Climate Change and the Tea Sector in Kenya: Impact Assessment and Policy Action
National Multi-stakeholder Workshop
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Simulation of tea yield with AquaCrop

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Structure of the presentation

1. Calculation scheme
   - Crop development
   - Crop transpiration
   - Biomass production
   - Yield formation

2. Running simulations
   - Experimental fields
   - Farmer's fields
   - Effect of climate change

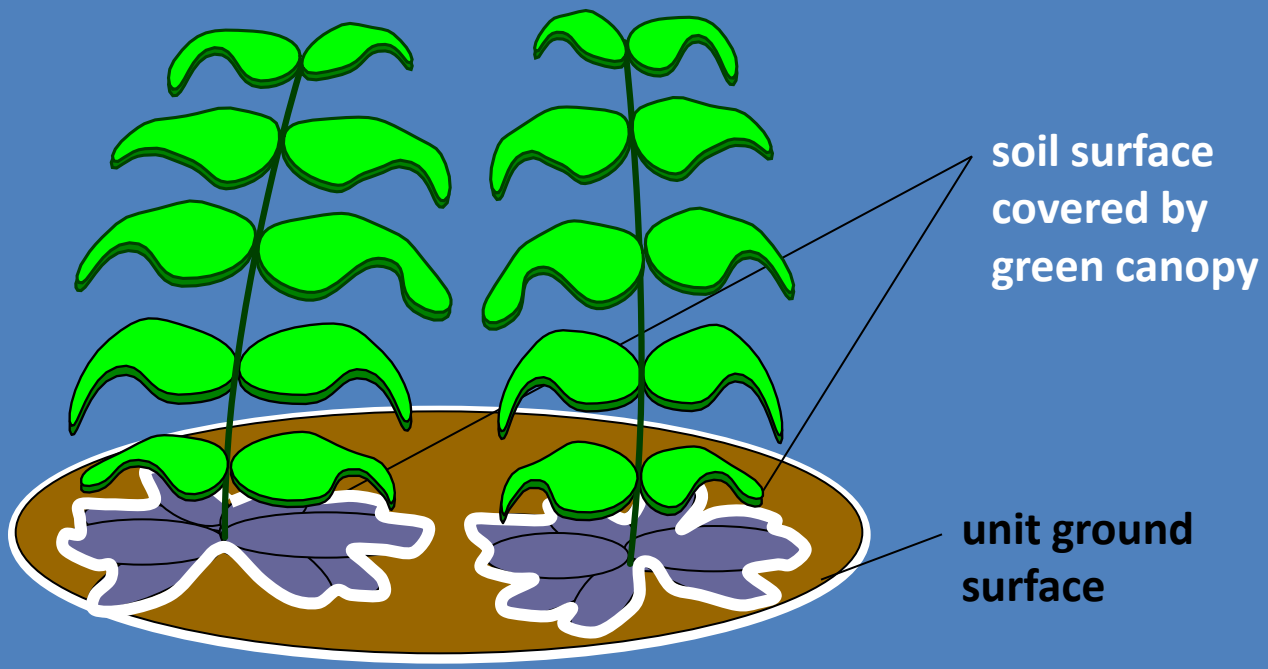
Instead of Leaf Area Index (LAI)

AquaCrop uses **green canopy cover (CC)**

$$CC = \frac{\text{soil surface covered by the green canopy}}{\text{unit ground surface area}}$$

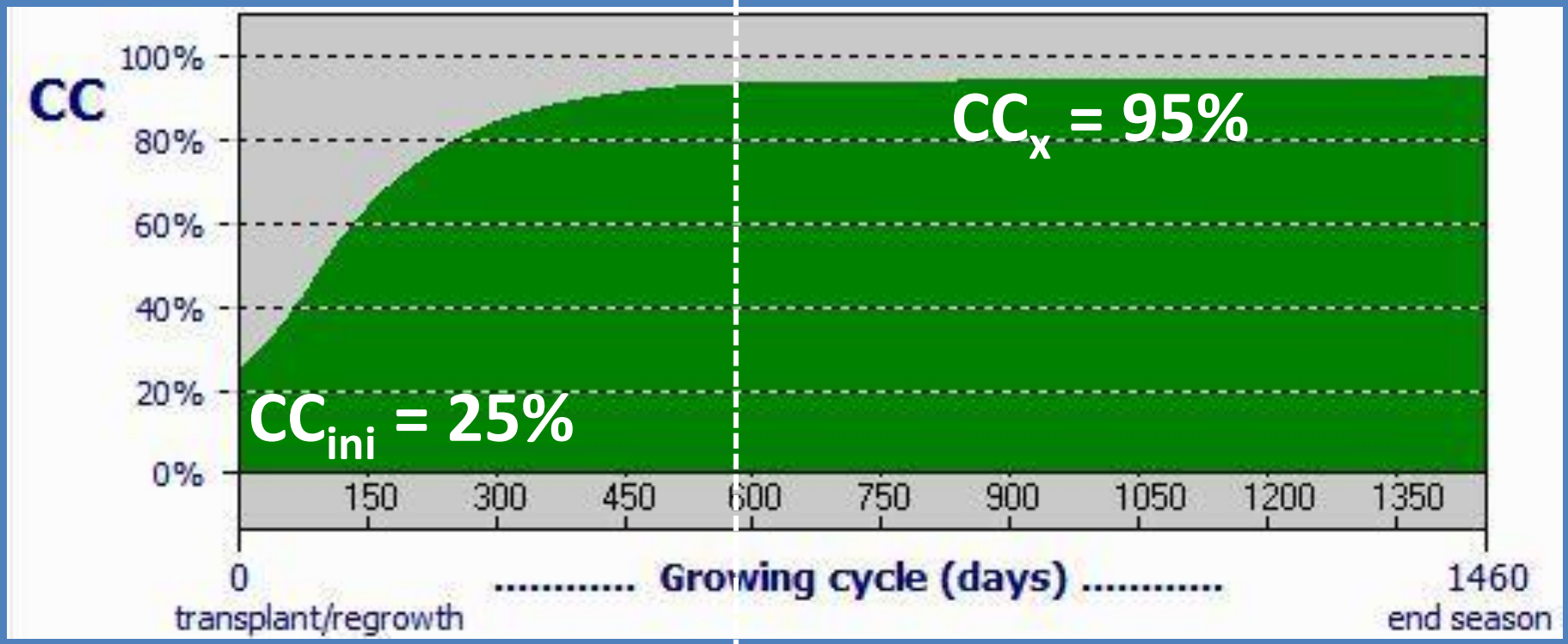
ranges from 0 (bare soil) to 1 (full canopy cover)

0 % → 100 %



Lung pruning

Canopy development (non-limiting conditions)

