



# What would happen to barley production in Finland if the global temperature increases above 4°C

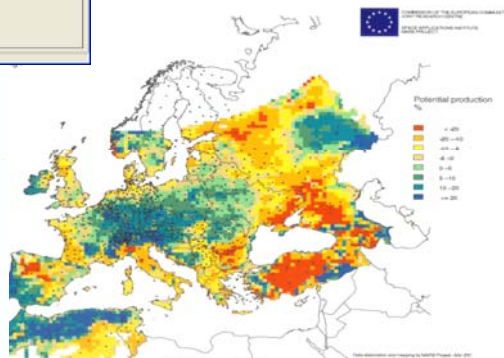
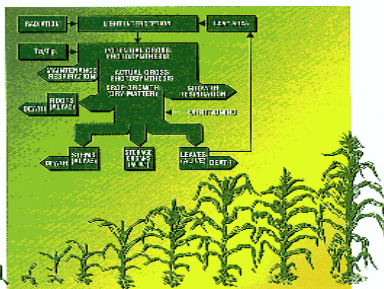


Reimund Rötter *and*  
 T Palosuo, N Virtanen, T Salo, T Carter, M Dubrovsky, M Trnka, et al.

## WOFOST, general



**WOFOST : World Food Studies (Wageningen-Amsterdam); and centre piece of a European Crop Growth Monitoring System (CGMS)**





