AQUACROP CALIBRATION AND VALIDATION: A CRUCIAL STEP

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Regional gathering
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ITALIAN AGENCY FOR DEVELOPMENT COOPERATION

WHY DO WE HAVE TO CALIBRATE AQUACROP? WHY IS IT A CRUCIAL STEP?

- A crop model is a simplified representation of reality
- Parametrization, calibration and validation
- Need for crop measurements at the local level
- What are the general steps in the calibration and validation processes?
- How are the simulation results assessed? How well do they fit real measurements?

HOW AQUACROP WORKS?

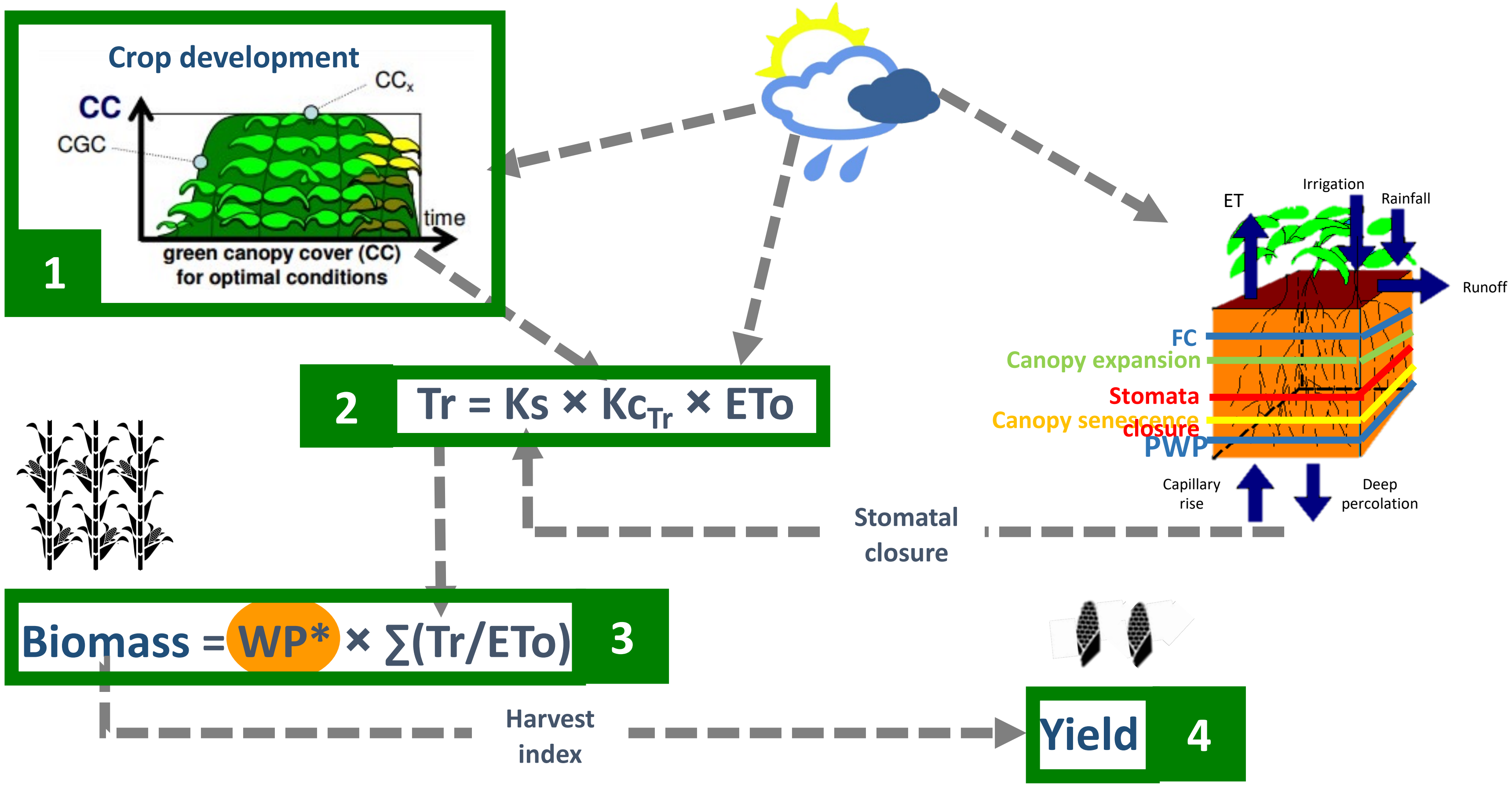


Figure by D. Raes

HOW AQUACROP WORKS?