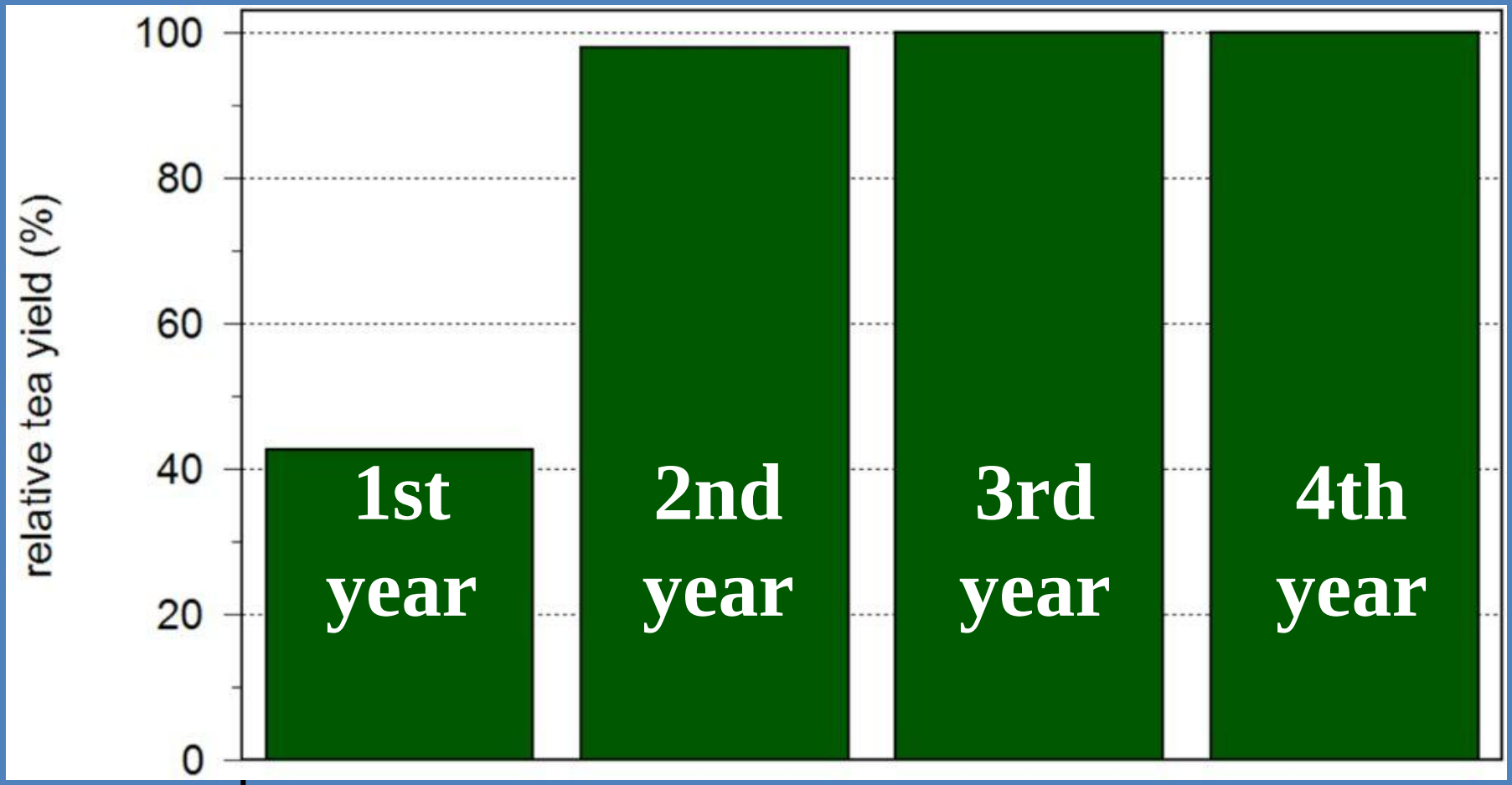


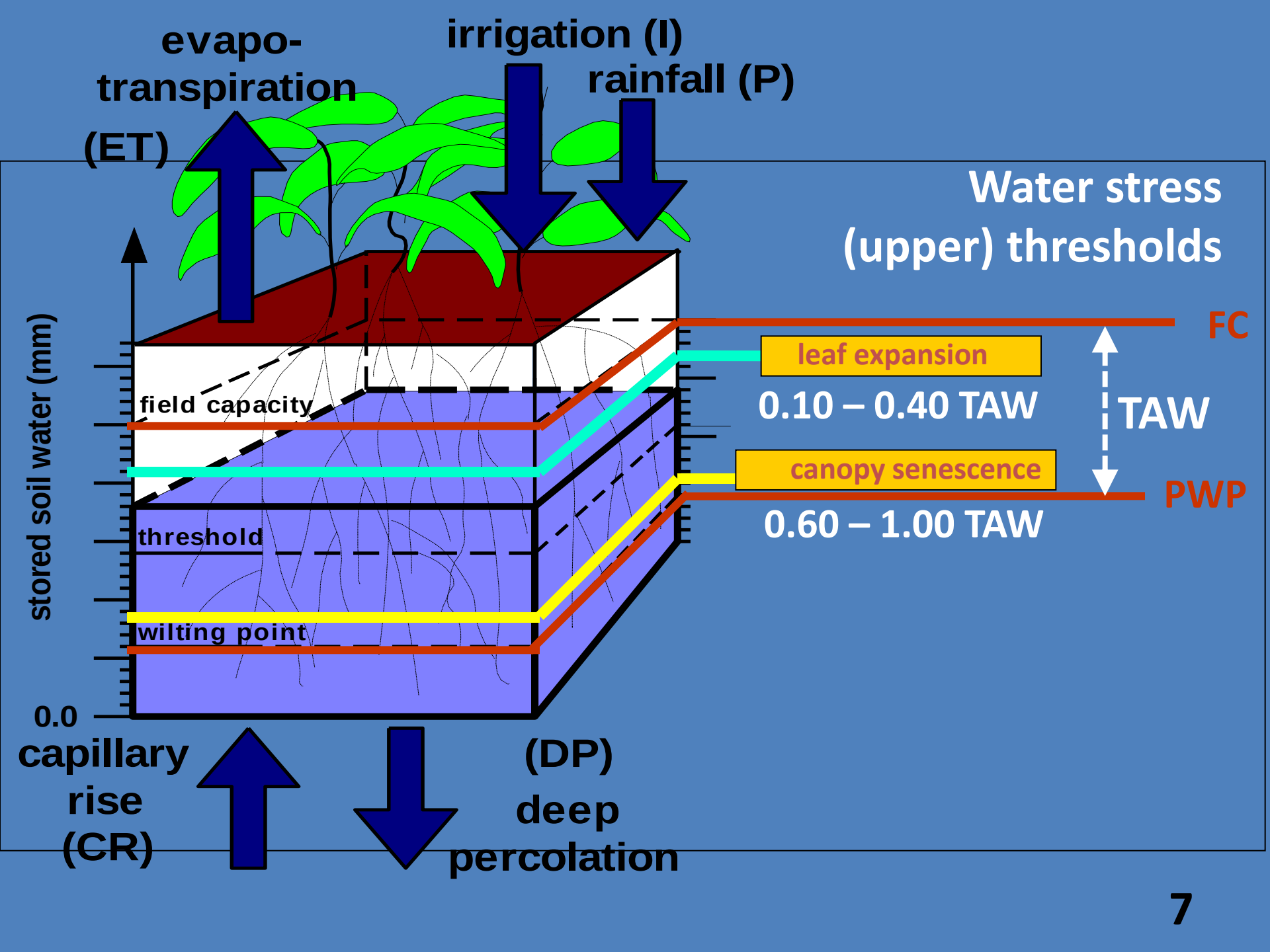
1.5 years

4 years

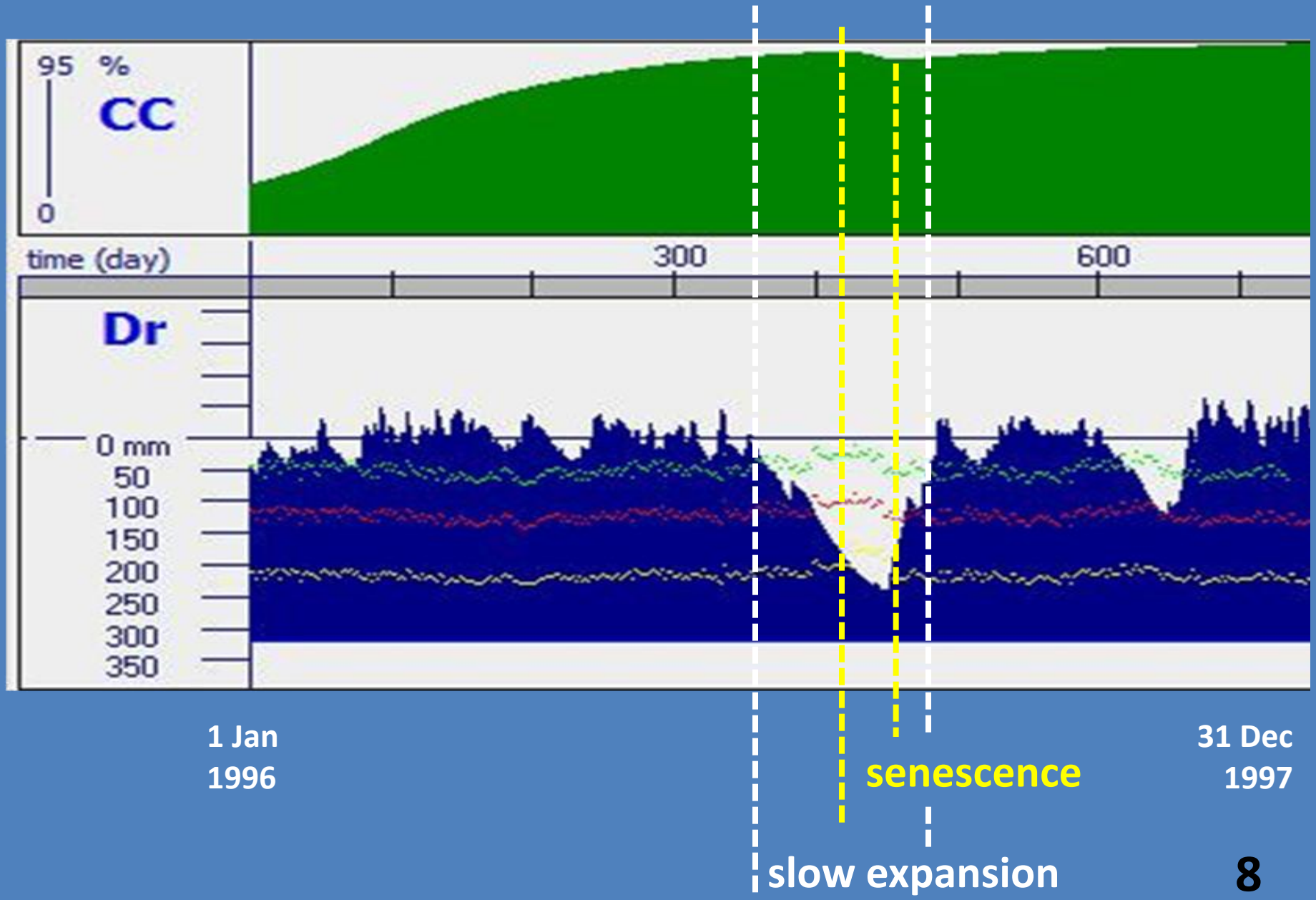
pruning

Relative tea yield (non-limiting conditions)




evapo-
transpiration
(ET)
irrigation (I)
rainfall (P)
Water stress
(upper) thresholds
FC
leaf expansion
0.10 – 0.40 TAW
TAW
canopy senescence
PWP
0.60 – 1.00 TAW
stored soil water (mm)
field capacity
threshold
wilting point
0.0
capillary
rise
(CR)
(DP)
deep
percolation