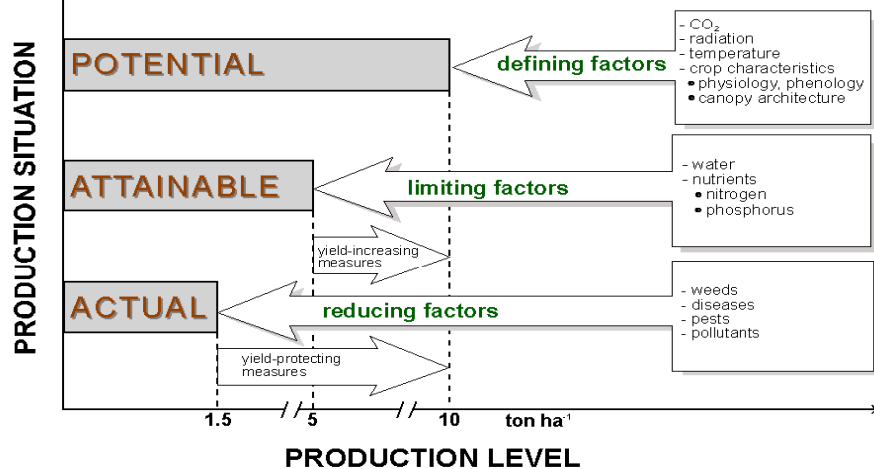
## 2. Set-up of the study

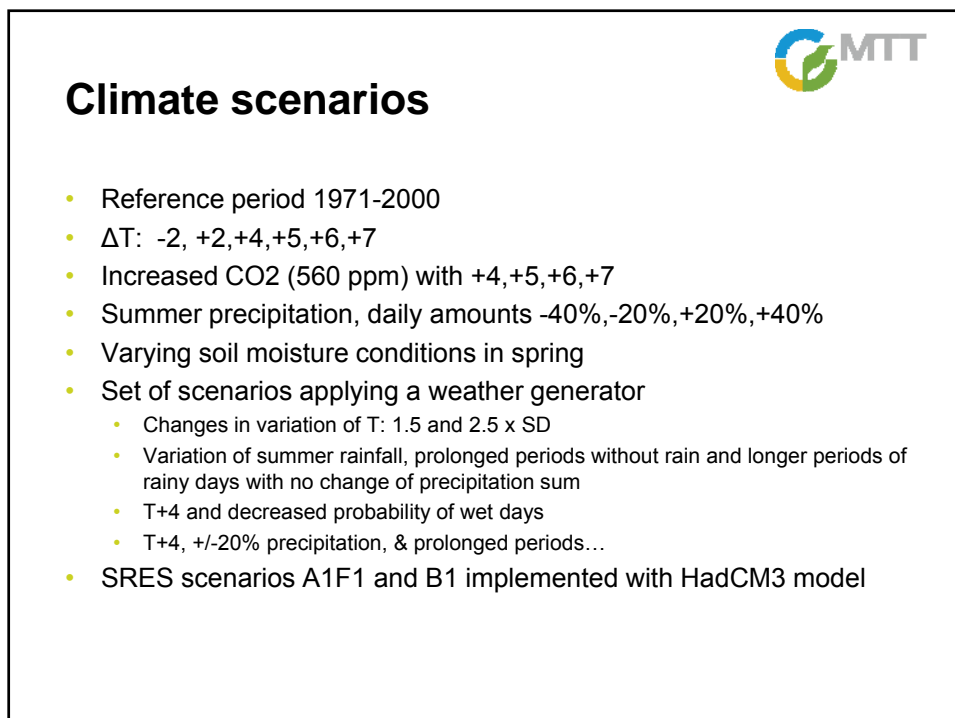
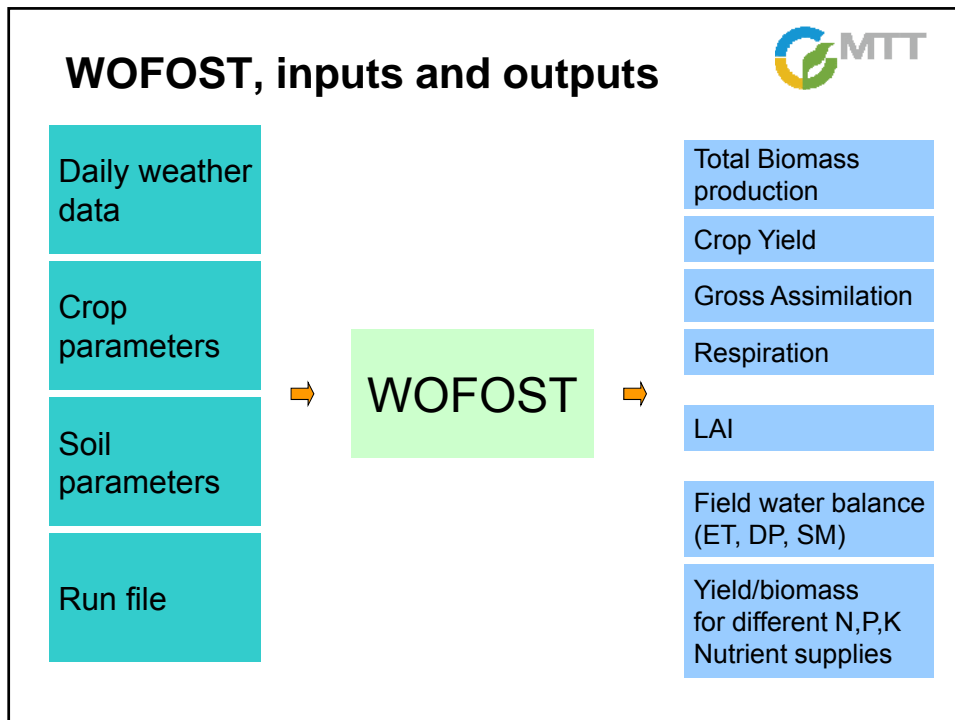
- Two stations: Jokioinen and Jyväskylä
- Two soil types: Heavy clay and coarse sandy soil
- One crop: Spring barley
- Variable sowing date
  - Specific sowing date for each year and both stations calculated based on temperature limit and soil moisture criteria
- Simulations of water-limited crop growth (i.e. excluding nutrient limitation) using WOFOST