We must check:

1. Canopy cover
2. Transpiration
3. Biomass
4. Yield

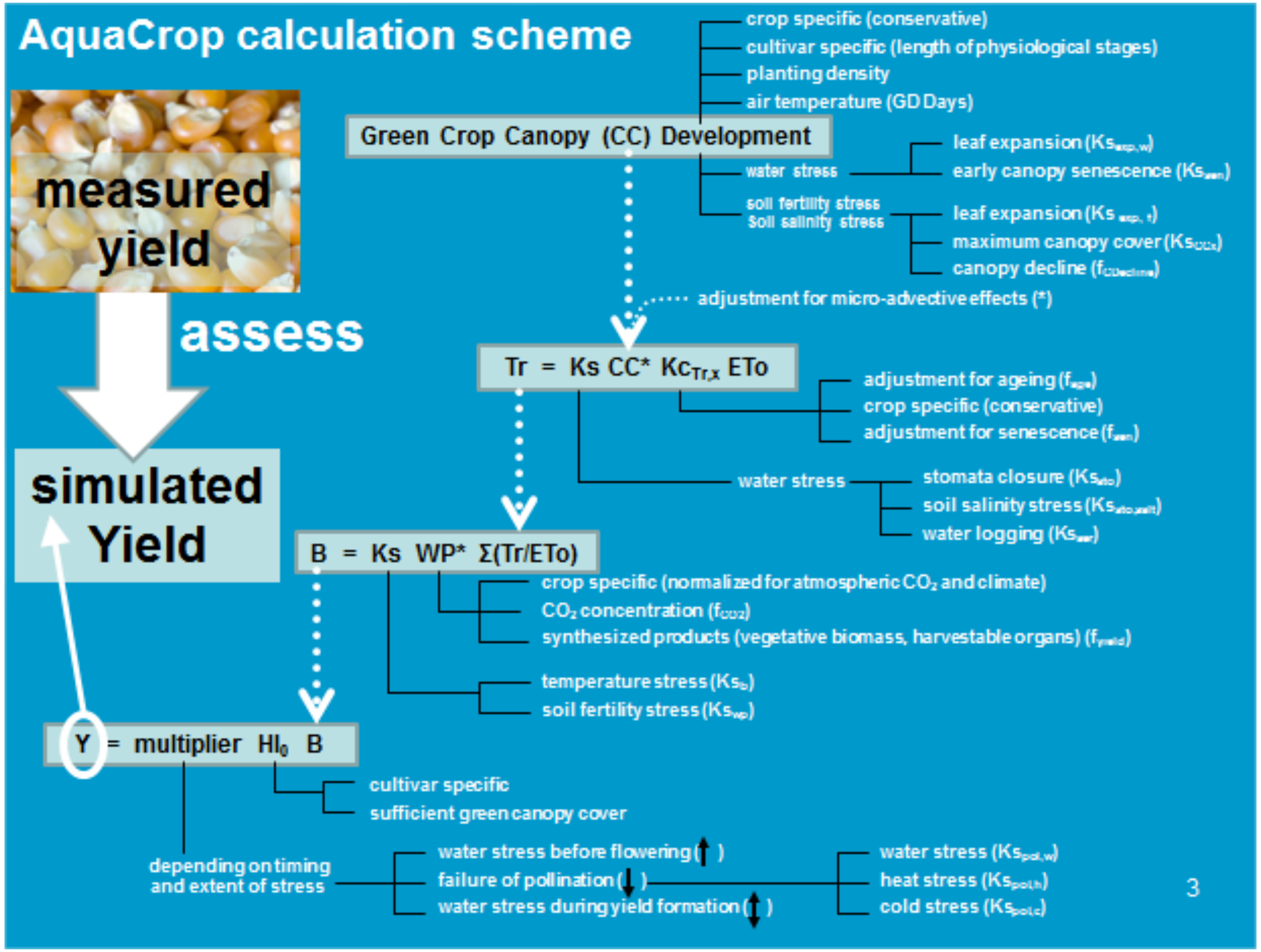
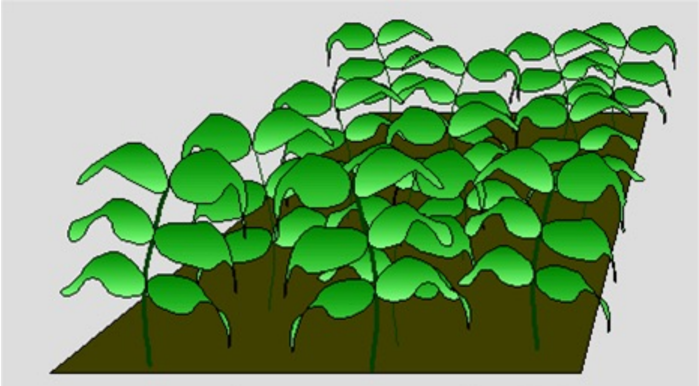