Effect of water stress on canopy development



water stress coefficient
for stomatal closure

weather conditions

crop coefficient

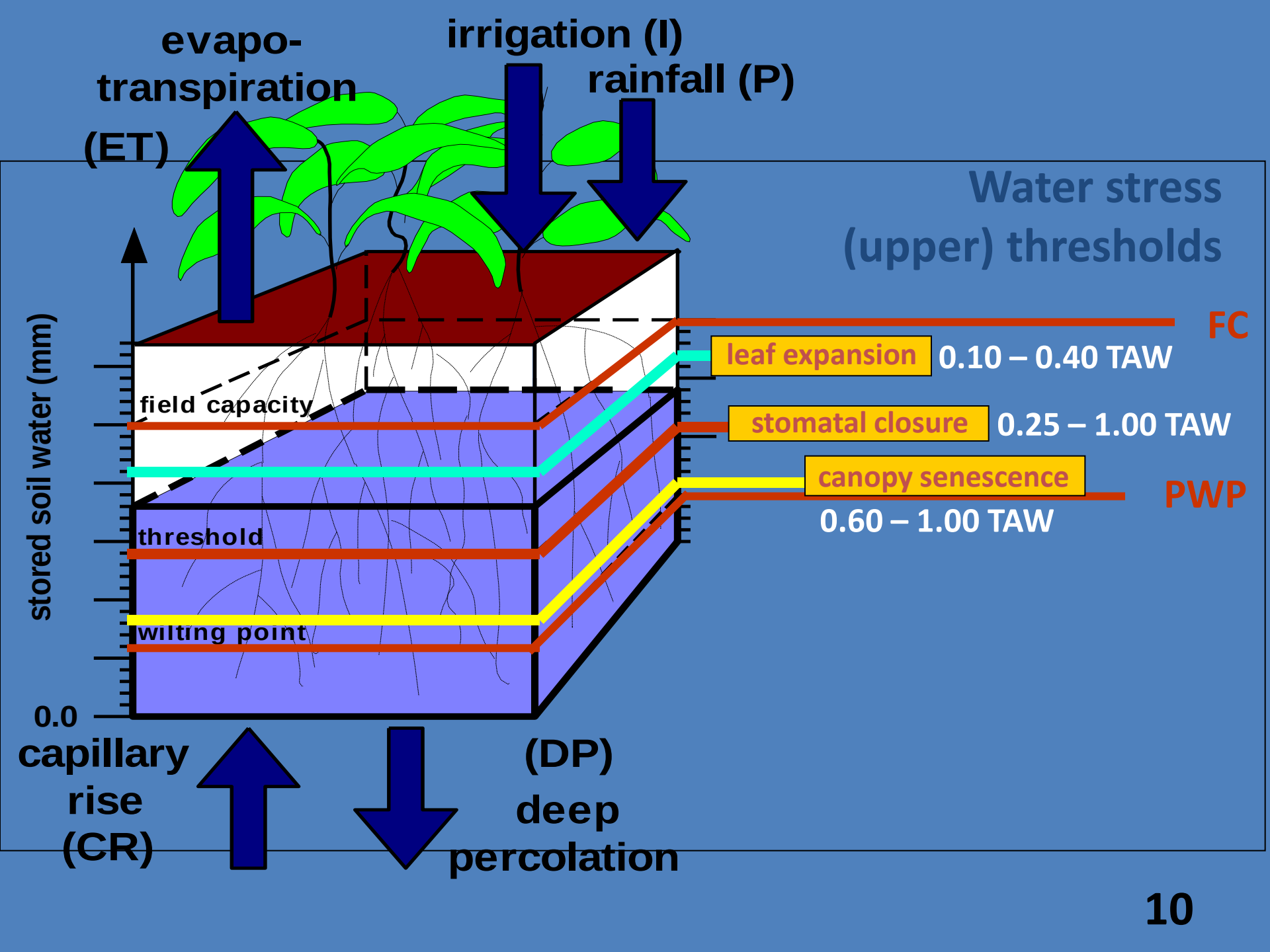
reference evapotranspiration
evaporative power of the
atmosphere

$$\text{Transpiration} = Ks_{sto} \times Kc_{Tr} \times ETo$$

characteristics of the transpiring crop

- proportional to green canopy cover (CC)
- proportional factor ($Kc_{Tr,x}$) = 0.85
  (integrating the effects of characteristics that distinguish the crop from the reference grass)

no water stress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1. Calculation scheme

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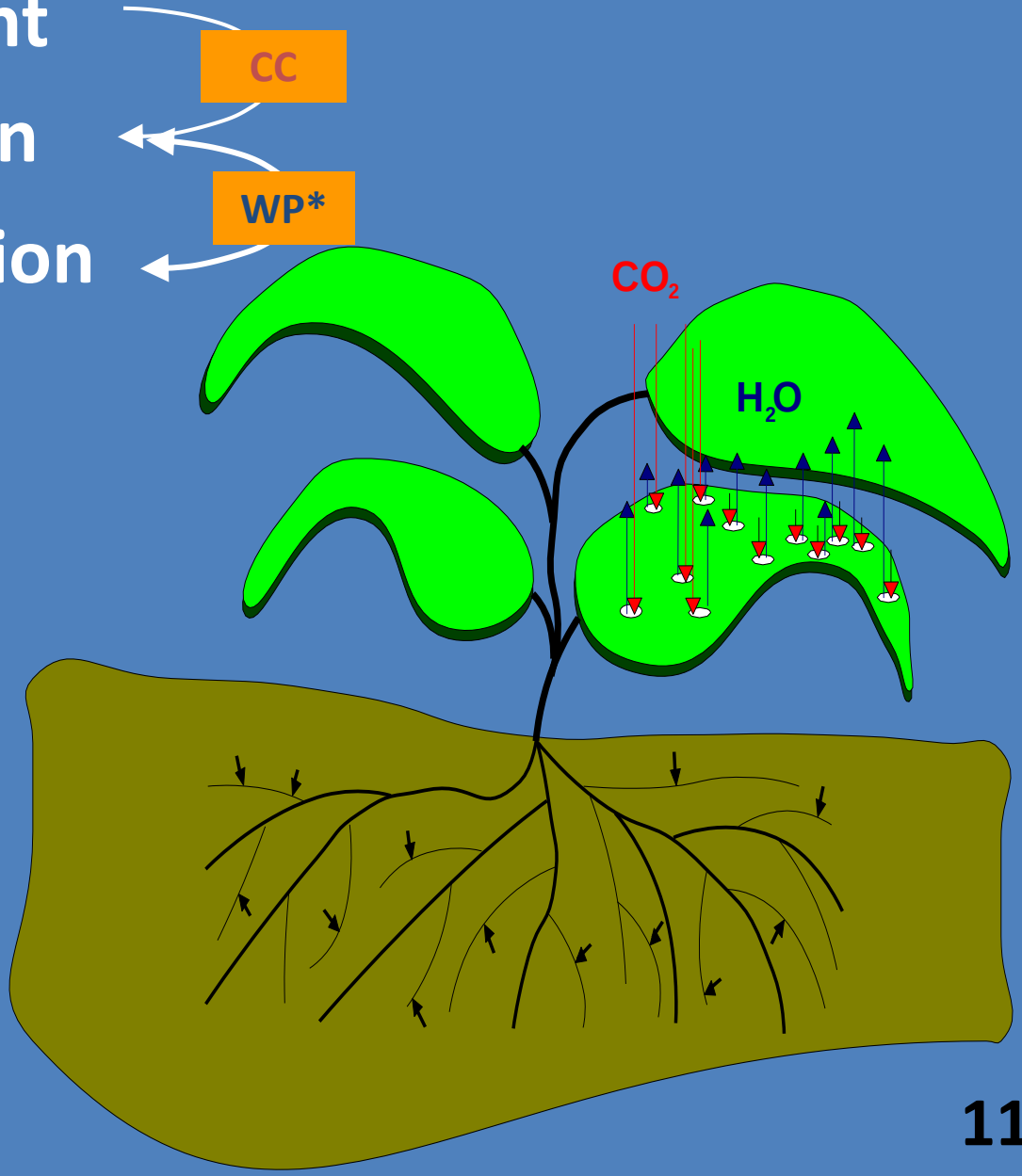
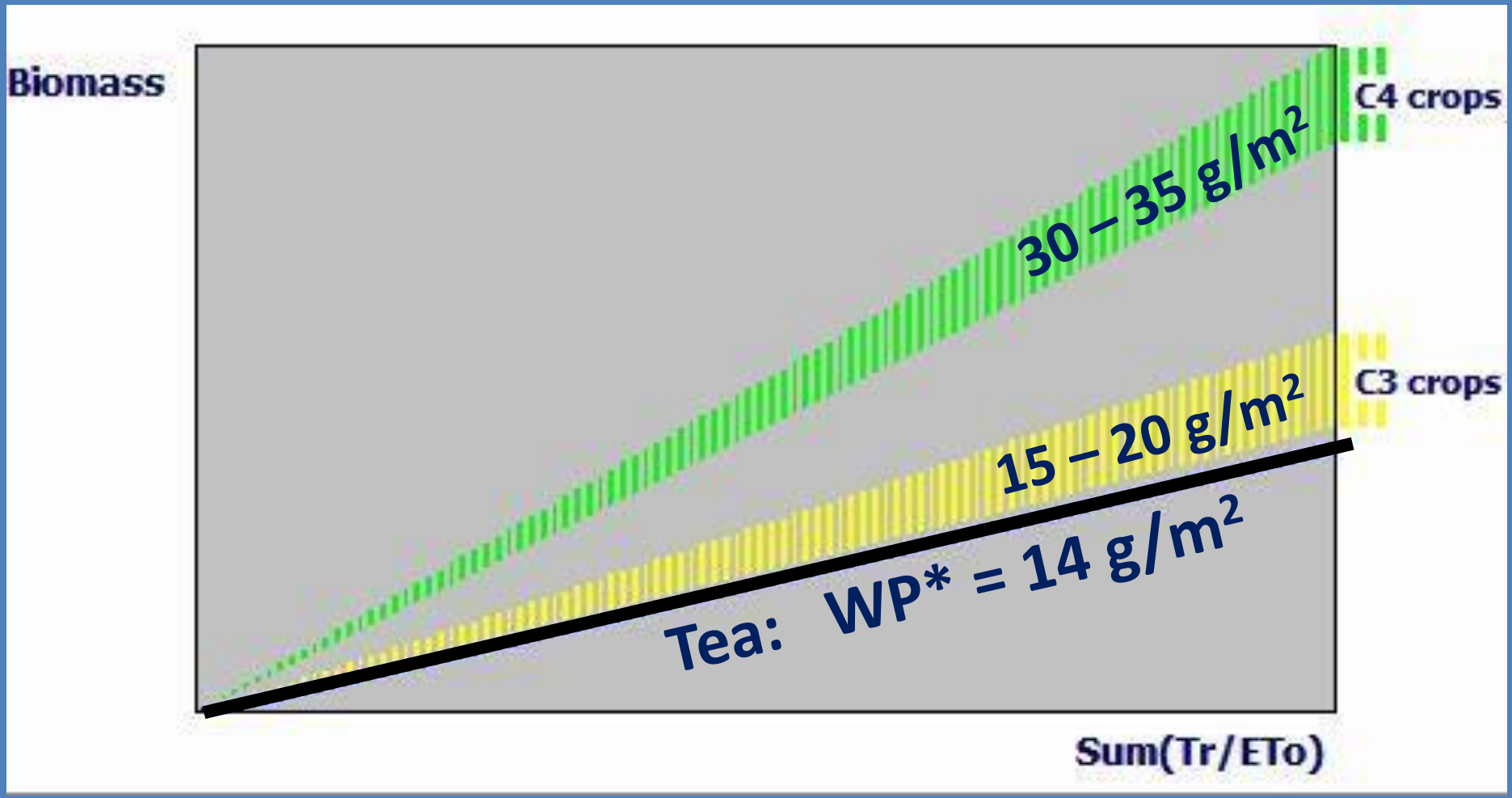
- Crop transpiration
- Biomass production



