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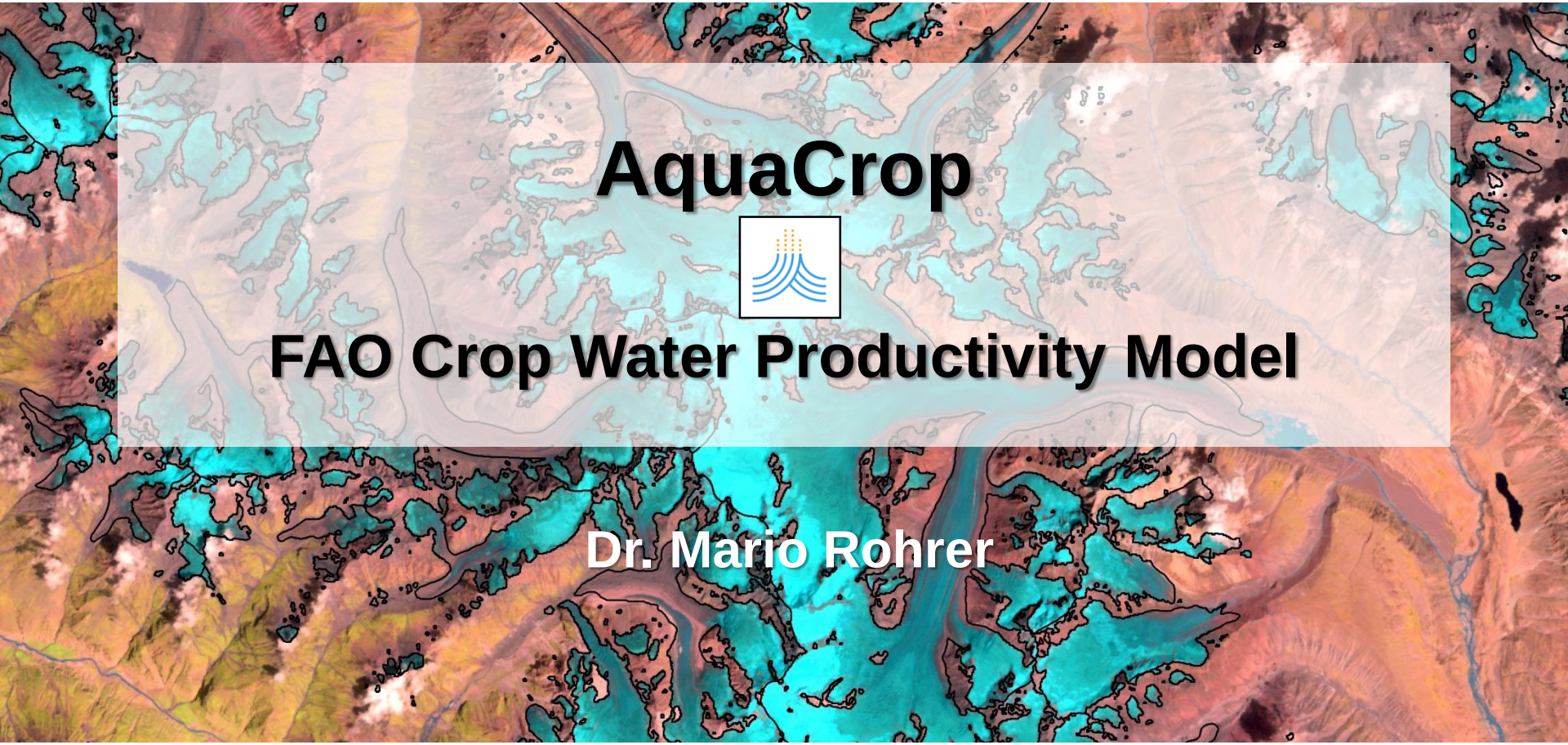

AquaCrop

FAO Crop Water Productivity Model

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IHCAP – Indian Himalayas Climate Change Adaptation Programme
Capacity building programme “Cryosphere” Level-2 (February 2015)

Contents

Food security (Definition)

Definition (World Food Summit, 1996)

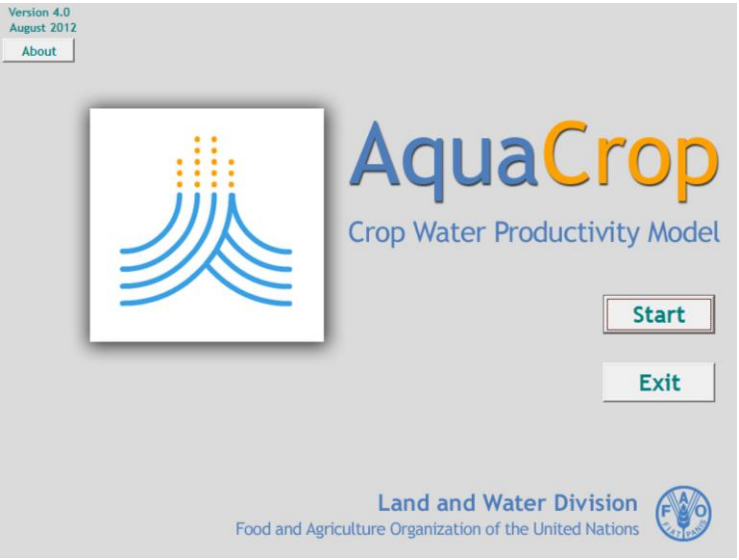
Food security exists when ***all people***, at ***all times***, have physical and economic access to ***sufficient***, ***safe*** and ***nutritious food*** that meets their dietary needs and food preferences for an active and healthy life.