Figure by D. Raes

WHAT DO WE NEED FOR CALIBRATION

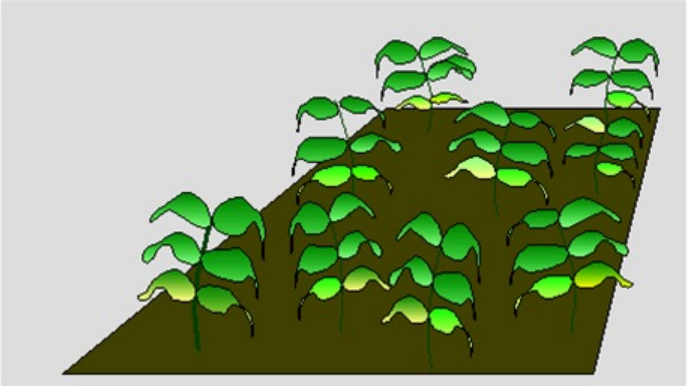
1st



Reference field

Non-limiting conditions

2nd



Stressed field

Water-limited conditions

FIELD MEASUREMENTS AND OBSERVATIONS

AQUACROP CALIBRATION: STARTING WITH THE ASSESSMENT OF GREEN CANOPY COVER

1. Green canopy cover

Non-conservative parameters	Scenario
Initial CC (CCo)	Non limited conditions
Maximum CC (CCx)	Non limited conditions
Crop phenology	Non limited conditions

Plant density → Initial CC (CCo), Maximum CC (CCx)

Variety specific → Crop phenology

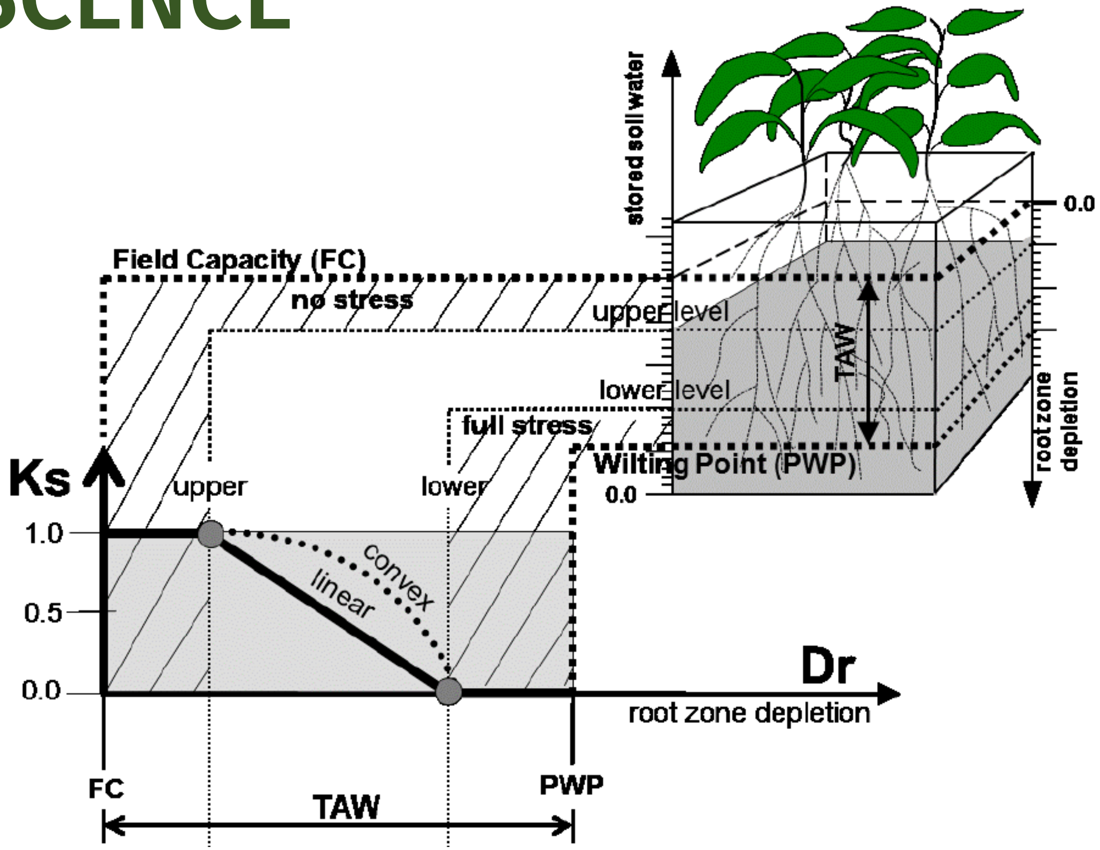
Conservative parameters	Scenario
Water stress parameters	Non limited conditions + Water limited conditions