WP* normalized biomass water productivity



1. Calculation scheme

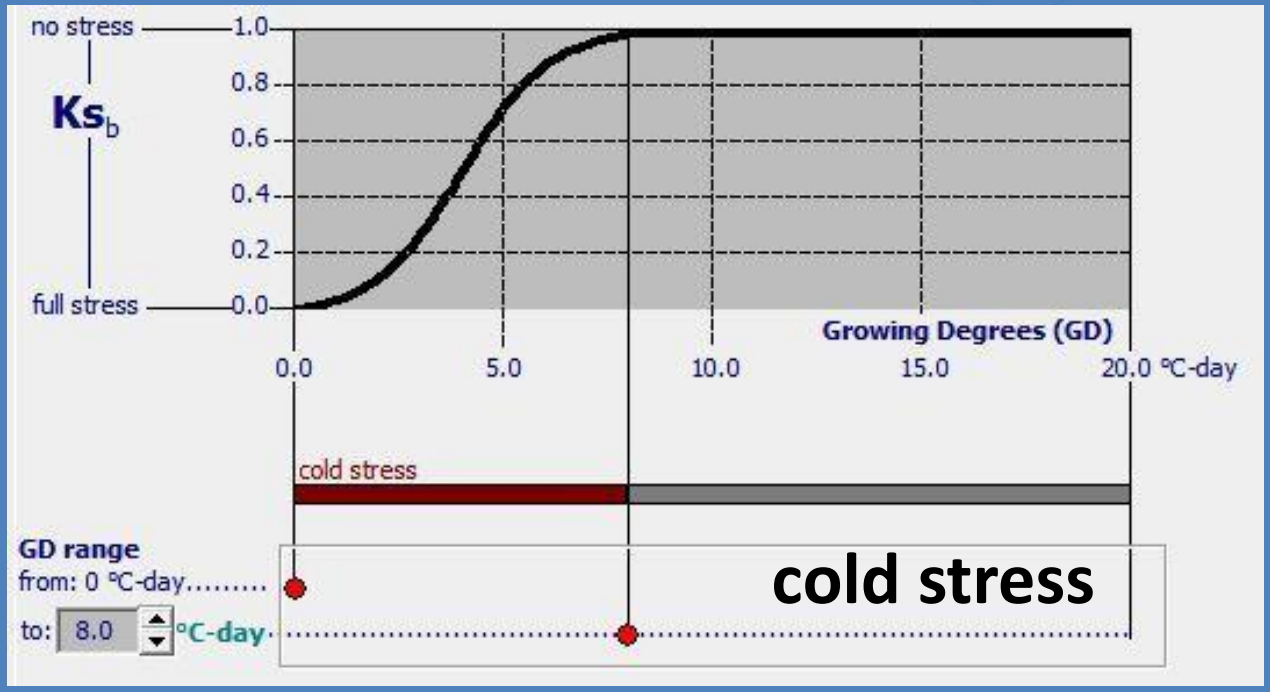
- Crop development
- Crop transpiration
- Biomass production