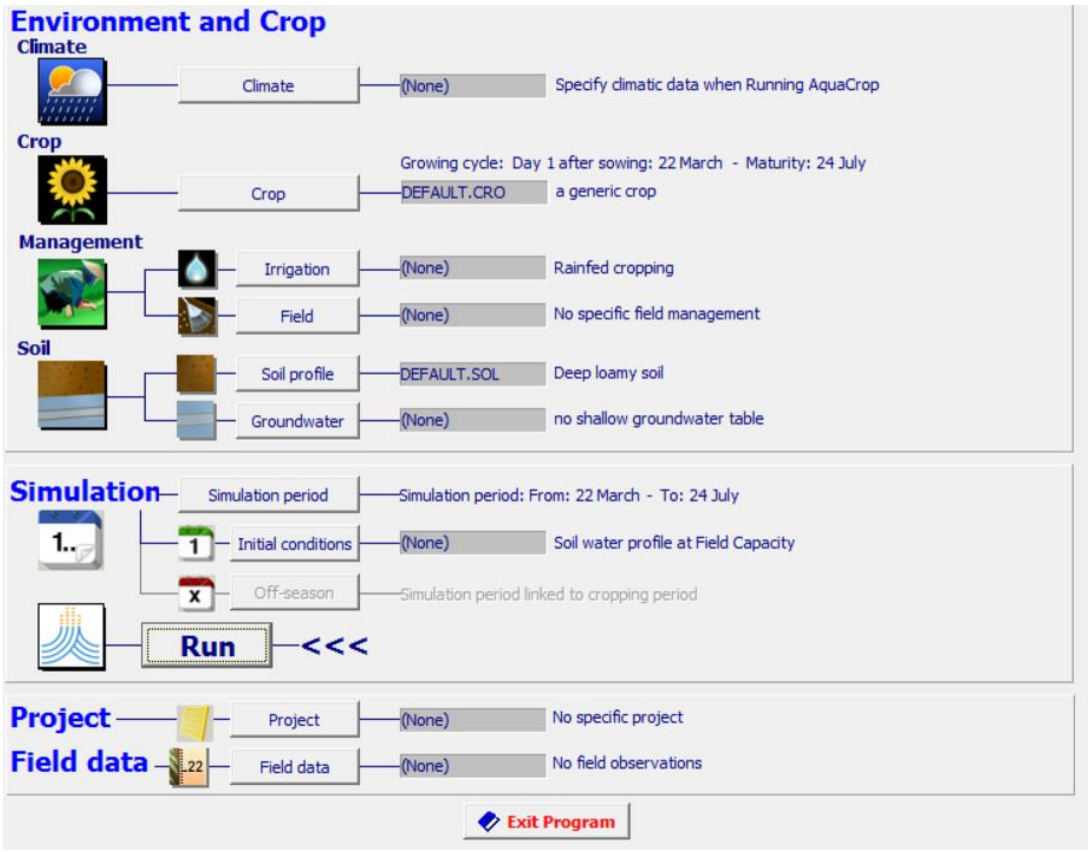
sufficient

nutritious

safe

AquaCrop: The water productivity model



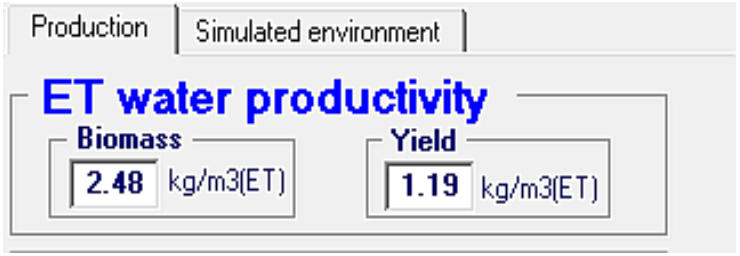


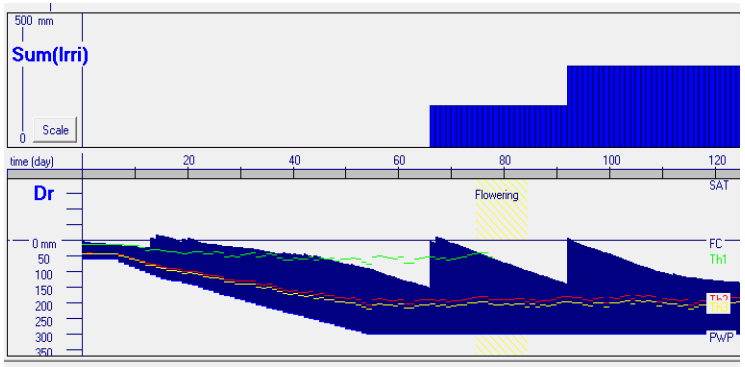
- ***AquaCrop*** is the new Crop water ***productivity*** model of FAO.
- In menus, which are ***hierarchically*** organized (***layers***), a lot ***more parameters*** than in CROPWAT can be adjusted

AquaCrop: Yield assessment and more

With AquaCrop you can do:

1. ***Yield*** assessment for single crops under full irrigation/no stress conditions and under deficit irrigation/multiple stress conditions.
2. Daily ***irrigation scheduling***.
3. Calculation of ***crop/weather scenarios***
4. Assessment of ***future crop scenarios*** under ***climate change*** conditions (enhanced CO2)
5. Simulation of many ***crop*** and ***soil variables***
6. ***Salt balance***





AquaCrop: The basic idea: Biomass = f(Sum(Transpiration/Et_0))

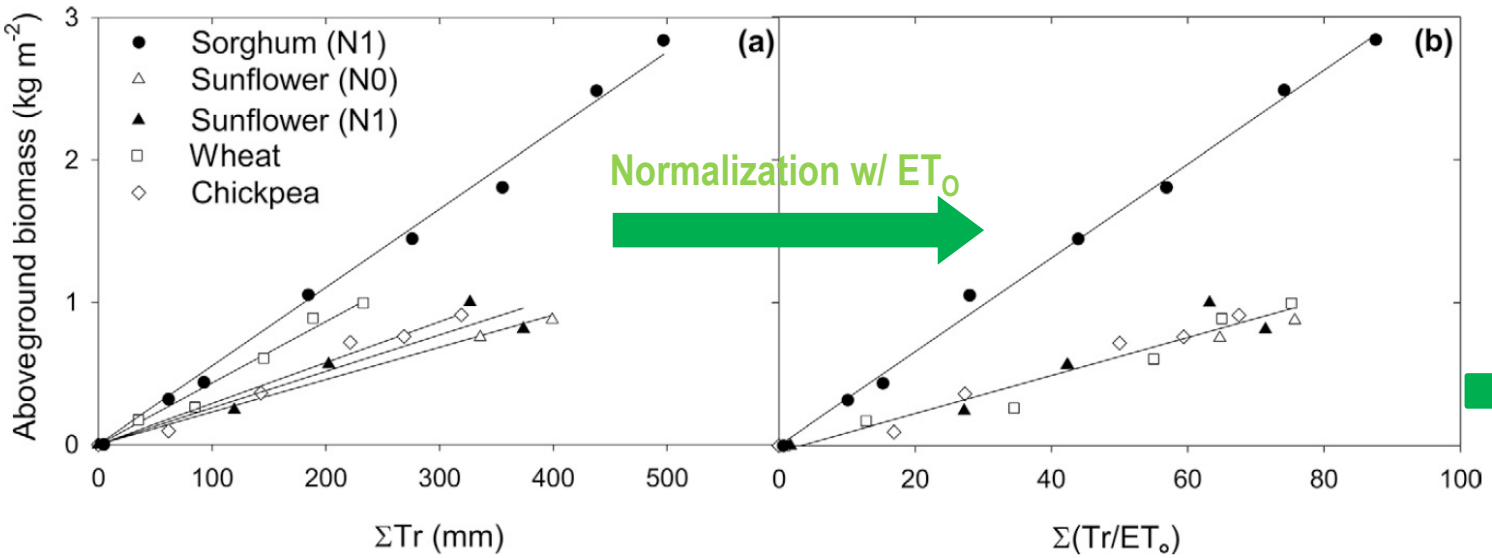
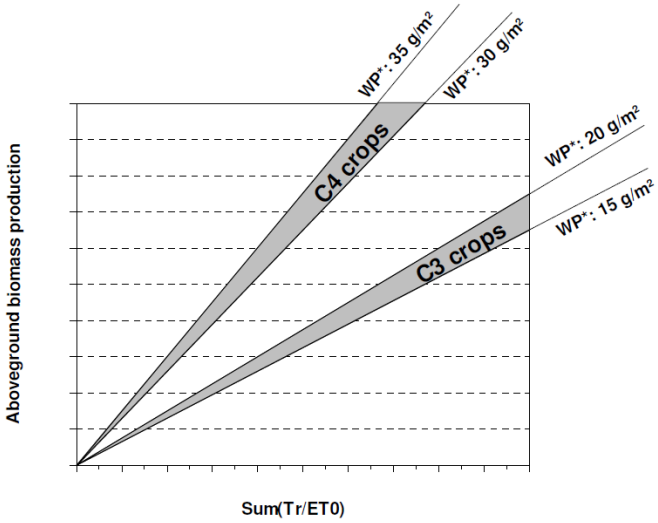


Fig. 2. Relationships (a) between aboveground biomass and cumulative transpiration (∑Tr) and (b) between aboveground biomass and cumulative normalized transpiration for reference-crop evapotranspiration [∑(Tr/ET_o)], during the crop cycle of sunflower (under two N levels and up to anthesis), sorghum, wheat, and chickpea (redrawn from Steduto and Albrizio, 2005).

