# Computer session: yield prediction, simulation of the genotype × environment interaction with an Excel version of APSIM

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*Training course*

*Environment & Traits*

# General Approach to Crop Growth and Biomass Accumulation

## Light-limited conditions

$\Delta$Biomass ($g/m^2/day$) = Q $\times$ LI $\times$ RUE [1]

where Q = incident radiation ($MJ/m^2/day$)
LI = light intercepted by the canopy ($MJ/m^2/day$)
RUE = radiation use efficiency (g/MJ)

$LI = (1 - e^{-k*LAI})$

where LAI = canopy leaf area index (m2 leaf/m2 ground area)
k = light extinction coefficient

## Water-limited conditions

$\Delta$Biomass (g/m$^2$/day) = T $\times$ TE [2]

where T = crop transpiration (mm/day)
TE = transpiration efficiency (g/m$^2$/mm)

TE = $TE_c$/(vpd/10)
where vpd = vapour pressure deficit of the atmosphere (hPa), and
$TE_c$ = transpiration efficiency coefficient (Pa)
10 = conversion from hPa to Pa ($\times$100) and g/g to g/m$^2$/mm ($\div$1000)

# General Approach to Crop Water Use

*Balance between potential crop water supply and crop water use*

<u>Non limiting water supply</u>

When water supply is non limiting, equating [1] and [2] gives the potential transpiration:

$\Delta$Biomass = Q $\times$ LI $\times$ RUE [1]
$\Delta$Biomass = T $\times$ TE [2]

T = Potential Demand = Q*(1 – $e^{-k*LAI}$)*RUE/($TE_c$/(vpd/10)) [3]

In which we find some analogies with the Penman Montheith equation :

$$J_w = \frac{s(\phi_n) + \rho_a c_p VPD_{air} g_a}{\lambda[s + \gamma(1 + g_a / g_s)]}$$

# General Approach to Crop Water Use

*Balance between potential crop water supply and crop water use*

<u>Limiting water supply</u>

Available Soil Water (mm): ASW = sw – ll
where sw = soil water content
ll = lower limit of soil water content

Root Depth (cm) = DAS * Root Growth Rate
where DAS = days after sowing
Root Growth Rate (cm / day)

Potential Supply by a layer (PSlayer) = %RootOccupancy * ASW * kl
where kl = extraction rate constant from the crop

Potential Supply = ΣPSlayer

ΣPSlayer equals crop transpiration (T) when water supply is limiting

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<u>How to derive potential supply:</u>

Extraction of soil water from a layer can be described by an exponential decay of volumetric soil water content (q, $cm^3/cm^3$) with time (t, days) -

$\theta = (\theta_u - \theta_l).e^{-kl.t}$

where $\theta_u$ and $\theta_l$ are water content at ul and ll, respectively.

So, $d\theta/dt = -kl.(\theta_u - \theta_l).e^{-kl.t}$
$= -kl.\theta$

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*Balance between potential crop water supply and crop water use*

<u>Summing over successive days:</u>

T is determined via equation [3] or [4] depending on whether the day was light (demand) or water (supply) limited:

Transpiration = Minimum(Potential Supply, Potential Demand)

The ratio of Potential Supply to Potential Demand (S/D) can be used as an indicator:

S/D < 1 means water-limited conditions
S/D >=1 means light-limited conditions

Biomass increment is then evaluated using [1] or [2] (depending on S/D)