Simulation of Crop Yield

Name of Author

The inputs to the model are:

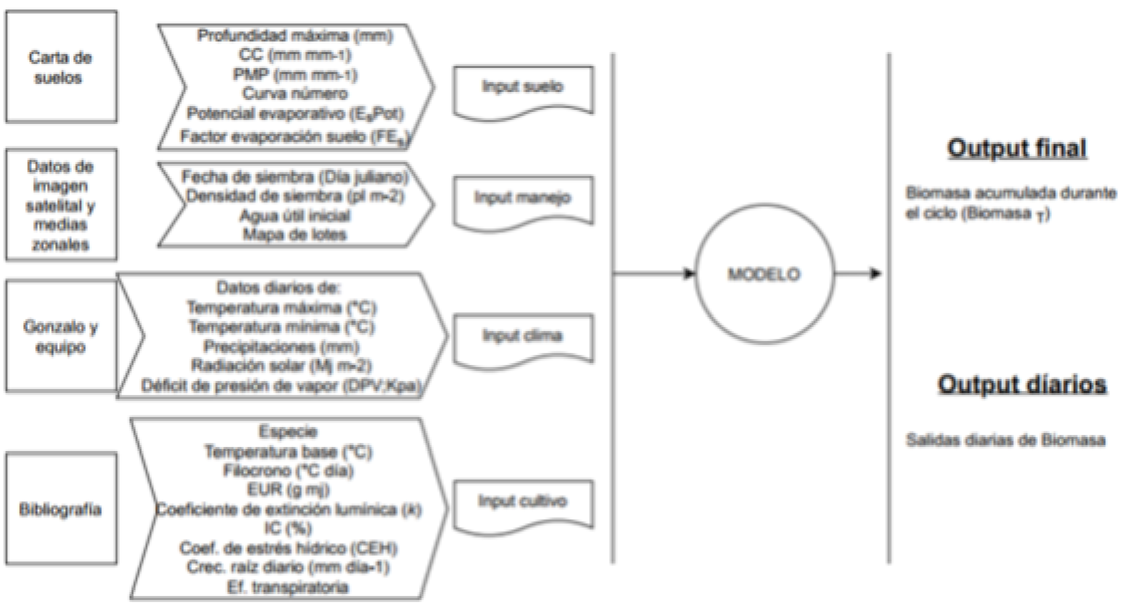


Figure 1. General diagram of the main inputs and outputs of the model.

- crop management (input manejo),
- soil description (input suelo),
- daily climate variables (input clima) and
- crop characteristics that describe its response to these variables (input cultivo).
- It’s a daily step model in which the main daily output is biomass.

Summary

The main equation of the model (conceptual) is:

	$b = \int_t r(t) C_E \delta_i dt$	(Eq. 1)

where *b* is the biomass at the end of the period, r = f(PAR,CT,EUR) (section 1) is the rate of daily growth dependent on PAR, EUR, and CT , CE is a weather stressor (section 2 and 3), δi indicates the occurrence of hail and/or frost (Section 4). The yield R is:

	$R = b \times IC_R$	(Eq. 2)

where IC_R is the "indice de cosecha" that accounts for the amount of biomass that corresponds to the harvestable biomass and is obtained as follows.

	$ICi = \frac{\left(ic_{in} \times ic_{pot}\right)}{\left(ic_{in} + \left(ic_{pot} - ic_{in}\right) \times \mathrm{exp} exp - Y^{ddf}\right.}$	(Eq. 3)

Where ic_pot results from Eq.4, ic_in and Y are theoretical parameters, and ddf is the number of days after crop flowering. ic_pot is an input cultivo that could be affected by a water stress during the period center at flowering (Eq.4). The determination of CEH_PC is described in secction 3.3.

	$IC_R = IC_{pot} \times CEH_{PC}$	(Eq. 3)

1. Simulation of potential yield *r(t)*

Crop yield *R* is the product of the total amount of *b* produced per surface area and *IC* (Eq.2). The model estimates *b* at each day of simulation either until the crop reaches crop maturity, or the growth is affected by an environmental stressor (section 4). The total amount of biomass *b* obtained at the end of a period *i* (b_T) is estimated by the following equation:

	$b \;= b_i + b_{i-1}$	(Eq. 4)

where the amount of biomass accumulated at day *i* (b_i) is added to the amount accumulated the previous day (b_{i-1}). The daily value of biomass (b_i) is computed as:

$$b_i = \%CT \times PAR \times EUR_{ACT} \times FCCH \qquad \text{(Eq. 5)}$$

Equation 5 (Figure 2) represents the relationship between the total amount of solar radiation that reaches the surface and is available to plants (PAR), the fraction of this solar radiation that it's captured by the crop (%CT), and the efficiency in which this PAR is transformed into b (EUR_{Act}). PAR is a meteorological input (Input clima). Generally, this value corresponds to 0.45% of the daily solar radiation (MJ m-2).
Daily biomass (Eq.5) could also be estimated by water consumption. An alternative approach is described in section 1.1