## WOFOST, general

### 1. Crop growth simulation - Modeling approach of C.T. de Wit School

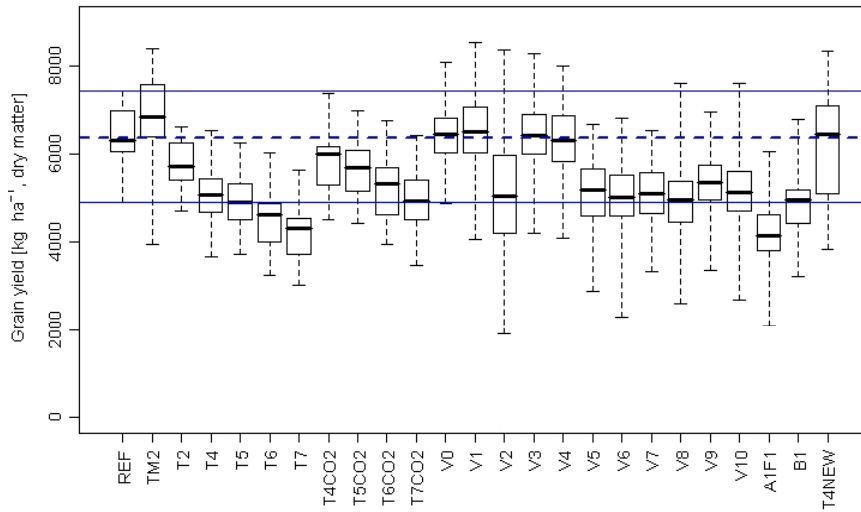




### 3. RESULTS (1)



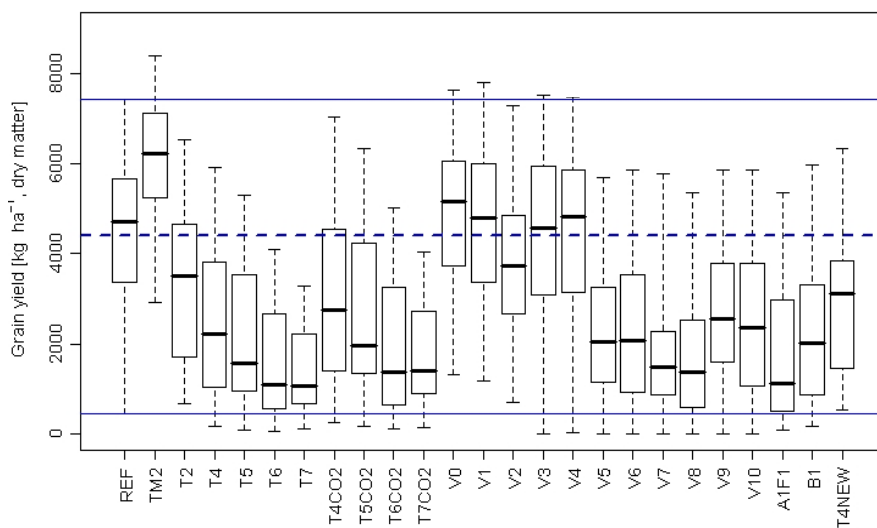
Jokioinen Clay soil



### 3. RESULTS (2)



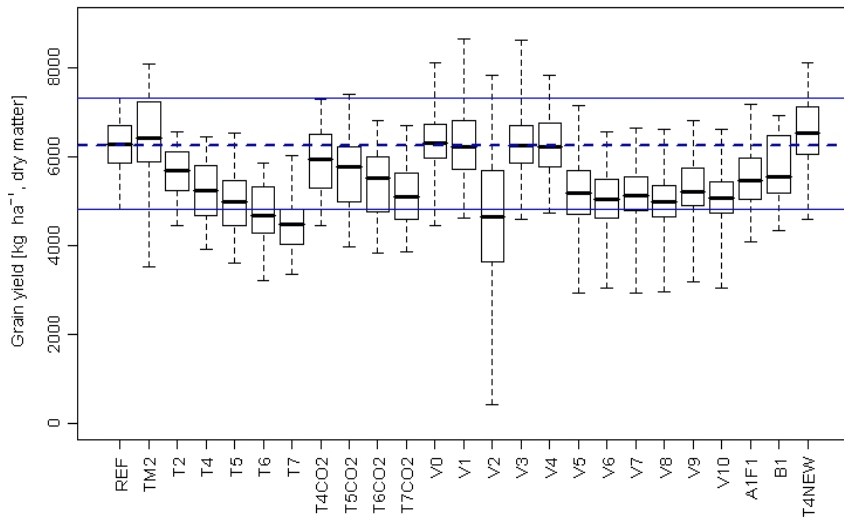
Jokioinen Sandy soil



### 3. RESULTS (3)



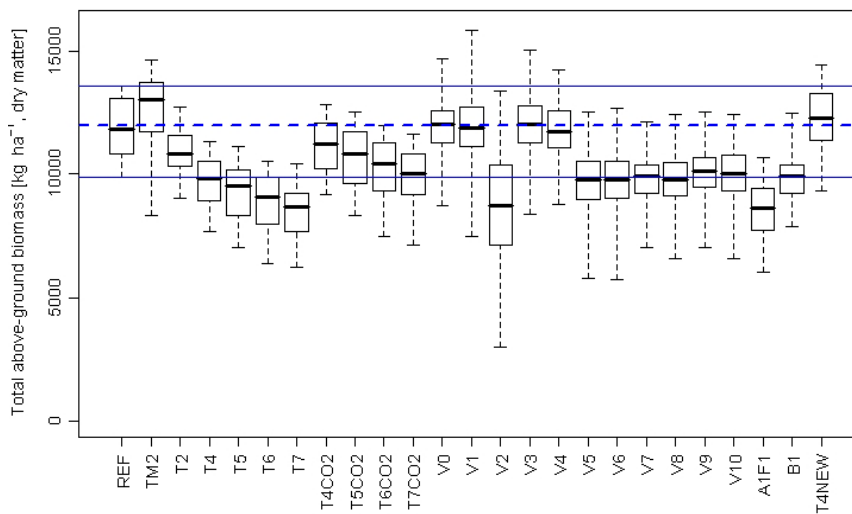
