## Soil water balance

The water stored in the soil profile is considered to be divided into three zones (Figure5.a): (i) the excess water zone, corresponding to gravitational water, not immediately available for plants; (ii) the optimal yield zone, where water is readly available in an amount favourable to obtain the maximum yield of a given crop; (iii) the water stress zone, where available water is not enough to attain the maximum evapotranspiration, therefore inducing crop water stress and yield reduction.

The water storage zones as a function of the crop development stages is given in Figure 5. The upper boundary for the excess water zone is constant and corresponds to the soil moisture at saturation considering the maximum soil depth (Figure 5). The upper limit of the optimal yield zone corresponds to the maximal available soil water (mm), *Rmax*. The lower limit of the optimal yield zone corresponds to the minimal available soil water *Rmin* (mm) and is related to *Rmax* through the soil water deplection fraction, *p*(%), then

$$Rmin = (1 - p)\, Rmax$$

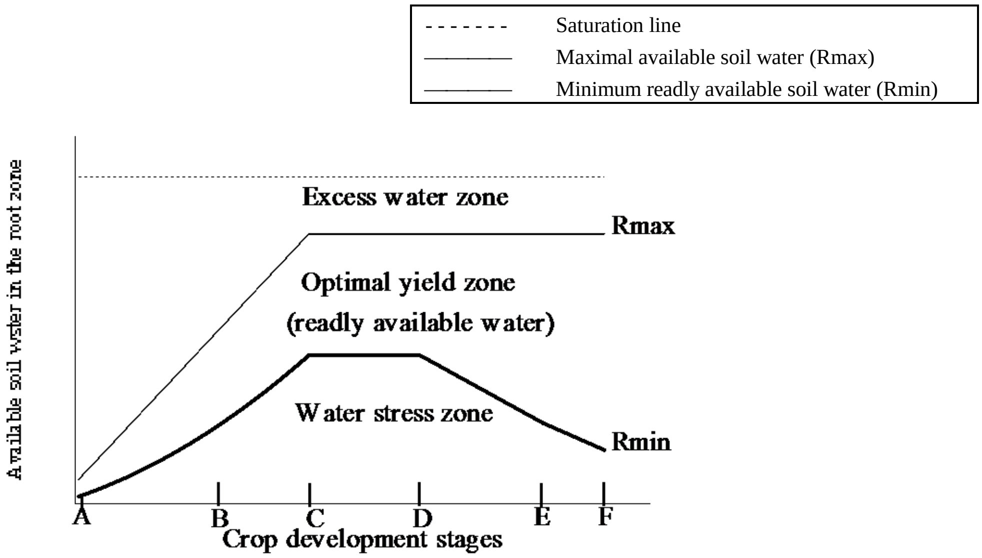


**Figure 5** The water in the soil profile in relation to crop development: a) limits and classification of the soil water till the maximum root depth, Zm; b) root depth in relation to crop development.

The soil water balance equation can be written

$$\Delta R = (Pe + Vz + Ir + Gc - ETc - Dr)\Delta t$$

where $\Delta R$ is the soil water variation (mm) during the time interval $\Delta t$ (days). The water entering the system during the same period $\Delta t$ is: *Pe* = effective precipitation (mm); *Vz* = the water stored (mm) in the deeper layer ot thickness *z*' which started to be explored by the roots after equivalent root growth during this time period; *Ir* = irrigation depth (mm); *Gc* = groundwater contribution (mm). The water leaving the system, for the same period is: *ETa* = actual evapotranspiration (mm); and *Dr* = deep percolation losses (mm).

*Gc* (mm/day) is computed from the potential for capillary rise *G* (mm/day) as follows

$$Gc = G - \frac{G}{Rmin} R$$

In the optimal yield zone *Dr*=0 (no gravity water exists), *Gc*=0 (in general) and *ETc=ETmaximum).* Then equation water balances, after integration, simplifies to

$$R(t) = R_i + (Pe + Vz - ETm)t$$

expressing a linear decrease of available soil water *R* with the time *t*, for intervals between irrigations.

In the water stress zone *R* is below *Rmin* and accordingly $ETc_{aj}$ is lower than *ETc.*

Complementing the information, other printed and graphical outputs are available (Teixeira and Pereira, 1992).

## Reference

Teixeira J.L. and Pereira L.S. (1992). ISAREG, an irrigation scheduling simulation model. *ICID Bulletin*, 41(2): 29-48.