- Above ground ***biomass*** production is a ***well defined linear function*** of ***Transpiration*** normalized with Et_0.
- For ***C3*** (***weat, chickpea, rice***,…) crops and for ***C4*** (***sorghum, millet, maize***, …) crops this functions are in a ***small slope range***.

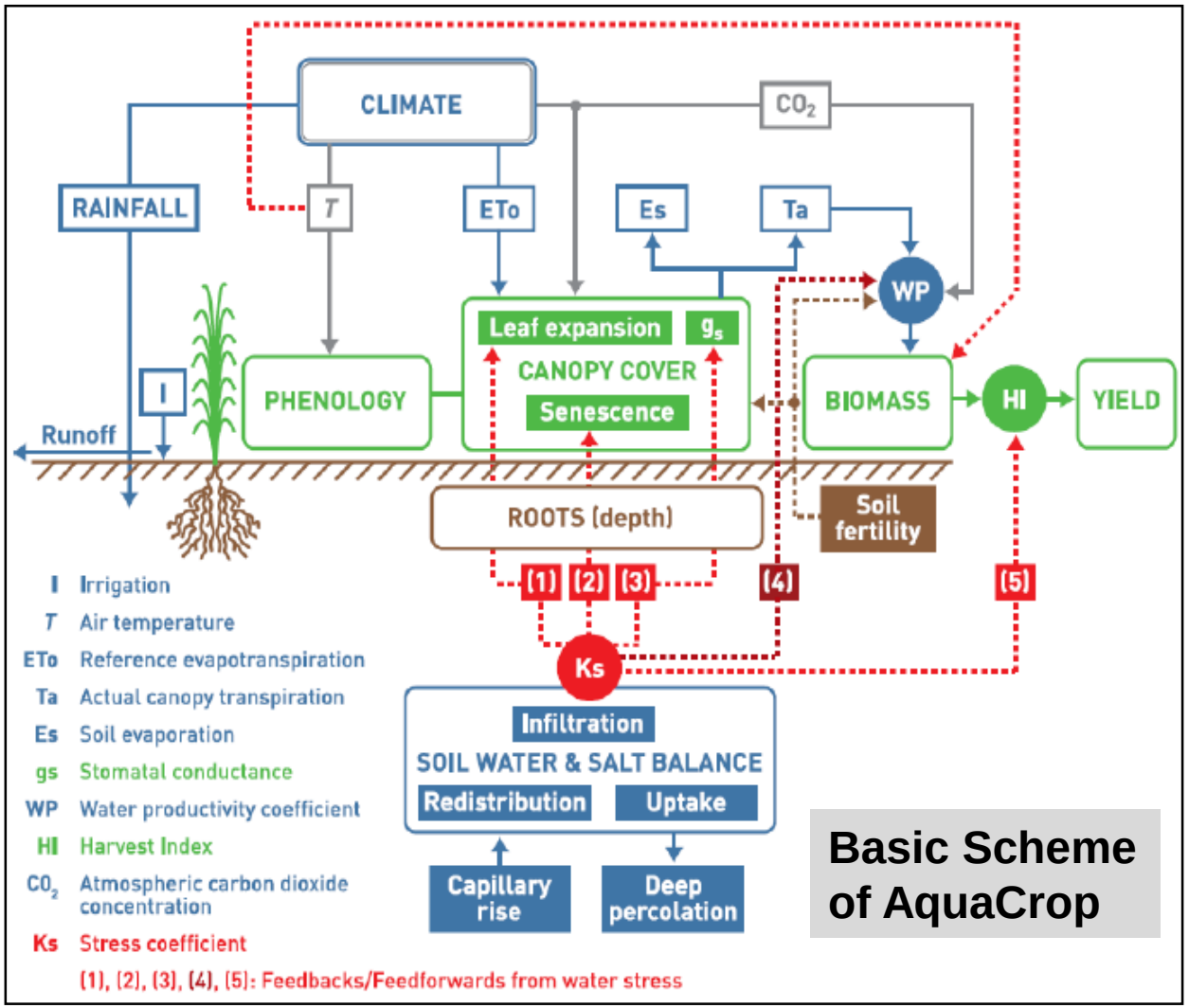


AquaCrop: Scheme

Most important differences

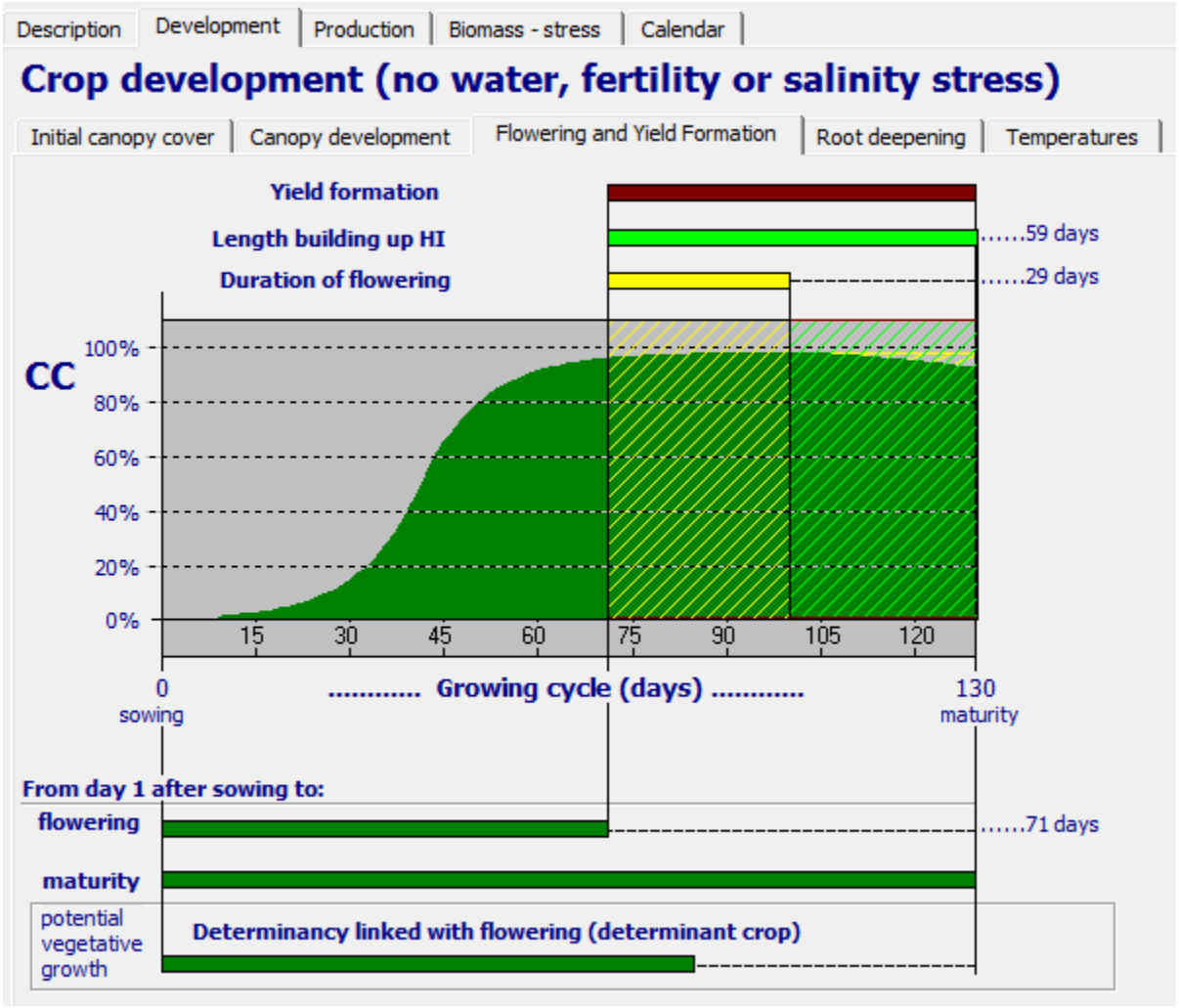
from **AquaCrop** to **CROPWAT**:

- ***Crop Coefficient*** is split in evaporation and ***transpiration*** part
- ***Transpiration*** amount of crop is used to calculate ***Biomass***
- Via a ***Harvest Index (HI)*** a ***Yield*** is calculated from Biomass



Basic Scheme of AquaCrop

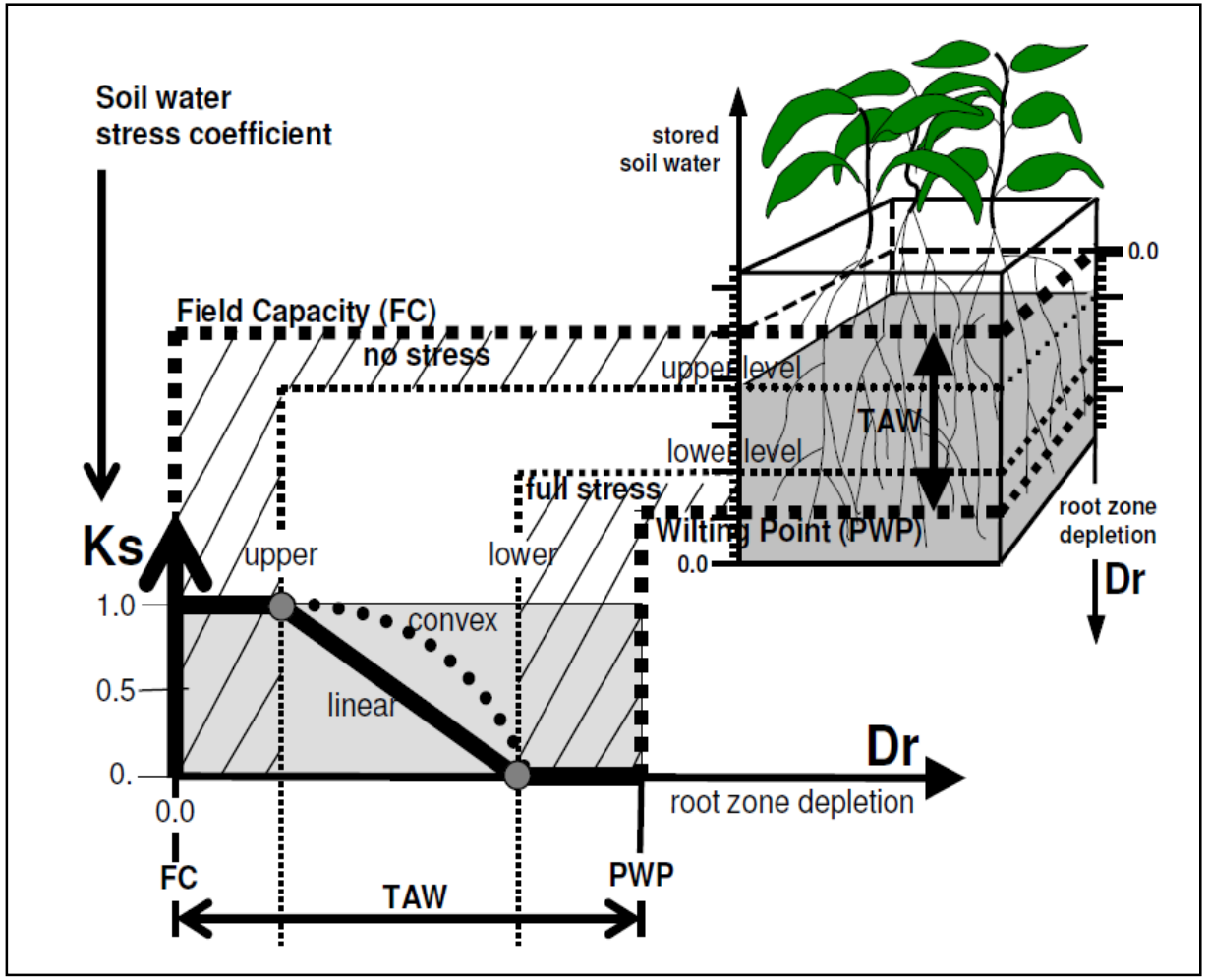
AquaCrop: Phenology



AquaCrop: Step 1: Simulation of Soil Water Balance

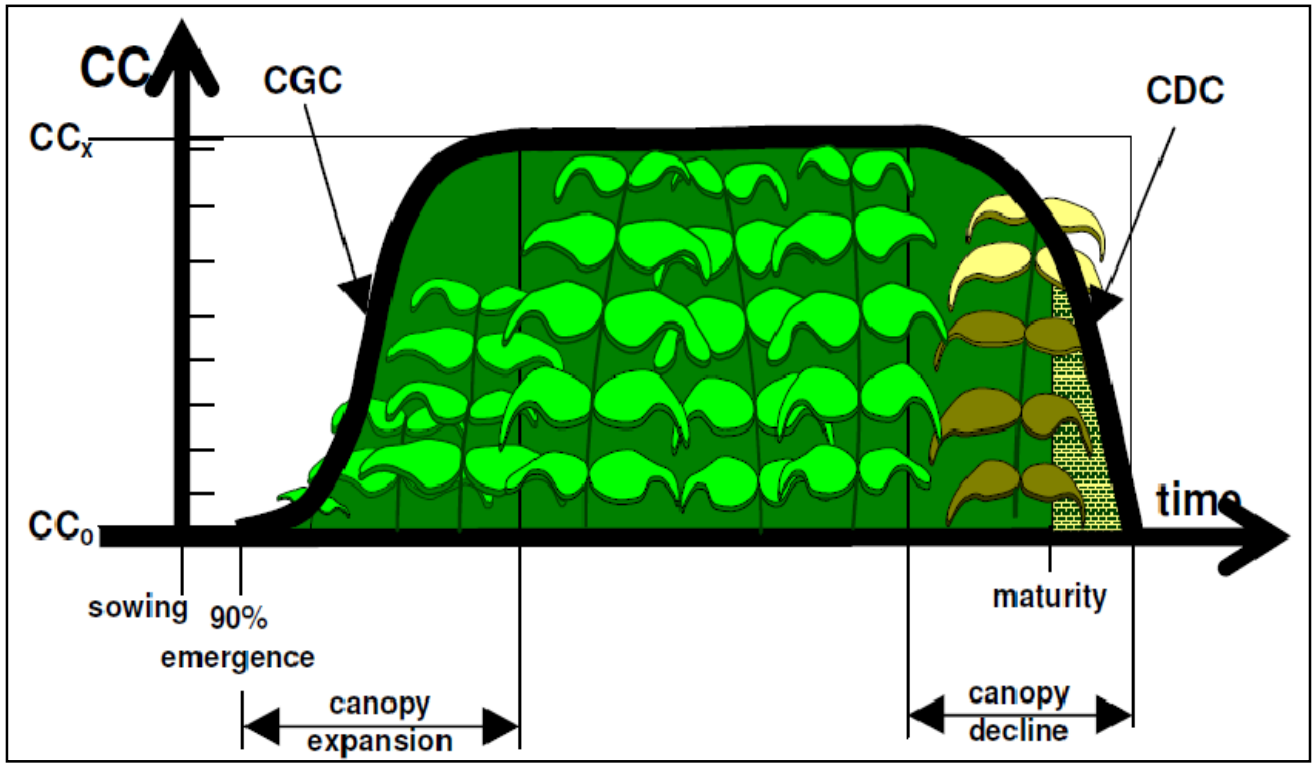
Soil Water Balance

- **Amount of water stored** in the **root zone** simulated by accounting for incoming and outgoing water fluxes at its boundaries.