EFFECTS OF WATER DEFICITS ON CANOPY EXPANSION AND SENESCENCE

1. Green canopy cover

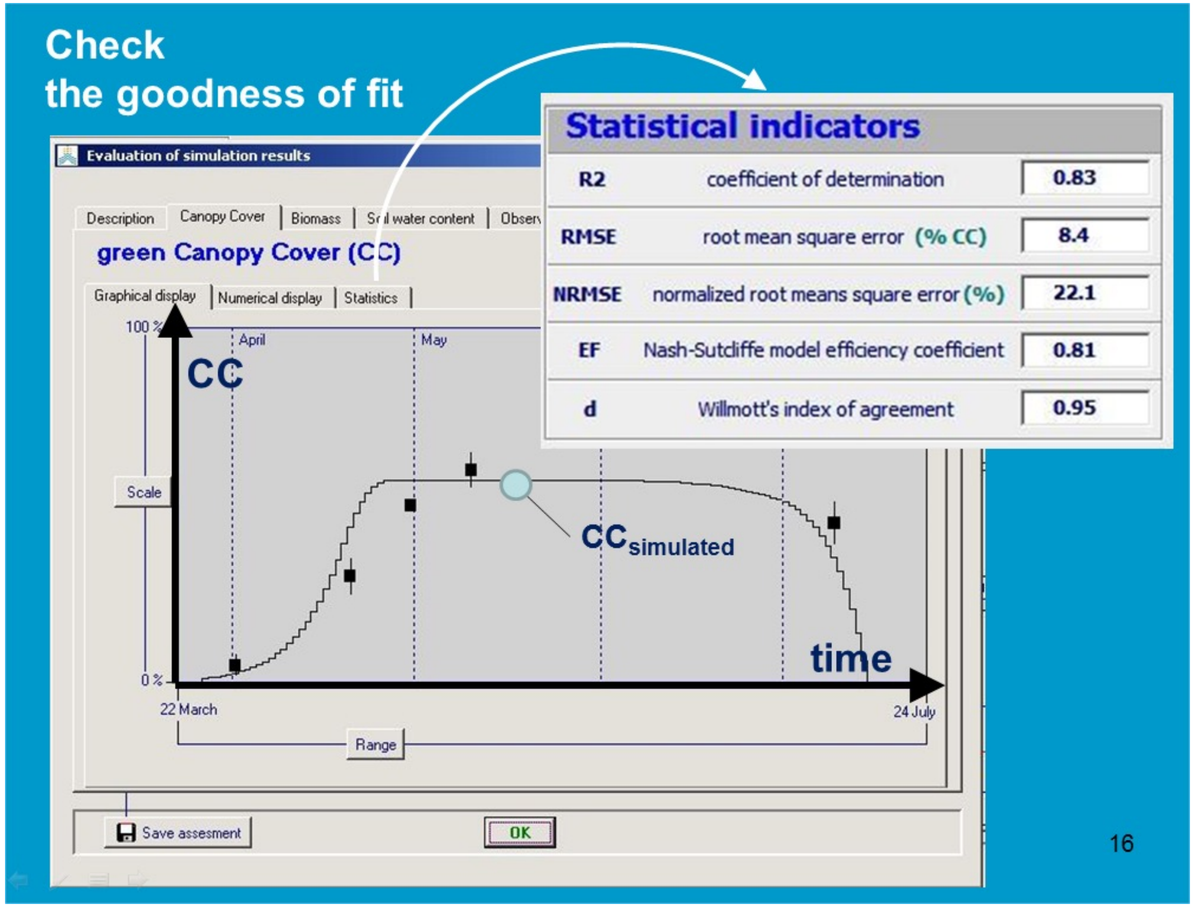
Water stress parameters

- Canopy expansion ($Ks_{exp,w}$)
- Early canopy senescence (Ks_{sen})



