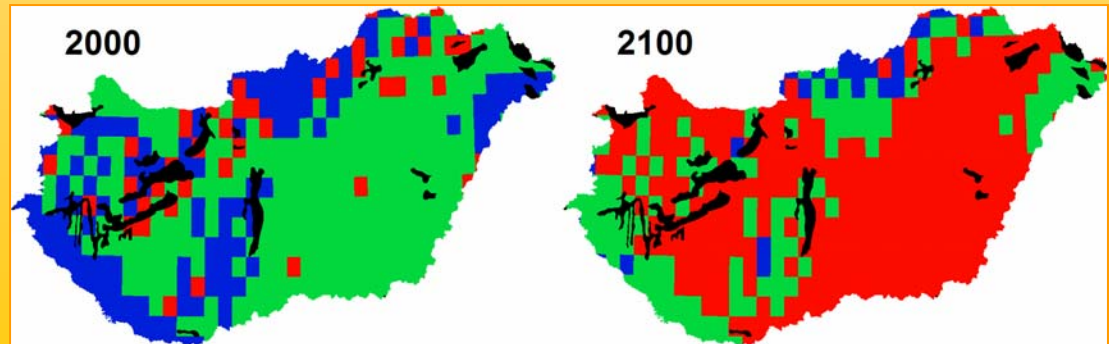
win. wheat



maize



sunflower

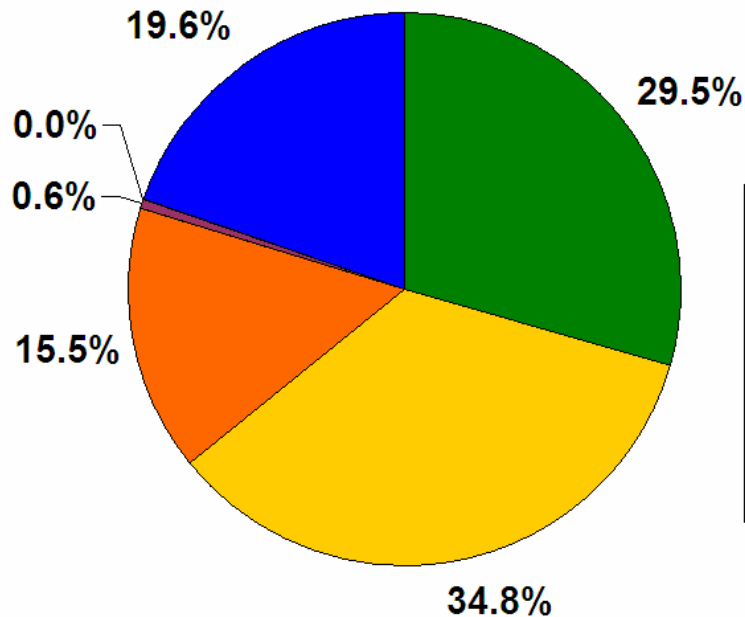


Search adaptation strategies

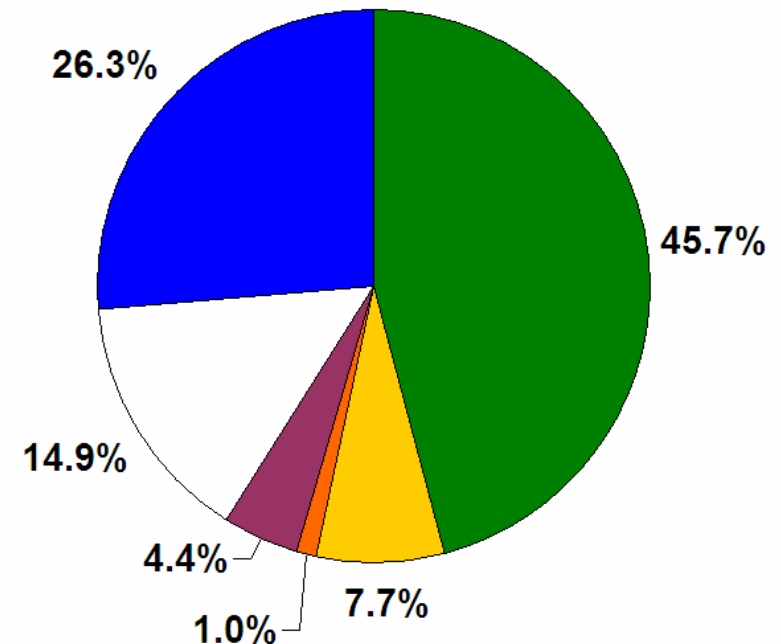
» Spatial analogies - 2060

Distributions of sowing areas

CARPATHIAN BASIN



NORTHERN GREECE



Search adaptation strategies

If farmers would use the method of spatial analogies for adaptation to the possible changes the cost of subduing the harmful effects of the climate change might be decreased with several billion dollars even in the case of a couple of degrees of temperature rise.

Adams R.M. et al., 1998 – Climate Research

Search adaptation strategies

- 1. Set up agr-met stations with alternative crops**
- 2. Create COMPLETE & HOMOGENOUS database**
- 3. Calibrate crop simulation model**
- 4. Combine model with climate change and agro-technical scenarios**
- 5. Extensive analysis of output data**