- The **root zone depletion** determines the magnitude of a set of water stress coefficients (**Ks**)



AquaCrop: Step 2: Simulation of green canopy development (CC)

Variation of **Green Canopy Cover (CC)** throughout crop cycle under **non-stress conditions**.



CCo: Initial Green Canopy Cover

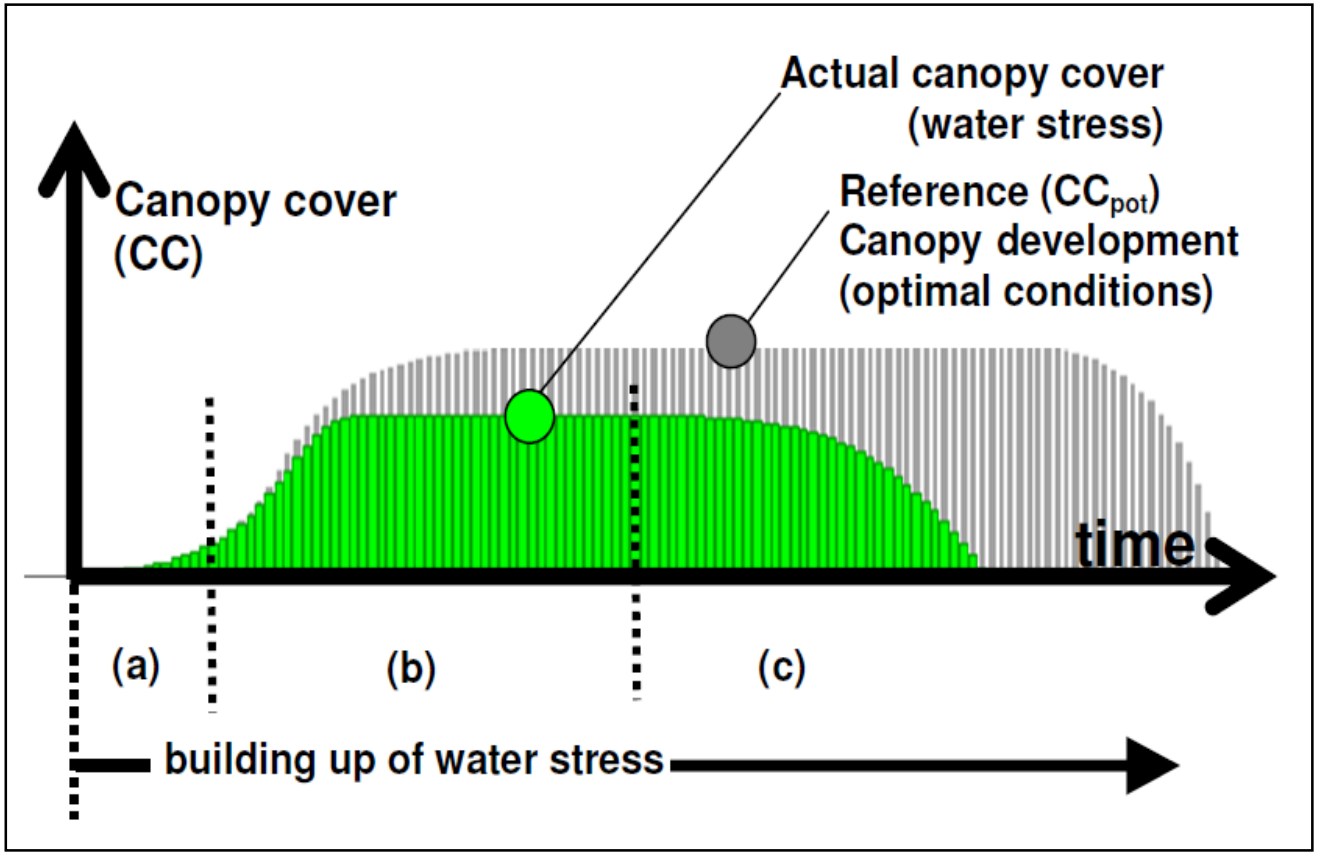
CCx: Maximum Green Canopy Cover

CGC: Green Canopy Growth Coeff.

CDC: Green Canopy Decline Coeff.