COMPARING SIMULATED CANOPY COVER AGAINST MEASURED

1. Green canopy cover



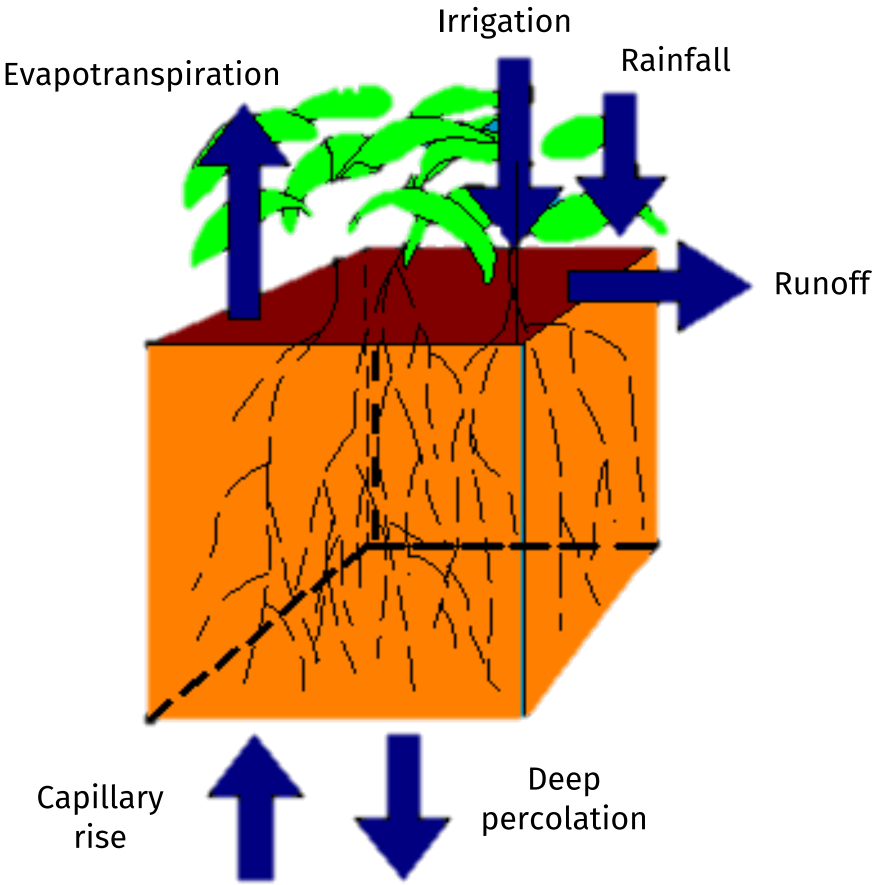
WHAT ARE THESE INDICATORS?

DETERMINING PARAMETERS FOR THE CALIBRATION OF TRANSPIRATION

2. Crop transpiration

Check inputs:

- Precipitation
- Irrigation
- Soil depth
- Soil hydraulic characteristics
- Depth of groundwater table



CONSERVATIVE VS. NON-CONSERVATIVE PARAMETERS

2. Crop transpiration

Non-conservative parameters | **Scenario**

Parameters that affect SWC — Non limited conditions

↑

cc, pwp, Ks → **Soil characteristics**

Conservative parameters	Scenario
Crop coefficient (Kc_{Tr})	Non limited conditions
Water stress parameters	Non limited conditions + Water limited conditions

IMPACT OF WATER STRESS ON TRANSPIRATION

2. Crop transpiration

Water stress parameters

- Stomatal closure (Ks_{sto})
- Waterlogging (Ks_{aer})