CC

WP*

14 g/m²

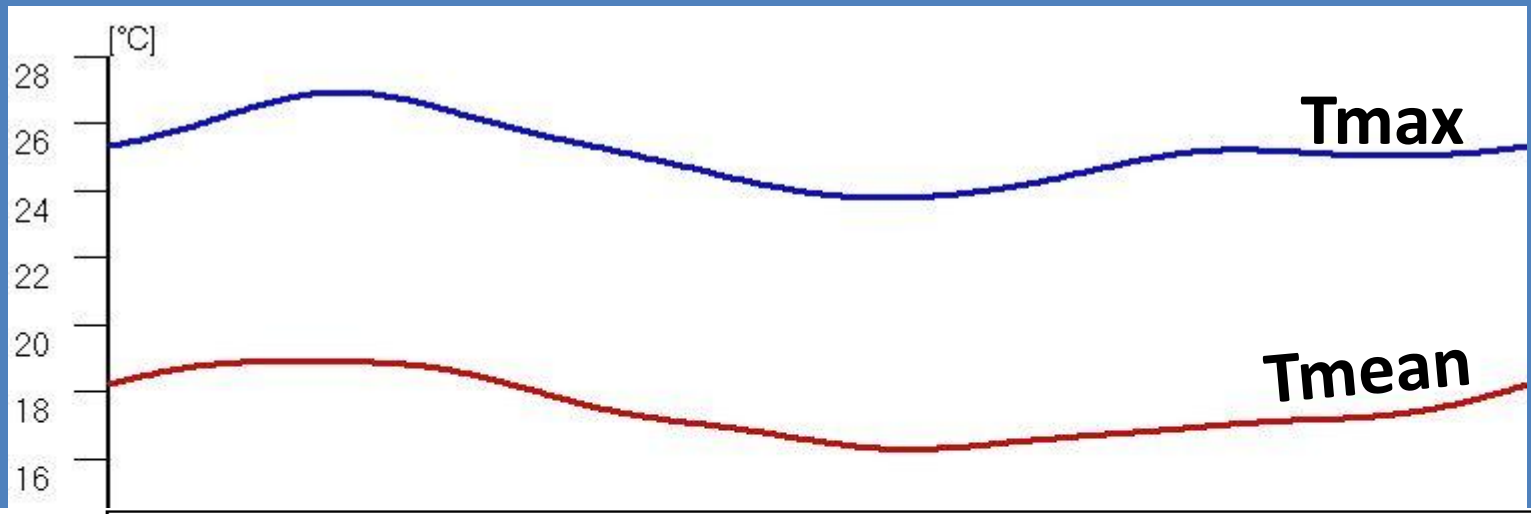
$$b_i = Ks_b \; WP^* \; (Tr_i/ETo_i)$$

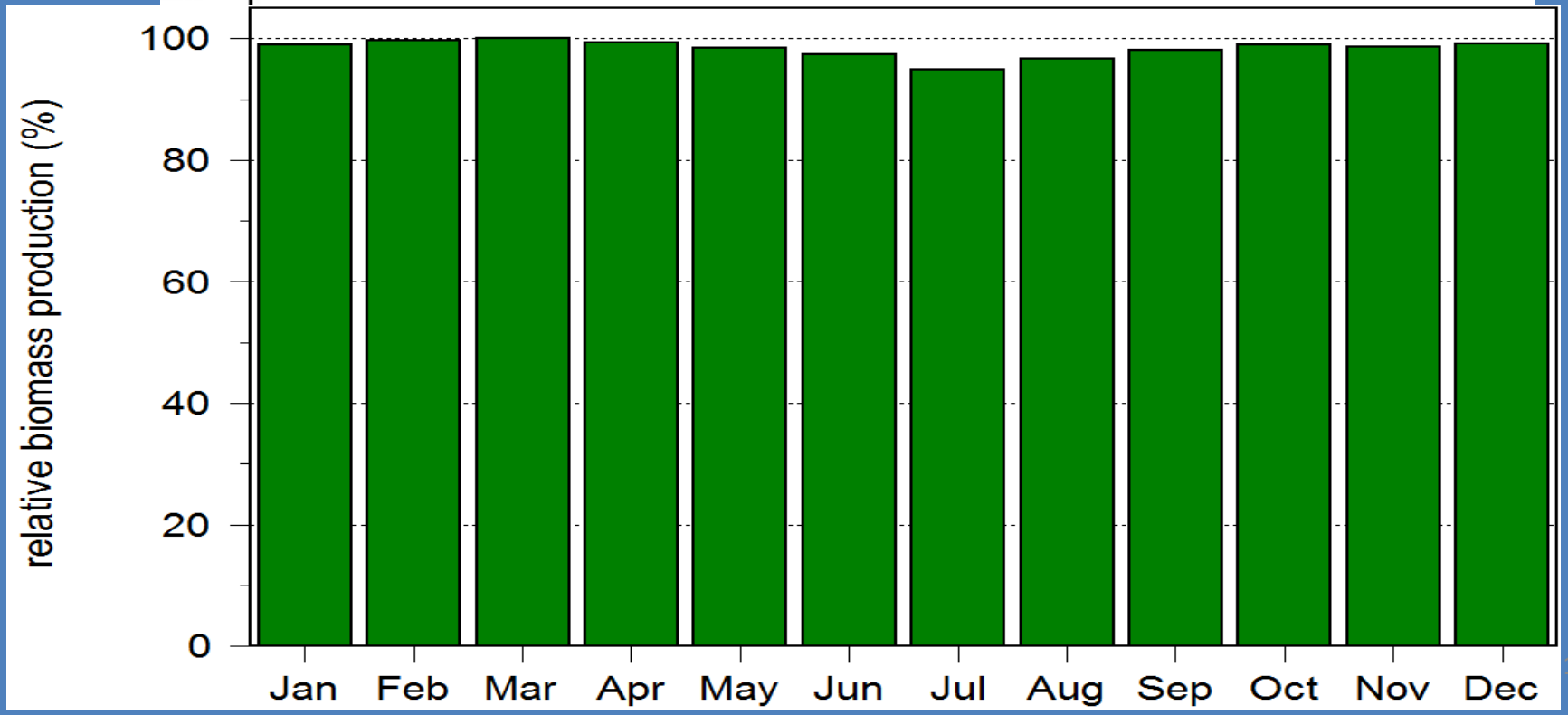


T_{base} = 8°C

Effect of cold stress on biomass production

°C





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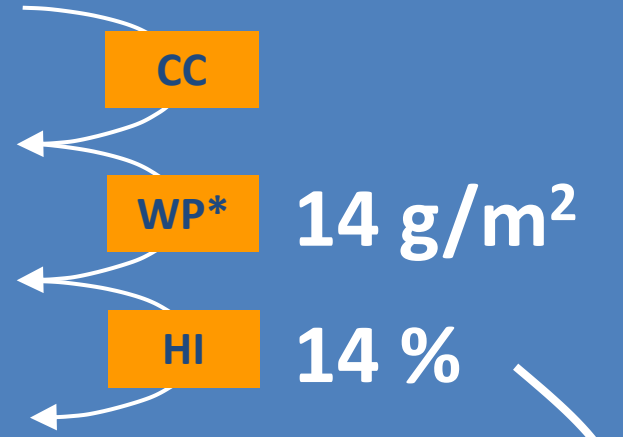

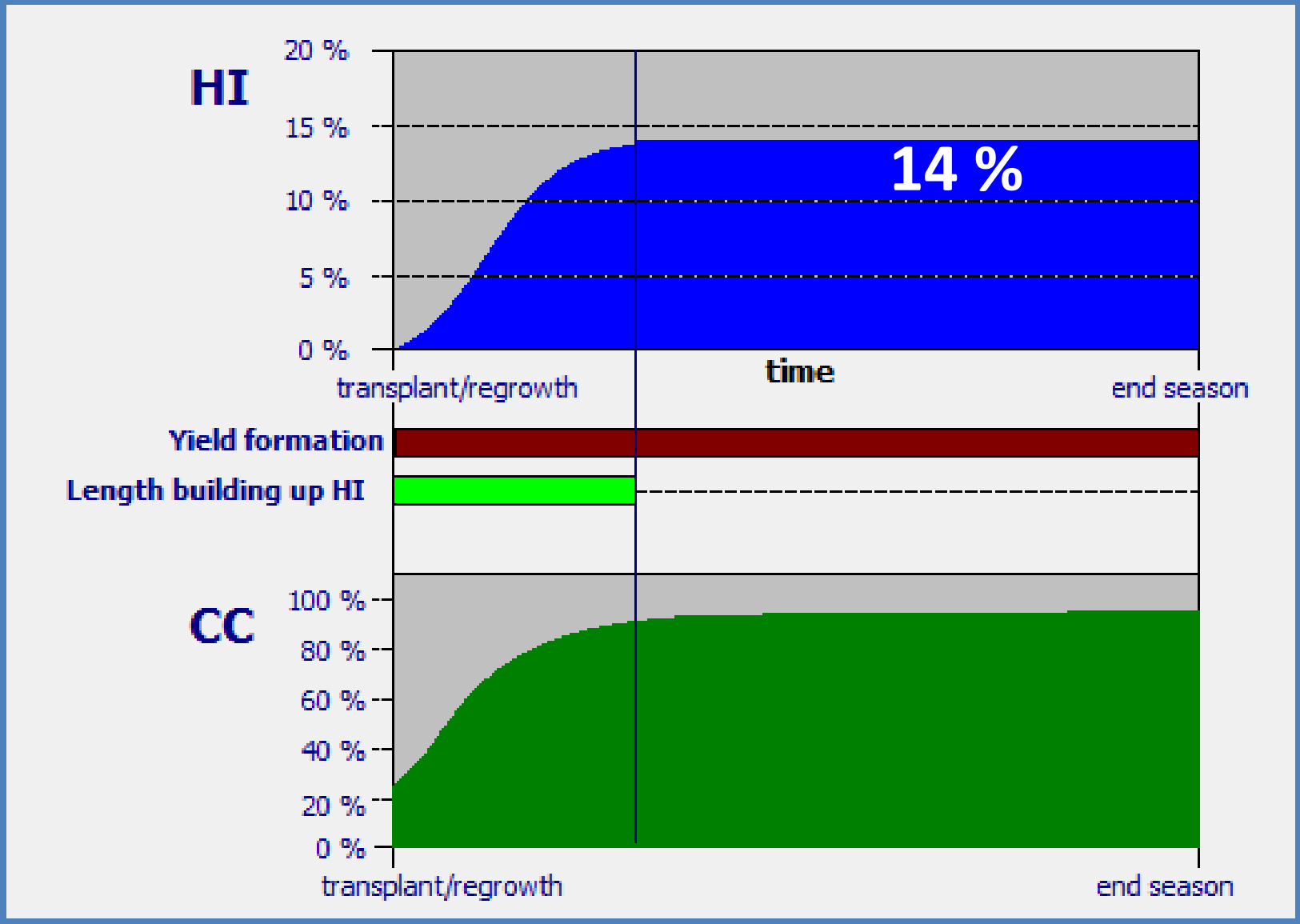
HI
20 %
15 %
10 %
5 %
0 %
14 %
time
transplant/regrowth
end season
Yield formation
Length building up HI
CC
100 %
80 %
60 %
40 %
20 %
0 %
transplant/regrowth
end season