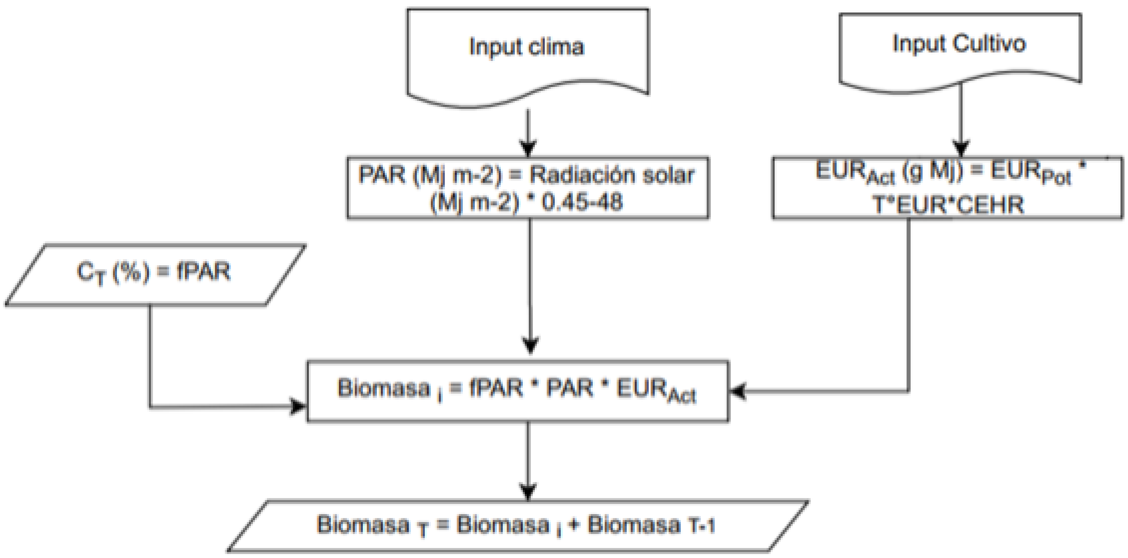


Figure 2. General diagram that relates all the parameters needed for the daily estimation of crop biomass.

1.1 Biomass estimation

Biomass could be estimated by water losses as transpiration and evapotranspiration as follows.

$$b_i = b_i + b_{i-1} + (CET_R \times WP \times \frac{TRANSP}{ET0}) \quad \text{(Eq. 5.a)}$$

Equation 5.a represents the relationship between the total amount of crop transpiration (TRANSP; section 2.3.2.4) of the total evapotranspiration of the crop cycle (ET0; input clima), a water productivity coefficient that depends on the crop type (WP; input cultivo) and a stressor coefficient described in section 1.4. References values of WP are shown in table 1. Note that WP for soybean changes between vegetative and reproductive stages.

Table 1: value of WP under optimal growing conditions for Maize.

Crop	WP

Maize	33.7
Soybean vegetative period	15
Soybean reproductive period	0.6% of the vegetative value
Wheat	15

1.2 Crop phenology

In this version of the model, it'll not be developed.

1.3 Capture of solar radiation

As crops grow, new leaves are developed which gradually cover the area around plants, which in turn increases the interception of solar radiation (fPAR). The percentage of area covered with leaves is the % cobertura (C_T, Figure 3). The maximum attainable value (C_{max}) depends on the crop species and management variables like plant population. Those variables also affect the time in which this % is obtained ($d_{s,max}$).

When the crop reaches its senescence status at $d_{s,sen}$ days after sowing, the %cobertura is reduced as leaves fall. Another parameter required it's the initial cover C_{in} percentage (% of C_T) - C_{in} is a function of crop type and management practices. The parameters α and β indicate the potential daily increment of the C_T and are defined in equation 5. Those are obtained by dividing the difference between C_{max} and C_{in} by the number of days until $d_{s,max}$ or the end of the crop cycle for α and β respectively. In the Table 2 some parameters are described for maize, where CEH (coeficiente de estrés hídrico para expansión foliar) is described in section 3.2 equation 15.