Jyväskylä Clay soil



### 3. RESULTS (4)



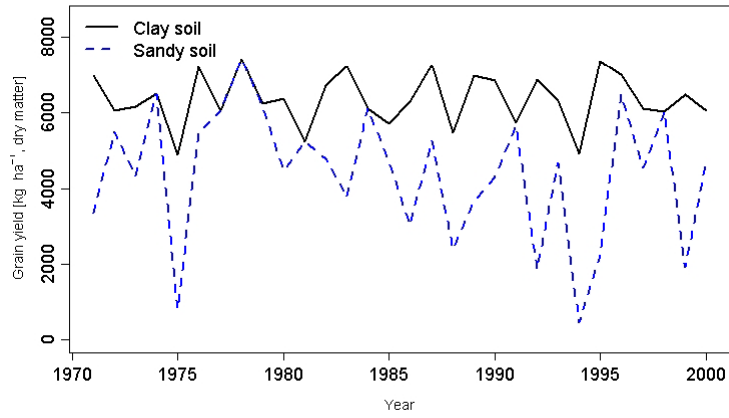
Jokioinen Clay soil



### 3. RESULTS (5)



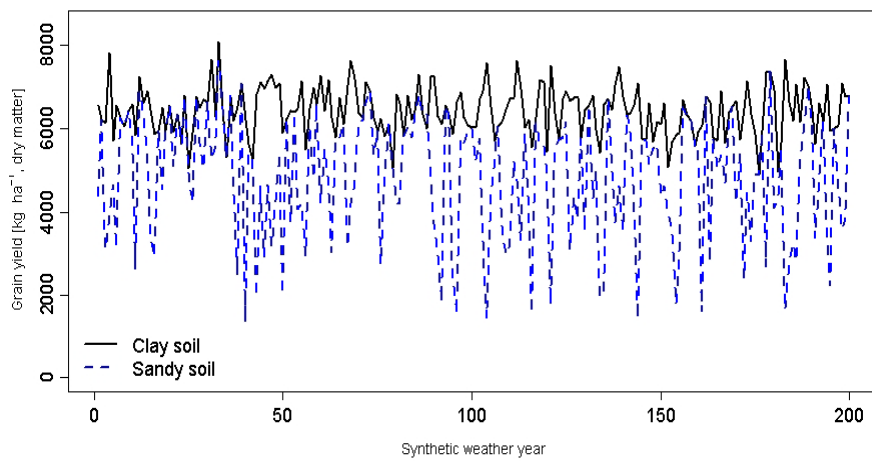
Jokioinen, Reference period



### 3. RESULTS (6)



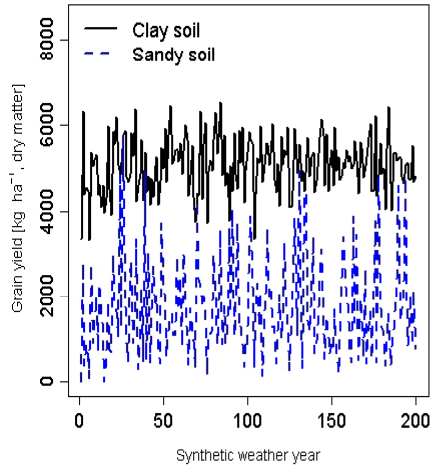
Jokioinen, Reference, 200 years synthetic weather