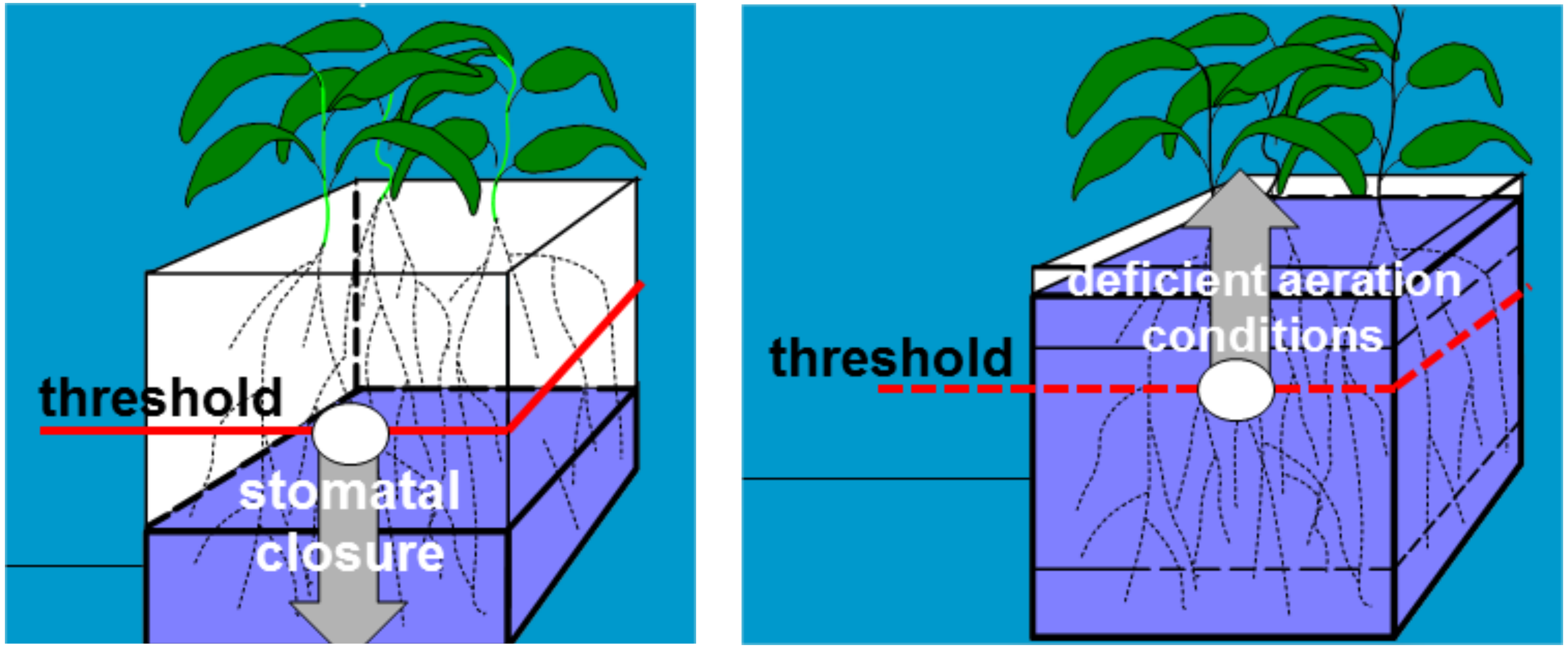
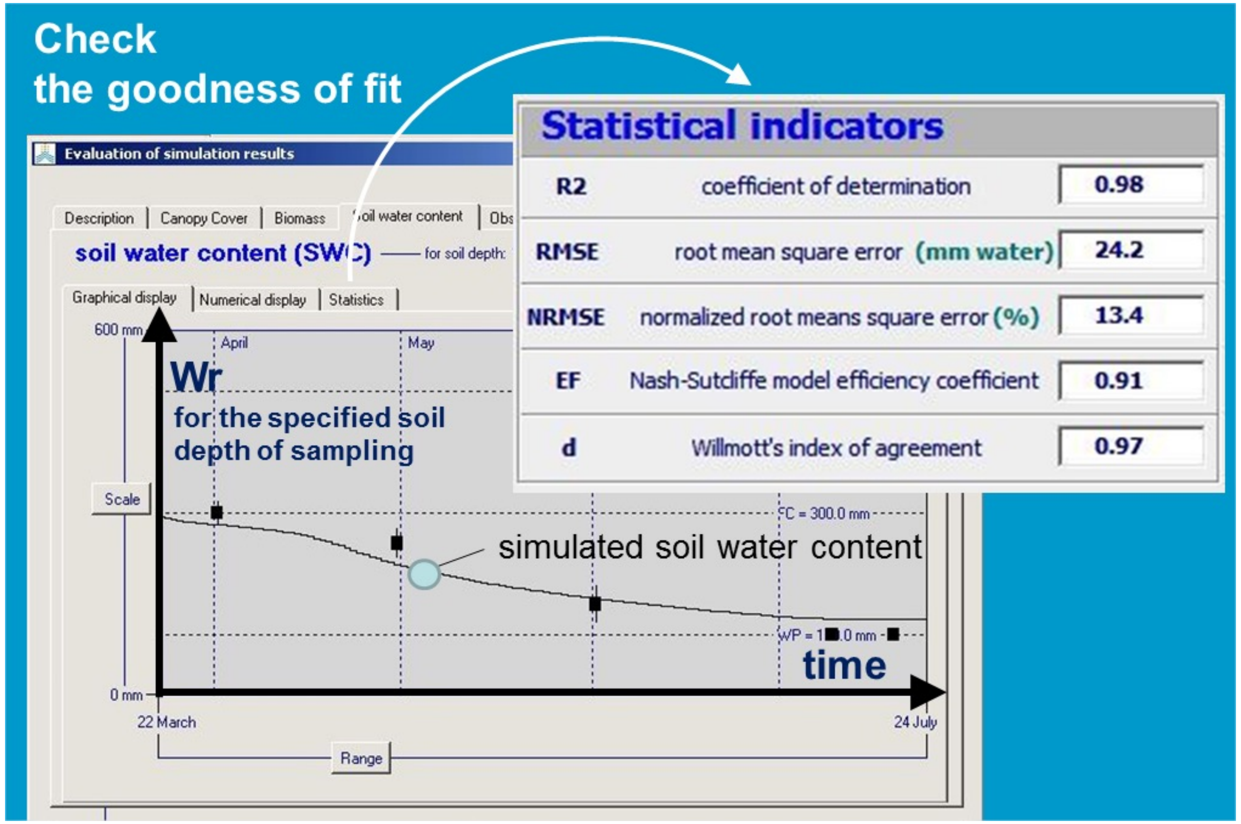