30 % = 1.2 years

1. Calculation scheme

- Crop development
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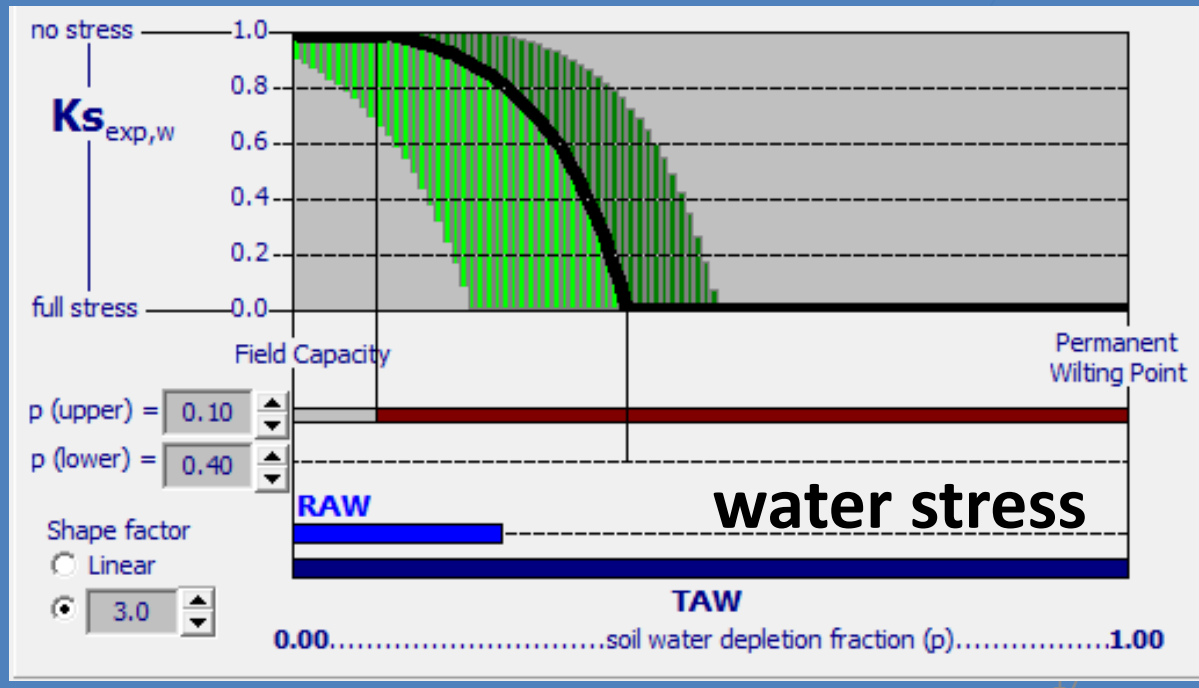
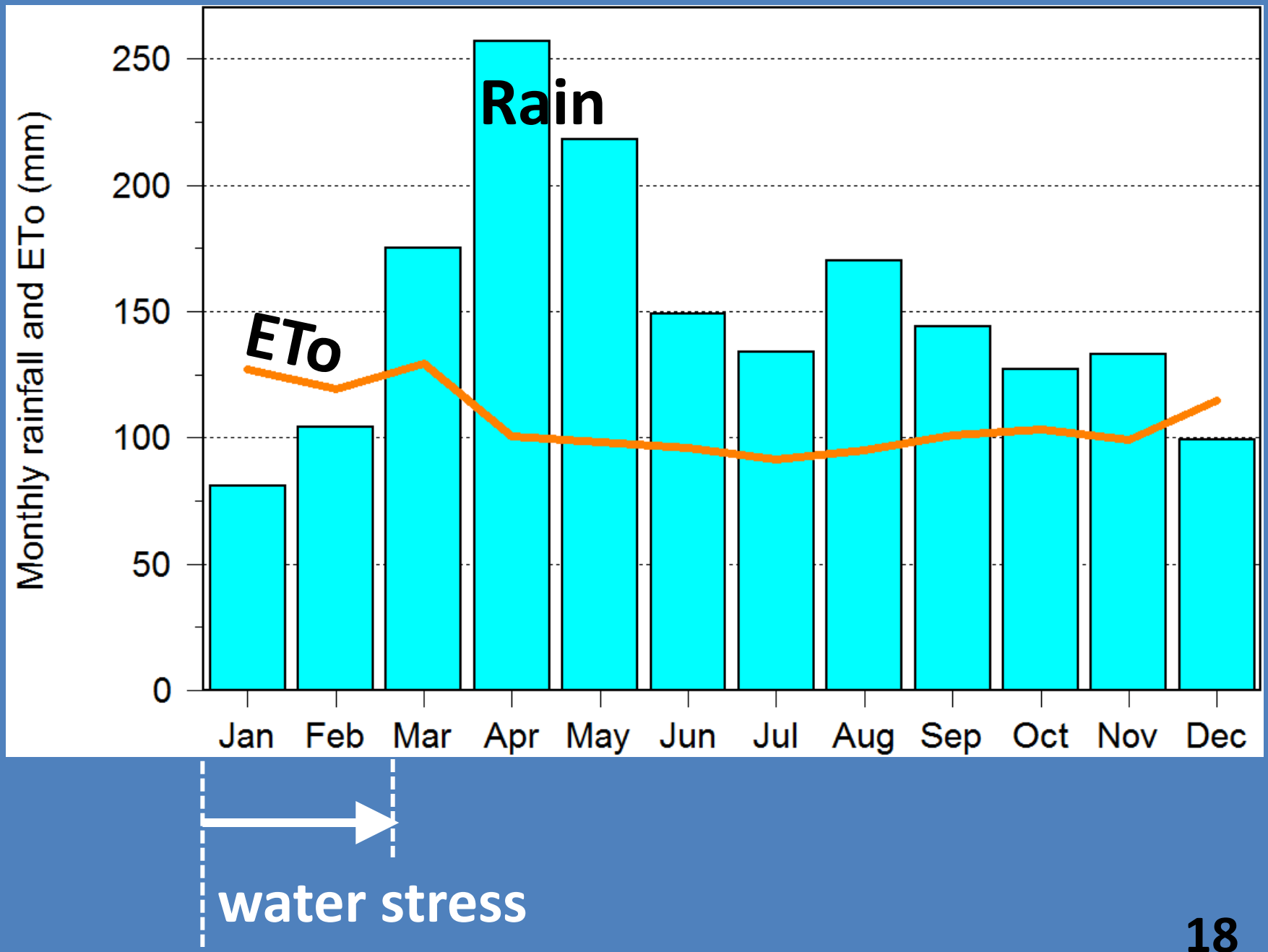
CC

WP* 14 g/m²

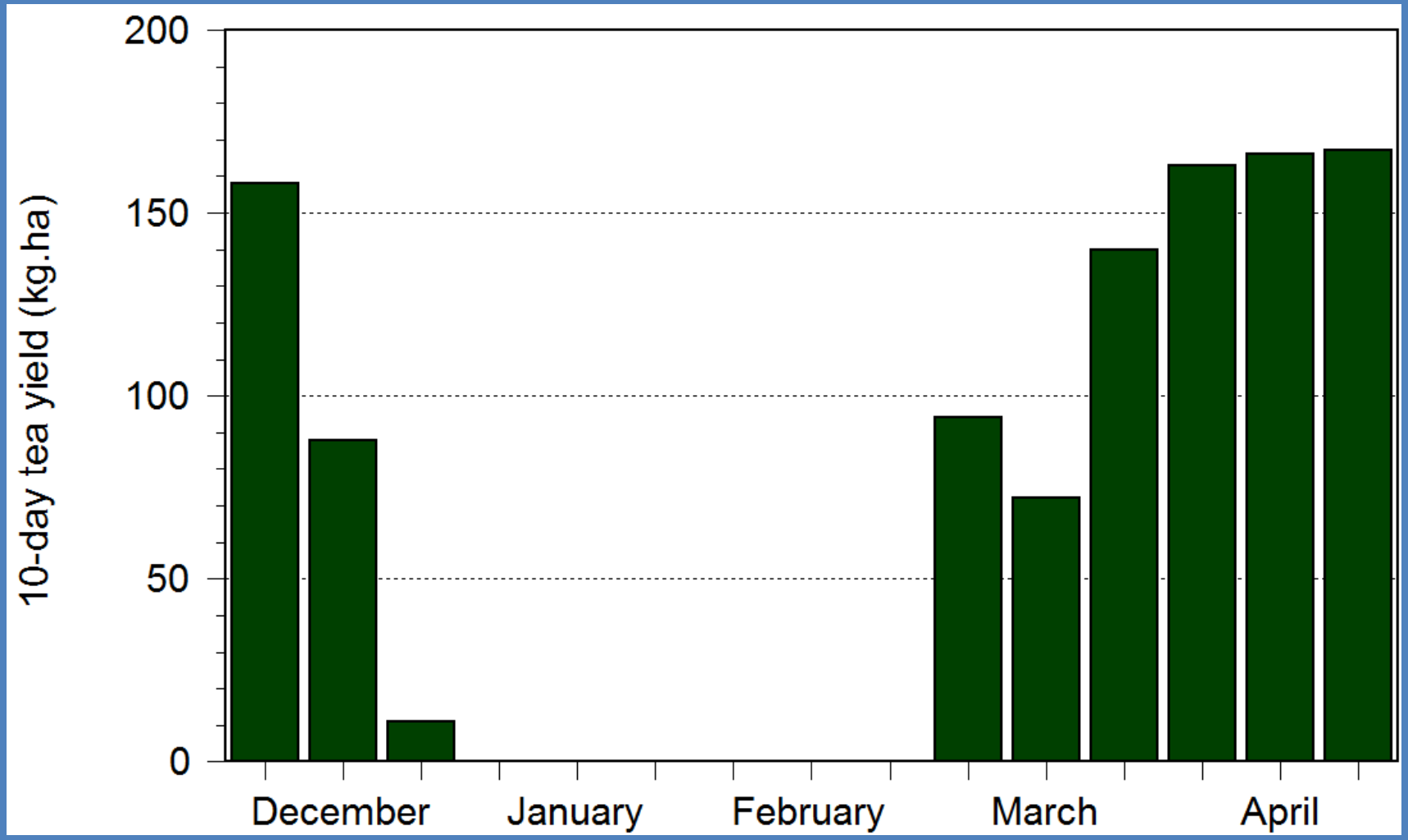
HI 14 %

$$y_i = Ks_{exp,w}\ HI\ b_i$$




Monthly rainfall and ETo (mm)
250
200
150
100
50
0
Rain
ETo
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
water stress