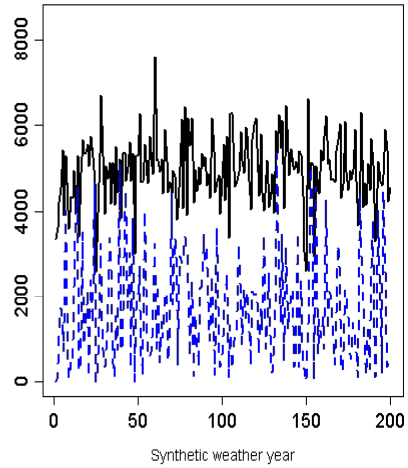
### 3. RESULTS (7)



Jokioinen, V7



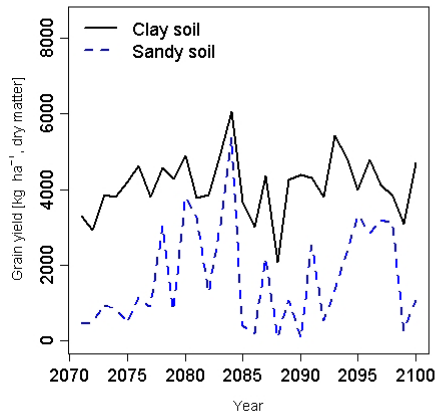
Jokioinen, V8



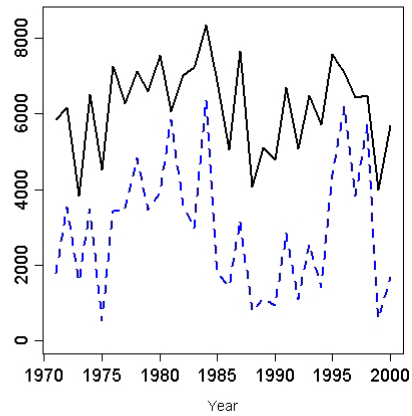
### 3. RESULTS (8)



Jokioinen, A1F1



Jokioinen, T+4 with new cultivar





### 3. RESULTS (9)

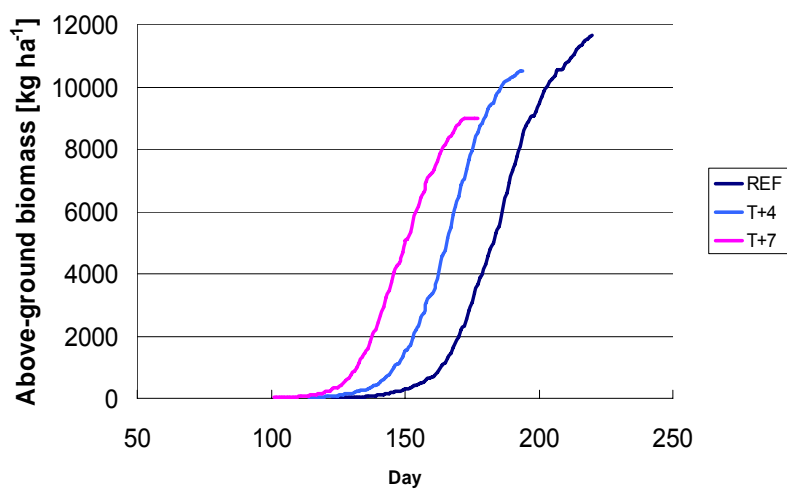
#### 1. Jokioinen: Average phenology and shifts under alternative climate change scenarios

Scenario	Sowing date (day no.)	Duration to EM (d)	Total duration EM to MAT (d)
REF	128	10	92
T-2	141	9	112
T+2	122	8	84
T+4	116	8	79
T+7	95	10	78
A1FI	112	9	73
V0	131	9	91
V1	118	13	94
V2	100	19	99
T4New	116	8	93



### 3. RESULTS (10)

Jokioinen, heavy clay (ref year 2000)