Figure by D. Raes

TRANSPIRATION CALIBRATION THROUGH SOIL WATER CONTENT

2. Crop transpiration



CALIBRATION OF SIMULATED BIOMASS PRODUCTION

3. Above ground biomass production

Taking biomass measurements:

- Collect representative samples (location and size of sampling areas)
- Appropriate sub-sampling and drying
- Losses of biomass in the field prior to sampling

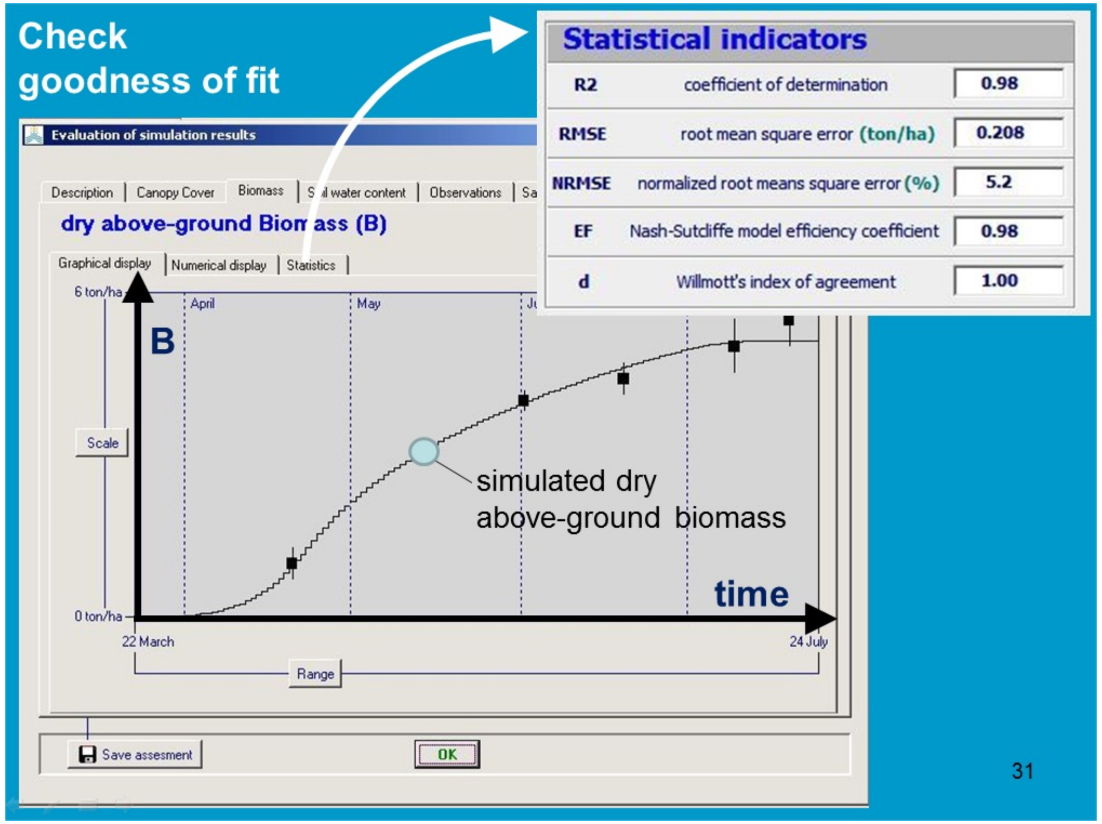
WHAT ARE THE PARAMETERS AFFECTING BIOMASS PRODUCTION?

3. Above ground biomass production

Conservative parameters	Scenario
WP*	Non limited conditions
Temperature stress parameters	Non limited conditions

CHECKING THE SIMULATION OF BIOMASS PRODUCTION

3. Above ground biomass production



YIELD CALIBRATION

4. Yield

Cultivar specific →

Non-conservative parameters	Scenario
Harvest index (HIo)	Non limited conditions

Conservative parameters	Scenario
Temperature stress parameters	Non limited conditions
Water stress parameters	Non limited conditions + Water limited conditions