AquaCrop: Step 2: Simulation of green canopy development (CC)

Simulation of CC when water stress builds up during crop cycle



CC expansion:

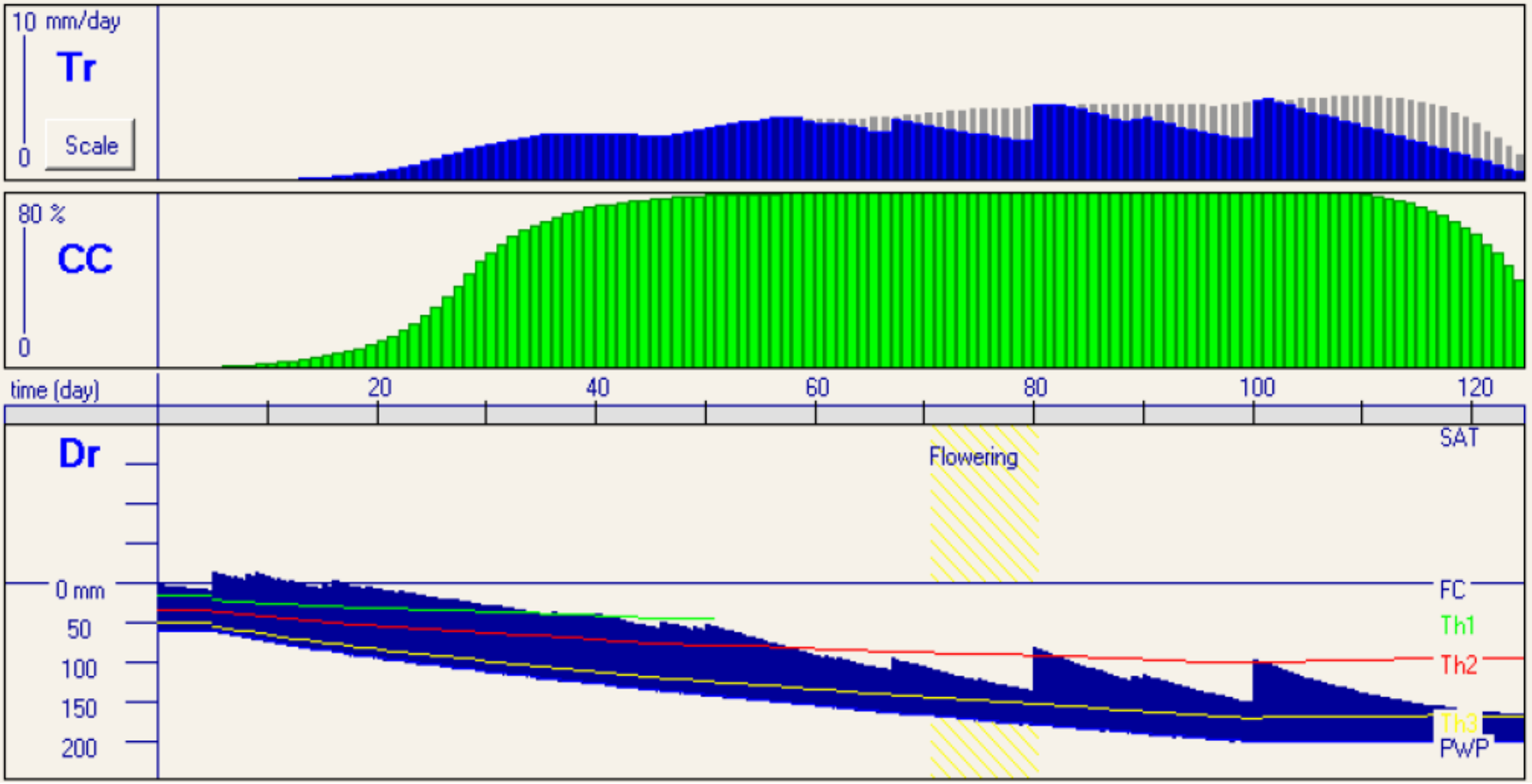
Most sensitive process to **water stress**:

(a) ***no effect*** of ***water stress*** on canopy development

(b) ***water stress affecting leaf expansion***

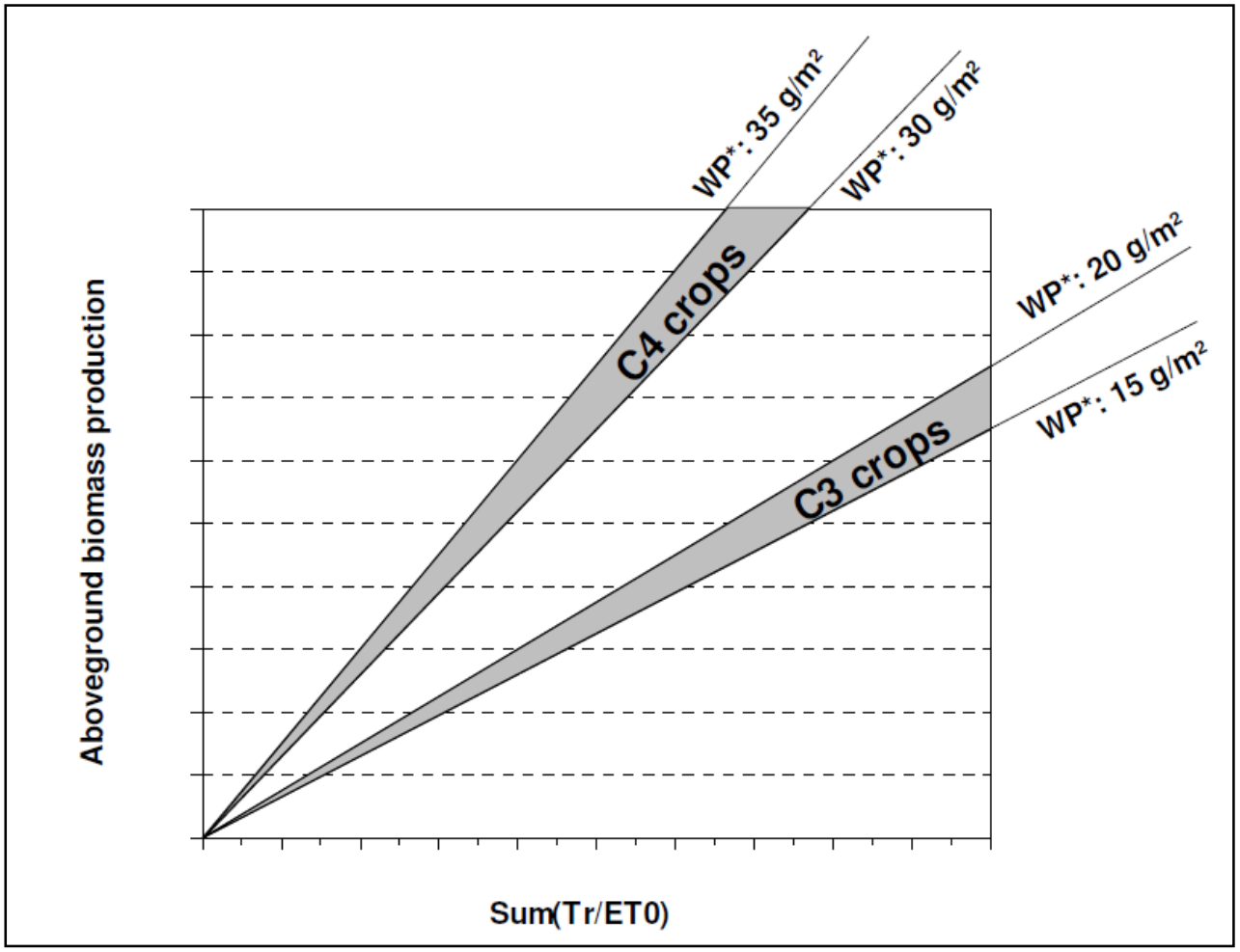
(c) ***water stress*** triggering ***early canopy decline***