## 4. Conclusions and outlook (1)

### *Lessons from the study*

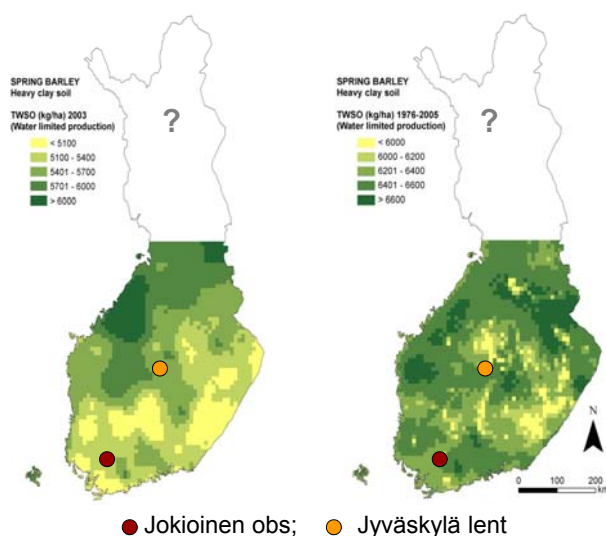
- Most distinct negative effects, (i) in general : A1FI; (ii) clay soil: (V2), T+5, T+6, T+7, and (a bit less) T+4 comb. with prolonged dry spells without (V5, V6), & with decreased precip (V7, V8), (iii) on sandy soil: (T6, T7, V7, V8), V2 much less
- CO<sub>2</sub> fertilization effect cannot compensate these negative impacts;
- There is huge influence of soil type on results, newly designed cultivar could only restore yield levels on clay soils
- Most promising adaptation: improved water and nutrient management, and introduction of new barley cultivars /and or cropping systems! (*research needs*)
- B4D: no positive effect on cereal production, but high risk for yield reduction

### *More general /outlook*

- Serious gap: Evaluation of regional crop yield model estimates !
- COST 734, current climate: Comparison crop model performance across EU (7 models, 2 cereals, 10 sites)




## 4. Conclusions and outlook (2)



*Models participating  
in COST 734  
comparison:*

- ✓ APES
- ✓ CERES/DSSAT
- ✓ CROPSYST
- ✓ Daisy
- ✓ FASSET
- ✓ HERMES
- ✓ WOFOST











## Supplementary slides (1)

Edit - C:\Program Files\WOFOST Control Center\CROPD\BARbs560


File Edit Navigate Options

```

** green area
SLATB = 0.00, 0.0020, ? specific leaf area
        0.30, 0.0035, ? as a function of DUS [-; ha kg-1]
        0.90, 0.0025,
        1.45, 0.0022,
        2.00, 0.0022
SPA = 0.000 ? specific pod area [ha kg-1]
SSATB = 0.0, 0.0, ? specific stem area [ha kg-1]
        2.0, 0.0 ? as function of DUS
SPAN = 25. ? life span of leaves growing at 35 Celsius [d]
TBASE = 0.0 ? lower threshold temp. for ageing of leaves [cel]

** assimilation
KDIFTB = 0.0, 0.44, ? extinction coefficient for diffuse visible light [-;
        2.0, 0.44 ? as function of DUS
EFFTB = 0.0, 0.40, ? light-use effic. single leaf [kg ha-1 hr-1 j-1 m2 s-1]
        40.0, 0.40 ? as function of daily mean temp.
AMAXTB = 0.00, 54.00, ? max. leaf CO2 assim. rate
        1.20, 44.00, ? function of DUS [-; kg ha-1 hr-1]
        2.00, 5.00
    
```

 Close



## M&Rfi\* weather generator

(freely available on web: [www.ufa.cas.cz/dub/wg/marfi/marfi.htm](http://www.ufa.cas.cz/dub/wg/marfi/marfi.htm))

- **M&Rfi weather generator** (~ Richardson's WGEN)
  - parametric weather generator
  - generates daily time series
  - **4 surface weather characteristics** (*though it can do much more...*), which are mostly required as an input to the crop growth models (including DSSAT crop models):
    - **PREC, TMAX, TMIN, SRAD**
- **each term is generated in three steps:**
  1. generation of **precipitation occurrence** ~ 1<sup>st</sup> – 3<sup>rd</sup> order Markov chain
  2. (if the day is wet) generation of precipitation amount: **PREC** ~ Gamma dist.
  3. generation of (**SRAD, TMAX, TMIN**) ~ AR(1) model

\* (*M&Rfi = Met&Roll flexible and improved*)