REGRESSION OF SIMULATED VS. OBSERVED VALUES

4. Yield

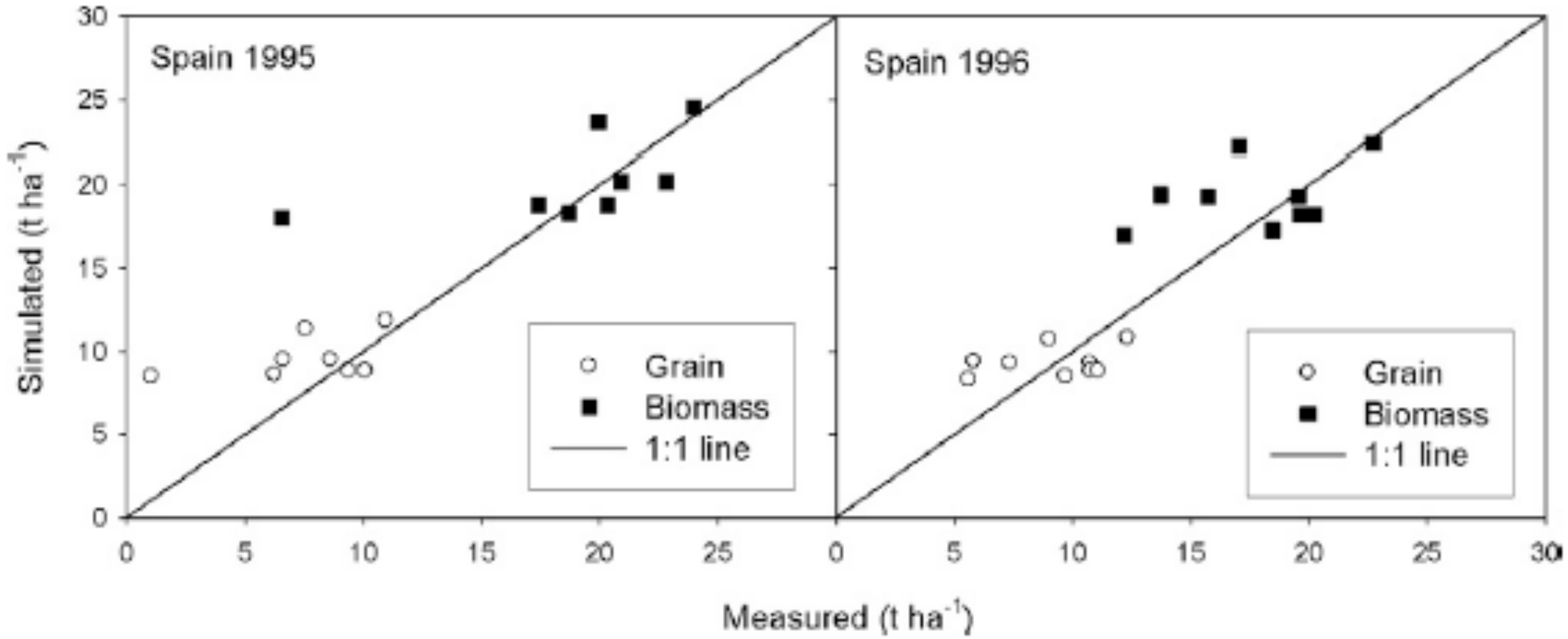


Figure from Heng et al., 2009

HOW ARE THE SIMULATION RESULTS ASSESSED?

Observed vs. Simulated

1. Green canopy cover
2. Crop transpiration/SWC
3. Above ground biomass production
4. Yield

Statistical indicators	
R2	coefficient of determination
RMSE	root mean square error (ton/ha)
NRMSE	normalized root means square error (%)
EF	Nash-Sutcliffe model efficiency coefficient
d	Willmott's index of agreement

HOW ARE THE SIMULATION RESULTS ASSESSED?

Statistical indicators

P_i = *Model predictions (Simulated values)*

O_i = *Observations (Observed values)*

$$RMSE = \sqrt{\frac{\sum (P_i - O_i)^2}{n}}$$

$$CV(RMSE) = \frac{1}{\overline{O}} \sqrt{\frac{\sum (P_i - O_i)^2}{n}}\ 100$$

$$EF = 1 - \frac{\sum (P_i - O_i)^2}{\sum \left(O_i - \overline{O}\right)^2}$$

$$d = 1 - \frac{\sum (P_i - O_i)^2}{\sum \left(|P_i - \overline{O}| + |O_i - \overline{O}|\right)^2}$$

HOW ARE THE SIMULATION RESULTS ASSESSED?

Acceptable ranges of indicator values				
Statistical indicator & range	**R^2**	**NRMSE**	**EF**	**d**
Possible range	0 - 1	0 - 100%	−∞ - 1.0	0 – 1
Very good	≥0.90	≤ 5%	≥0.80	≥ 0.9
Good	0.80-0.89	6 – 15%	0.60 – 0.79	0.80 – 0.89
Satisfactory	0.70-0.79	16 – 25%	0.40 – 0.59	0.65 – 0.79
Unsatisfactory	< 0.70	>25%	<0.40	<0.65

TO CONCLUDE,

In FAO I&D 66, the four Hsiao's rules:

1. Understand how the model simulates
2. Always pay attention to the graphic display of the output
3. Check your inputs before start chaning the parameters in the model
4. If simulations do not agree with measurements, the problema might be in the measurements

Use more than one dataset for calibration to be reliable, e.g., several years or different locations

THANK YOU