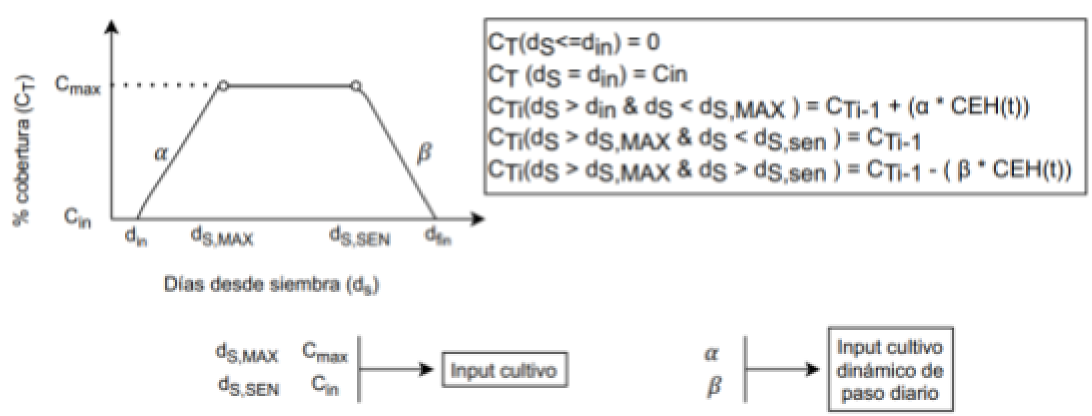


Figure 3. Evolution of the "% Cobertura" throughout the crop cycle expressed in days after sowing (DDS). C_{max} and C_{in} represents the initial and the maximum C_T obtained under optimal conditions of growing. DDS_{max} and DDS_{sen} indicate the DDS in which maximum C_T is obtained or the day that the plant start senescing respective.

	$\alpha = \frac{Cmax - Cin}{ds,MAX - din}$ $\beta = \frac{Cmax - Cin}{ds,SEN - dfin}$	(Eq. 6) (Eq. 7)

Table 2: value of crop parameters under optimal growing conditions for Maize.

Crop	Plant population (pl m-2)	C_{in} (%)	C_{max} (%)	α (% d)	β (% d)	d_{in}	d_{fin}	$d_{S,MAX}$	$d_{S,SEN}$
Maize	6	0.39	89	1.39	2.3	7	120	55	82
Maize	8	0.52	99	1.37	2.4	7	120	49	79
Soybean	-	0.39	95	1.78	4.7	7	140	60	120

1.4 Radiation use efficiency

The efficiency in which PAR is transformed into b is called radiation use efficiency (EUR g MJ m^2). This parameter depends on the crop specie and is affected by temperature and water.

EUR_{Act} expressed in g MJ m^2 results from the following equation:

$$EUR_{Act} = EUR_{Pot} * T°EUR * CEHR \quad \text{(Eq.8)}$$

The potential radiation use efficiency ($EUR_{Pot.}$) is an input Cultivo value, as it depends on the crop specie that is being simulated. This value, also is affected by the daily mean temperature (T°EUR) and the amount of water (CEHR). Under optimal conditions for crop growth only temperature effects are considered assuming a value for CEHR of 1.

The relationship with temperature, as seen in Figure 4, responds to an optimum (2 to 3 in Fig.4) in which the EUR its maximum and beyond those limits it's being affected till it reaches the critical upper and lower points (T°base EUR 1 and 4 respectively) in which the coefficient became cero and the efficiency it´s null. Those values for some crops are include in Table 3.

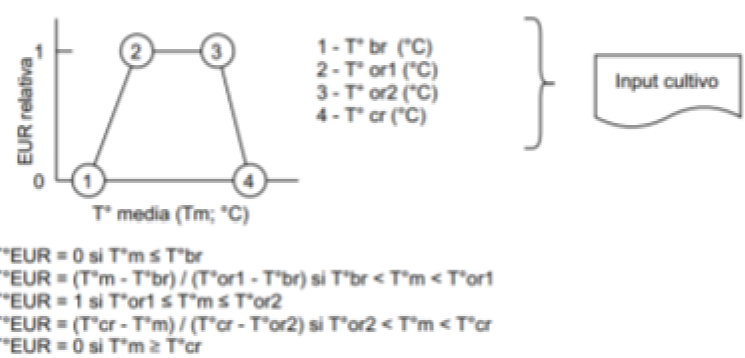


Figure 4. Effect of the mean daily temperature on EUR. Points 1 and 4 indicated the critical upper and

Crop	T°br (°C)	T°or1 (°C)	T°or2 (°C)	T°cr (°C)	EUR_{Pot} (g MJ m-2)
Maize	8	29	39	45	3.65
Soybean	10	20	30	40	0.86
Wheat	2	15	25	35	1.25

Table 3. Crop parameters relating daily mean temperature and EUR.

1.5 Yield estimation

Once daily biomass is defined and crop cycle ends, the final yield is estimated by equation 2. Some references values of biomass, yield and IC_pot are showed in table 3.

Table 3. Crop parameters of biomass, yield and IC_pot for maize, soybean and wheat.