Effect of water stress on tea yield



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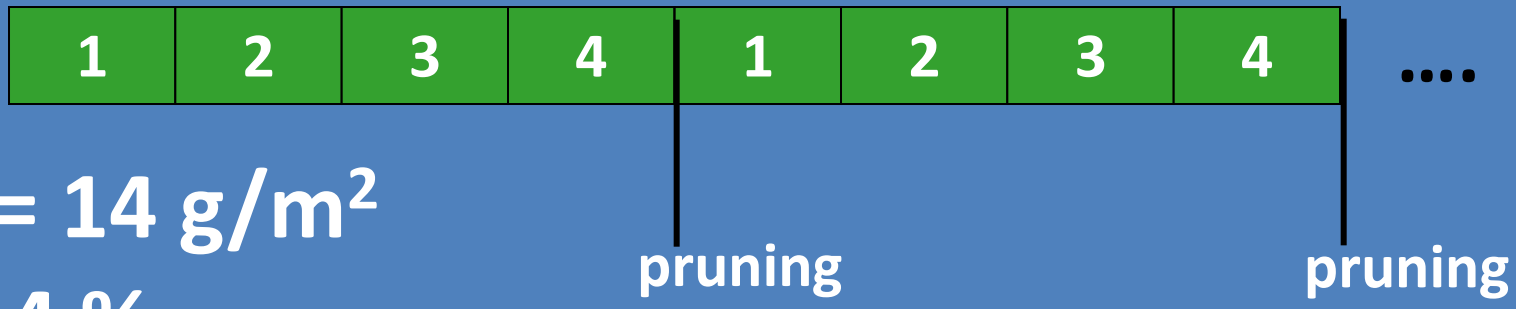
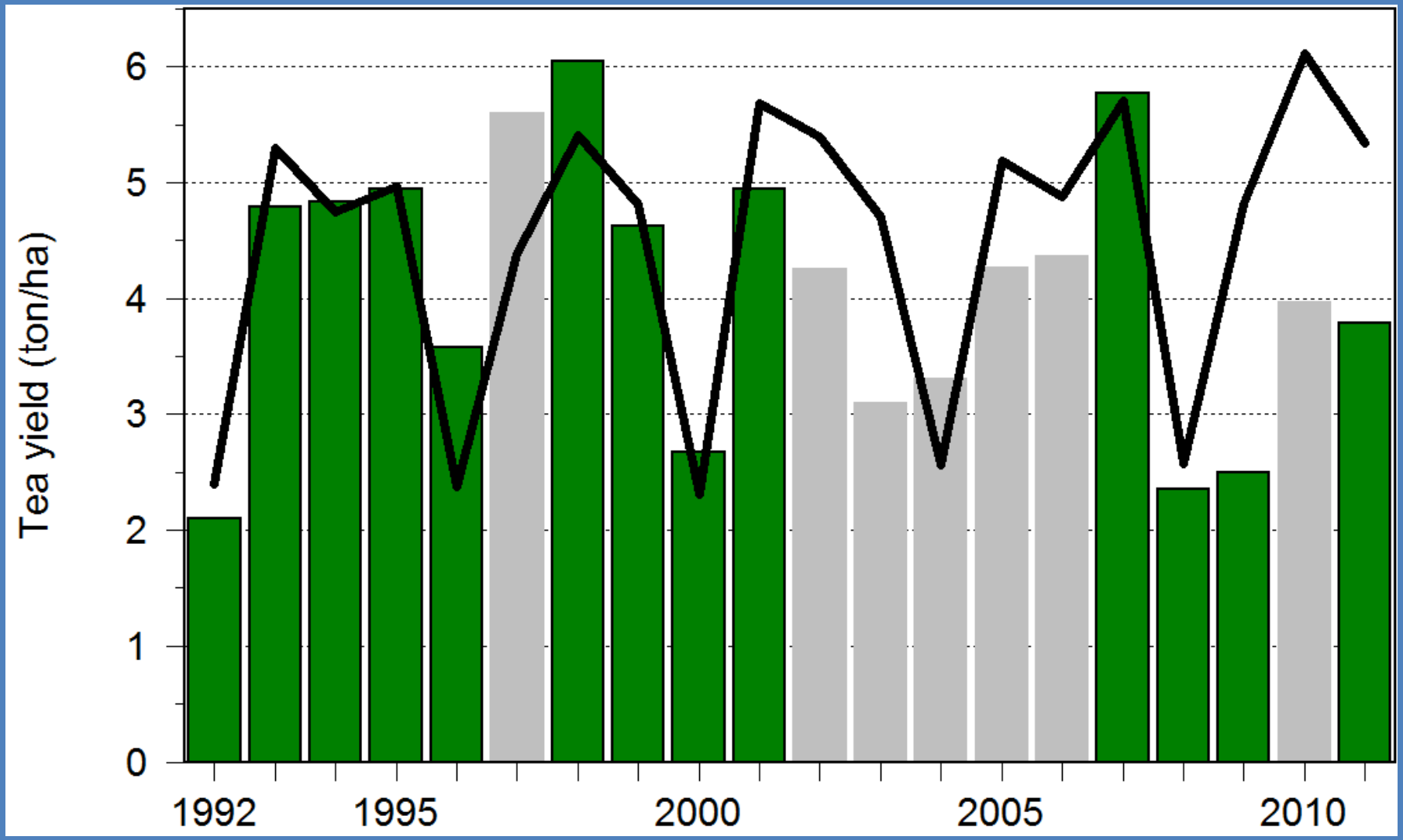
Experimental fields