AquaCrop: Step 3: Simulation of crop transpiration Tr



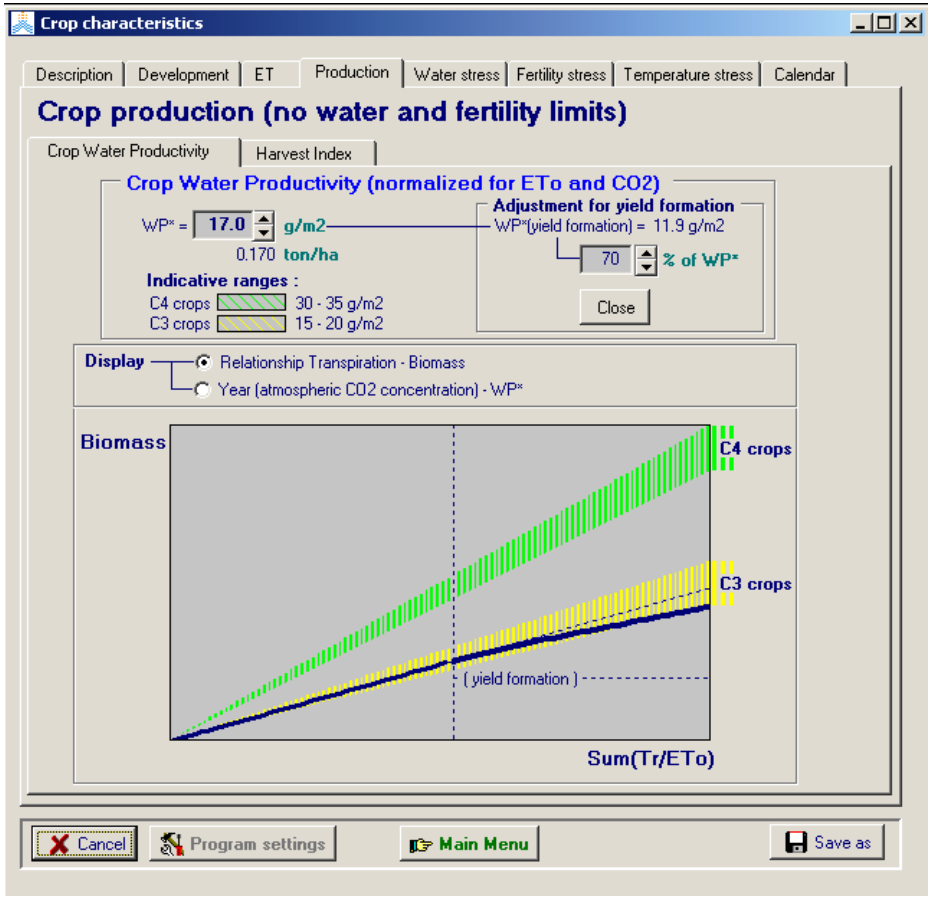
Simulation of **crop transpiration** in function of **rainfall** or **irrigation pulses**

AquaCrop: Step 4: Simulation of above ground Biomass



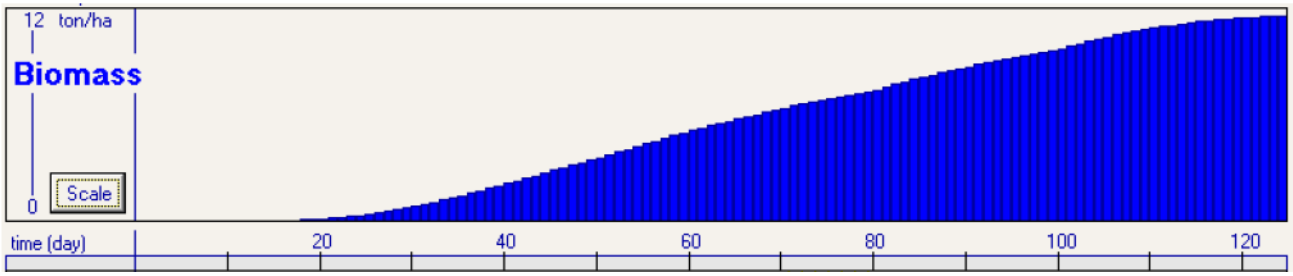
Core of AquaCrop growth engine: Biomass Production = f(Sum(Tr/Eto))

AquaCrop: Step 4: Simulation of above ground Biomass



Water Productivity

Normalized for Eto and CO_2
Adjustment of WP* for oil or protein food after flowering (anthesis). Eg. Sunflower



AquaCrop: Step 5: Partitioning of Biomass (B) into Yield (Y)

above ground biomass

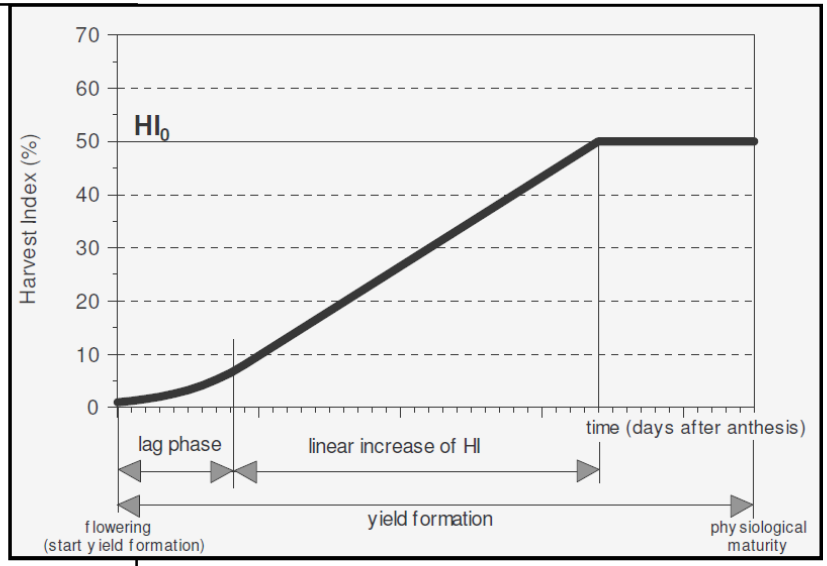
$$Y = f_{HI} \; HI_o \; B$$

reference Harvest Index ← adjustment for inadequate photosynthesis

adjustment factor

adjustment depends on timing and extent of stress

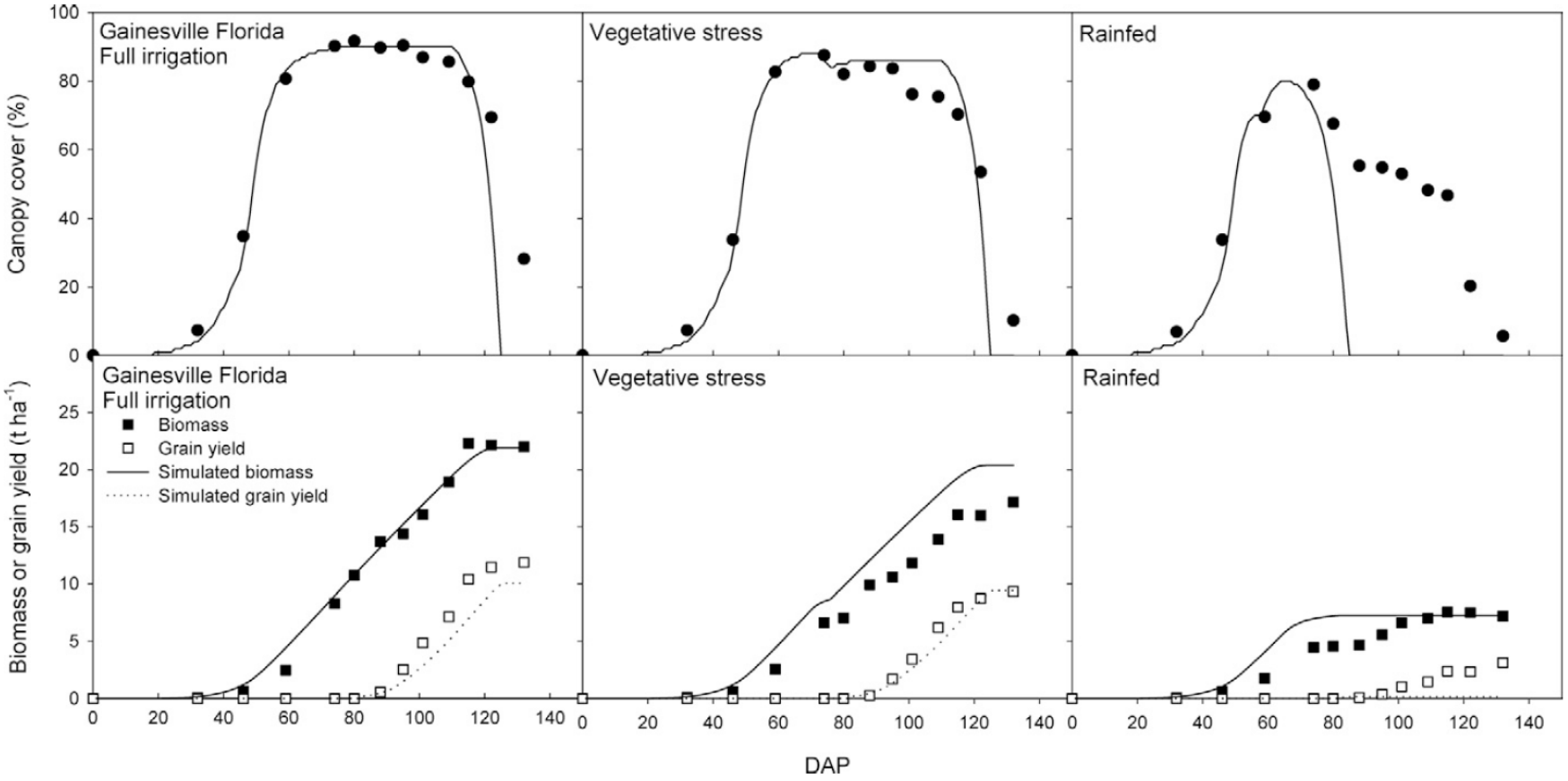
- water stress before yield formation (positive adjustment)
- failure of pollination (negative adjustment)
  - water stress ($Ks_{pol,w}$)
  - heat stress ($Ks_{pol,h}$)
  - cold stress ($Ks_{pol,h}$)
- water stress during yield formation
  - affecting leaf expansion (positive adjustment)
  - affecting stomata closure (negative adjustment)



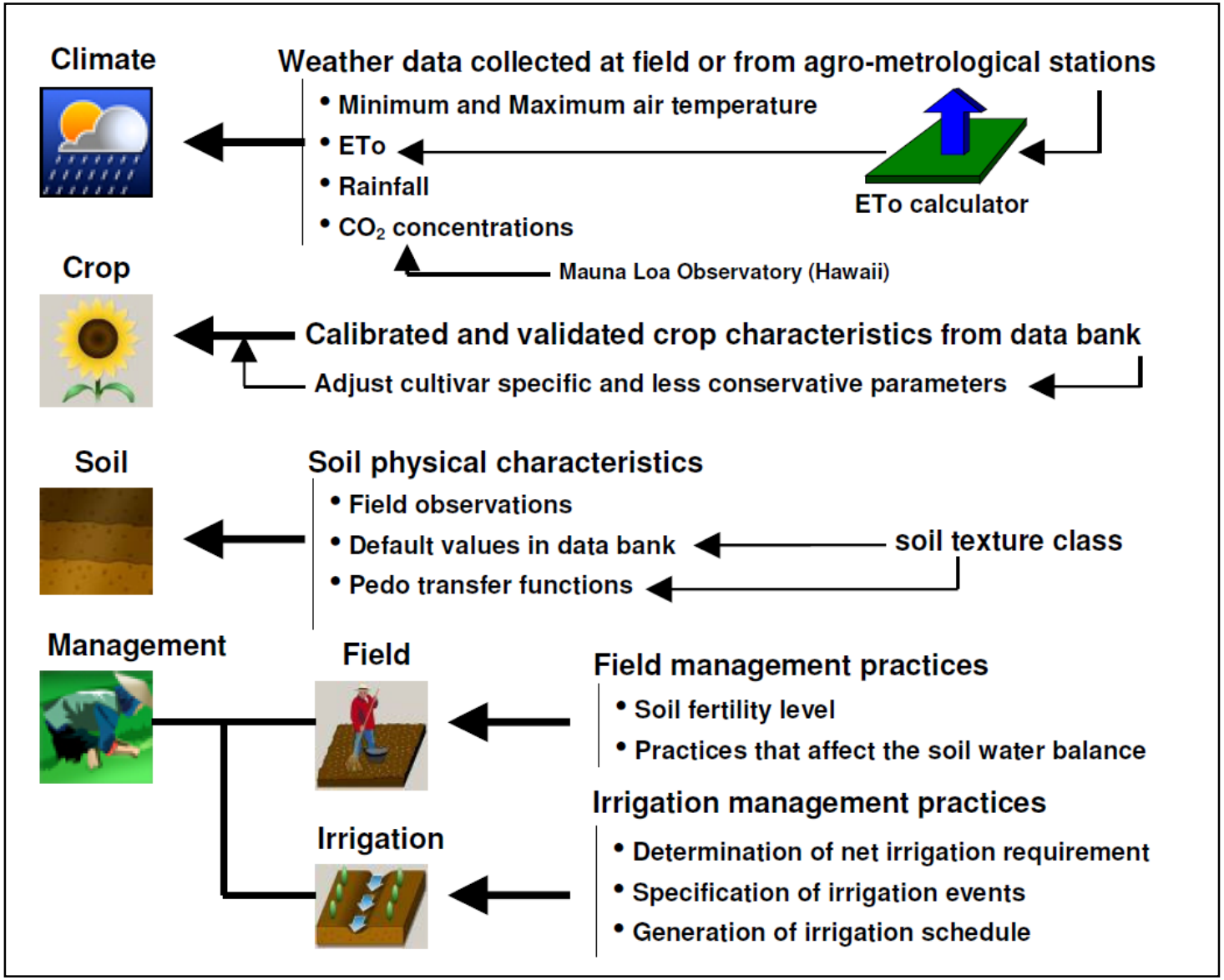
Building up of **reference Harvest Index (HI0)** from flowering till physiological maturity for fruit and grain producing crops.

AquaCrop: Deficit Irrigation

AquaCrop Maize with default parameterization (no calibration)



AquaCrop: Input requirements



Food security