WP* = 14 g/m²

HI = 14 %

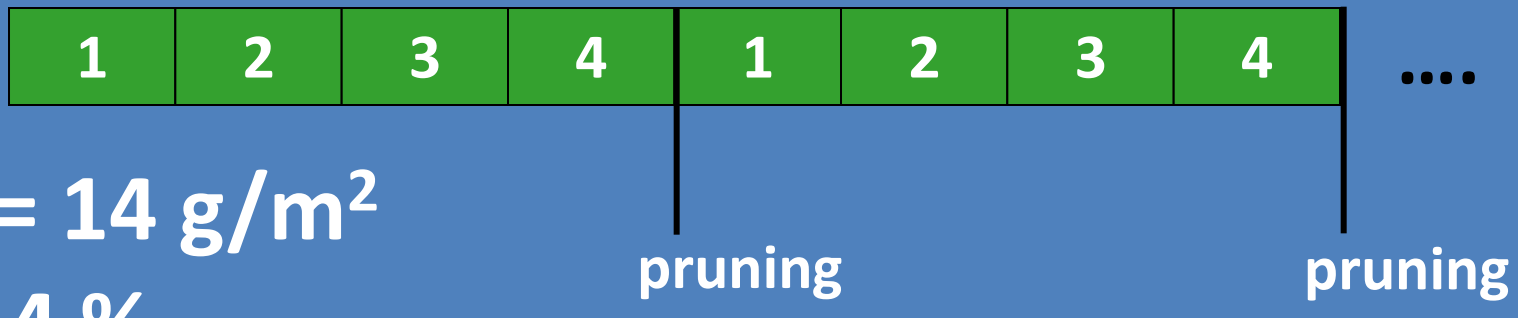
CC_x = 95 %



observed tea yield

simulated tea yield

Experimental fields

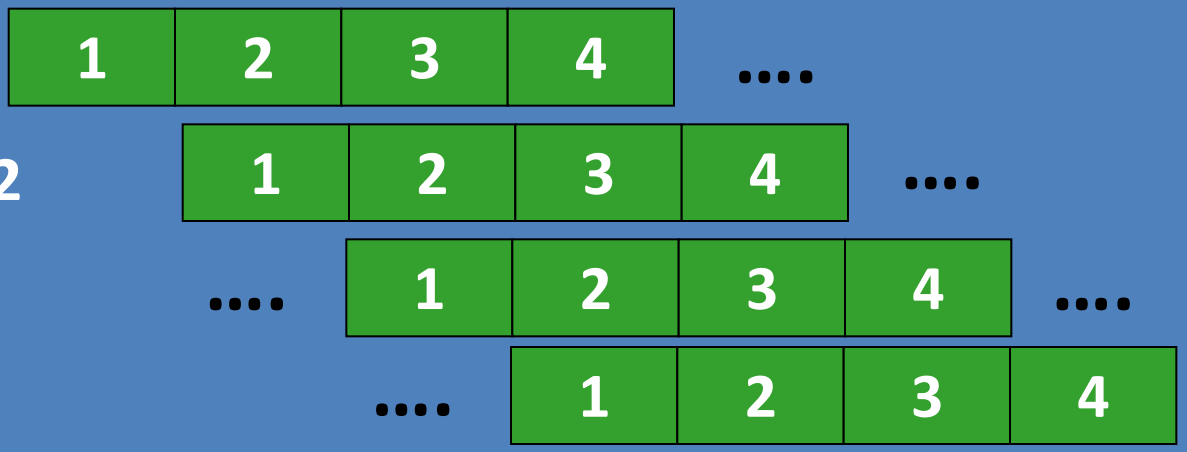


WP* = 14 g/m²

HI = 14 %

CC_x = 95 %

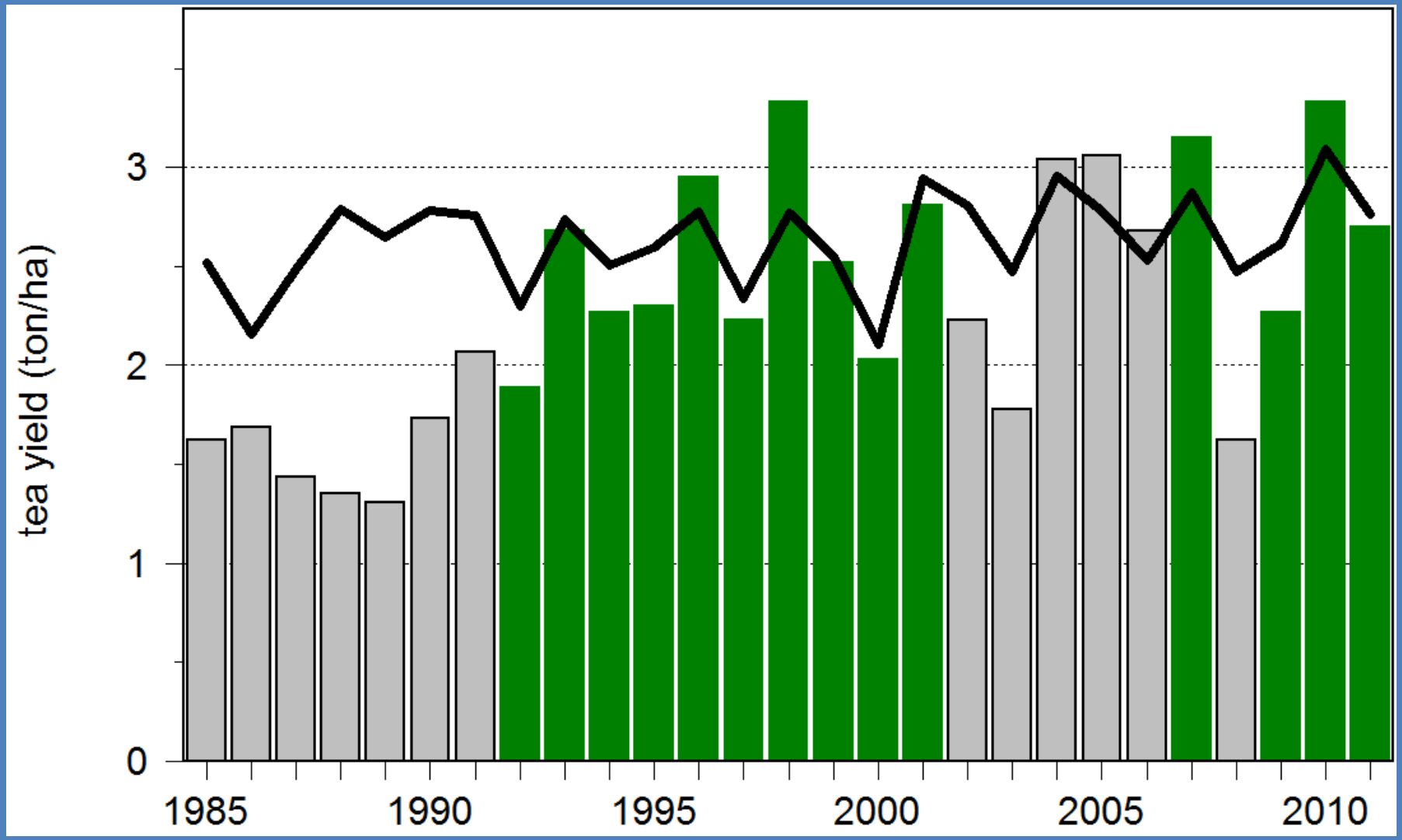
Farmer's fields



WP* = 14 g/m²

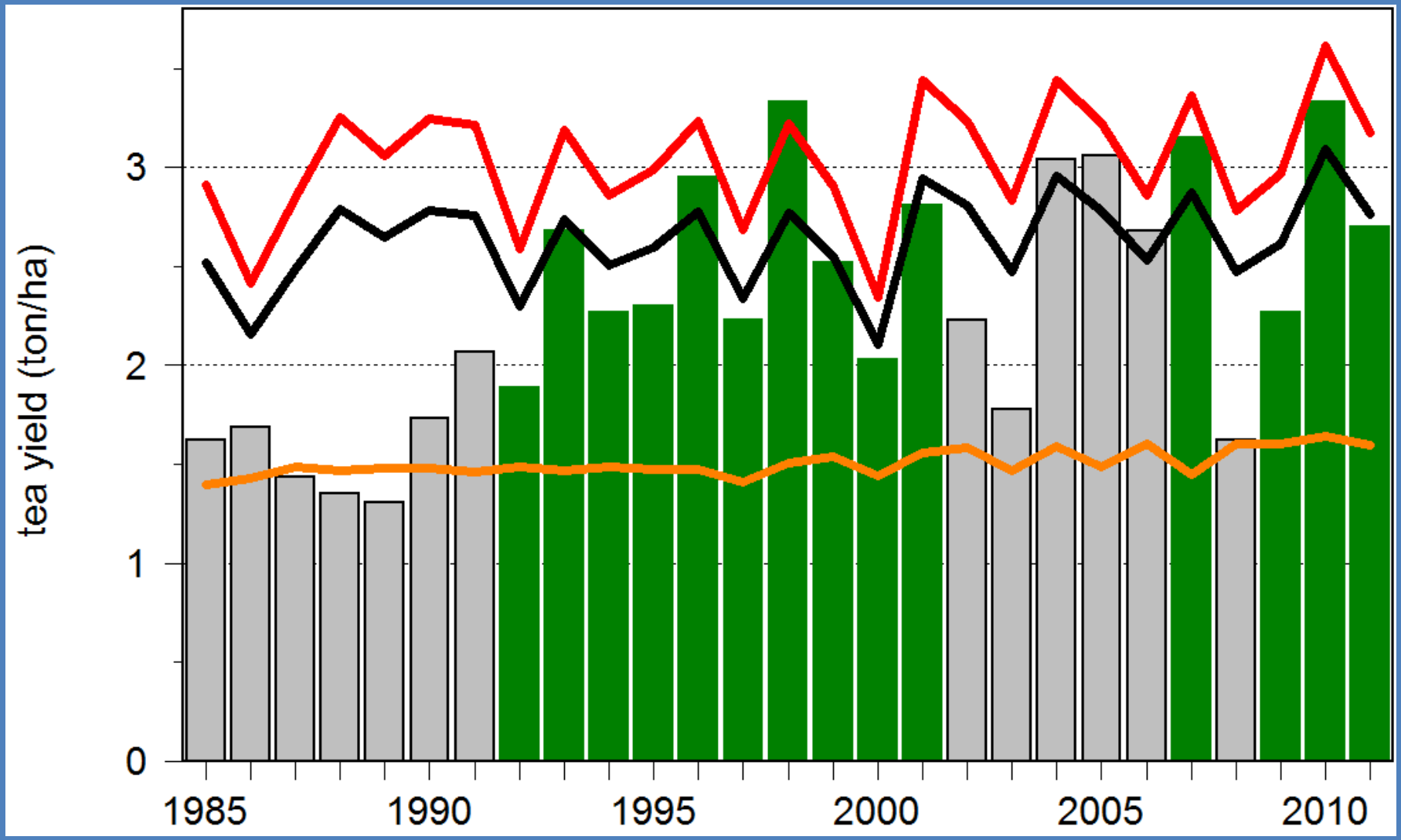
HI_o = 10 %

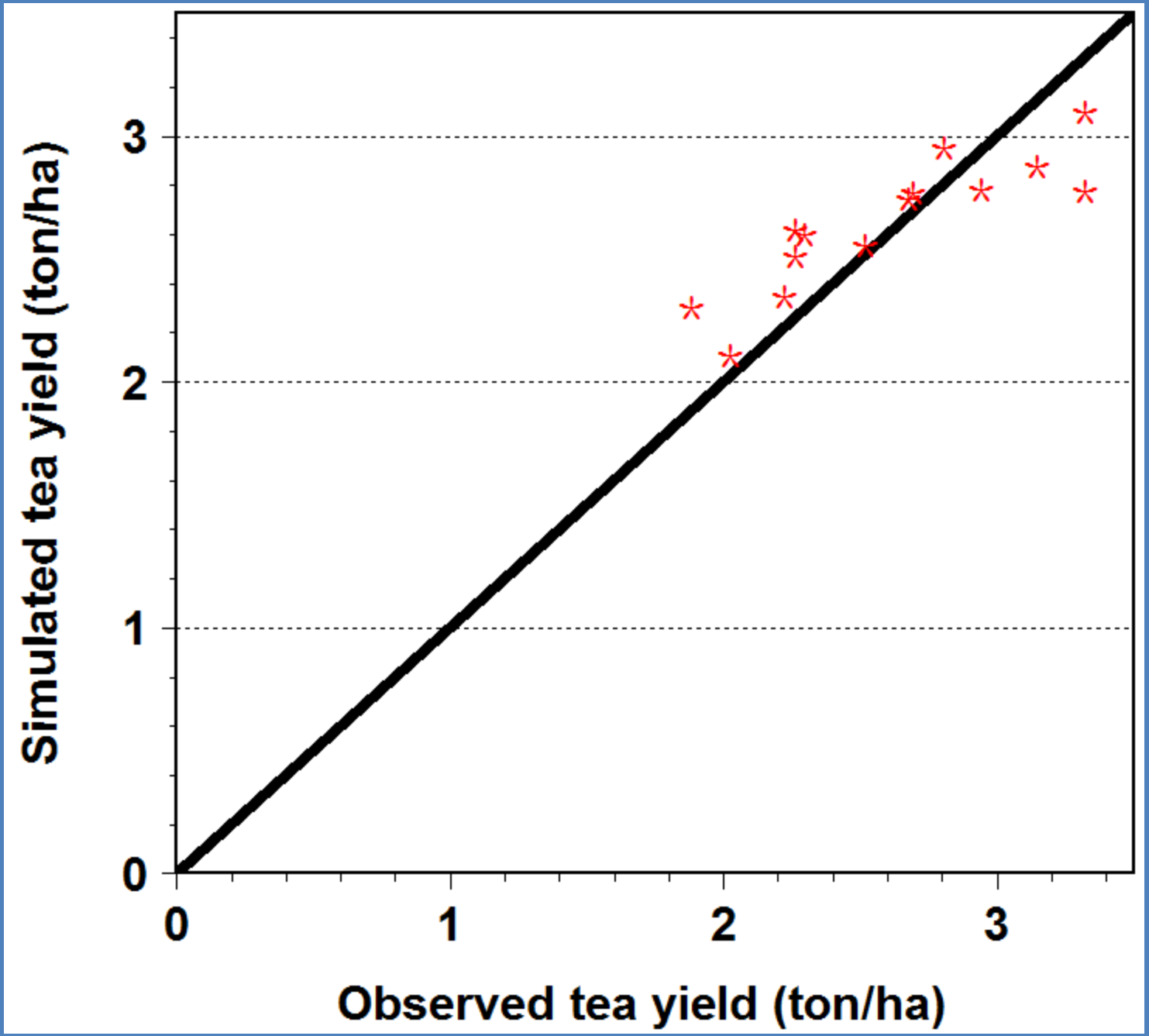
CC_x = 70 %



average observed tea yield

average simulated tea yield


tea yield (ton/ha)
0
1
2
3
1985
1990
1995
2000
2005
2010
average observed tea yield
average simulated tea yield
1st year
3rd year


Simulated tea yield (ton/ha)
0
1
2
3
0
1
2
3
Observed tea yield (ton/ha)

Statistical indicator	Value	Observation
R^2	0.76	values greater than 0.50 are considered acceptable
RMSE	261 kg/ha	it summarizes the mean difference in simulated and observed
NRMSE	10.0 %	a simulation can be considered excellent if NRMSE is smaller than 10%
EF	0.66	an EF of 1 indicates a perfect match between the model and the observations, an EF of 0 means that the model predictions are as accurate as the average of the observed data
d	0.85	0 indicating no agreement and 1 indicating a perfect agreement between the predicted and observed data. This statistical indicator overcomes the insensitivity of R^2 and EF to systematic over- or underestimations by the model

Effect of climate change