Crop	Biomass (g m-2)	Yield (g m-2)	IC_pot
Maize	1996-2576	856-1245	0.43-0.50
Soybean	546-1088	317-479	0.40-0.50
Wheat	1331-1992	409-806	0.30-0.40

2 Simulation of water balance

2.1 Available soil water

The soil could be seen as a reservoir of water in which the maximum volume of water that can be stored (AU_T;mm) corresponds to the total amount of water in the soil when it´s saturated. The actual amount of water that is available for the crop (AD_T) is obtained by balanced of all the inputs and outputs of water in the soil system. The amount of water that is available by the crop could be expressed as a percentage of the AU_T (% AU).
The value of %AU is used by the model as a threshold for the estimation of stress that affects growth (see section 3).

2.2 Estimation of the AU_T

The total amount of water that could be stored in a soil depends on it's characteristics referring to soil type and texture. The maximum water that a soil can hold it's called CC ($mm^3\ mm^{-3}$) and the minimum PMP ($mm^3\ mm^{-3}$). The AU_T result from multiplying CC by the soil depth. However not all the water contained in the soil could be extracted by crops, existing a lower limit in which the soil water retention don't allow the plant consume these water, this limits it's the PMP. So AU_T is defined as follows.

$$AU_T = (CC * \text{soil depth}) - (PMP * \text{soil depth}) \qquad \text{(Eq.9)}$$

As the crop growths root exploration became deeper and new soil layers are explored. This need to be considered in the estimation of the AU_T because at early crop growth not all the water in the soil could be used by the crop. For this purpose, the soil could be divided in four layers of 0.5m each one (C1, C2, C3 and C4) and AU_T be estimated by the sum of each one (AU1, AU2, AU3 and AU4 respectively).

At early stages of crop development only C1 is considered. As the crop growths and new layers of soil are explored by the roots, the rest of the AU start to being considered. The root exploration is considered by the Eq.10 where the root growth of the simulated day (Crec. Raíz diario – mm día-1) is added to the root depth of the day before (Prof. raíces $_{i-1}$). The value of the root depth ($PROF\_RAIZ_i$ is then used for the daily estimation of the AU_T. Both parameters are input cultivo.

$$PROF\_RAIZ_i \text{ (mm)} = PROF\_RAIZ_{i-1} + \text{Crec. Raíz diario (mm día-1)} \qquad \text{(Eq.10)}$$

A general diagram of those relations is shown in figure 5 and in table 4 the daily root growth for different crops.

Table 3. Crop parameters of daily root growth mm day-1 for different crop species.

Crop	Crec. Raíz diario (mm dia-1)
Maize	30
Soybean	34
Wheat	21

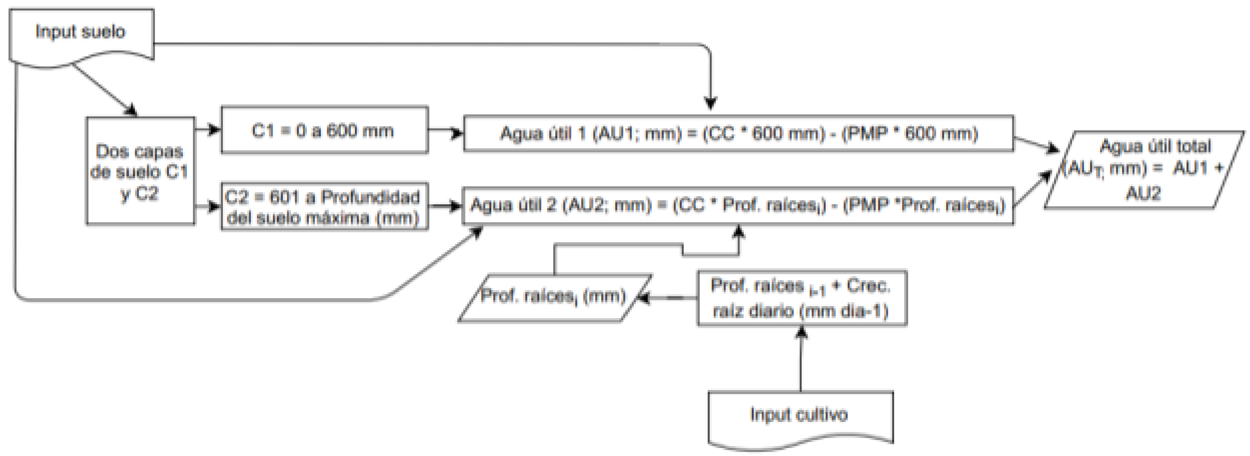


Figure 5. General diagram that relates all the parameters needed for the daily estimation of AU_T.

2.3 Estimation of AUD_T

Total available water is estimated daily by a balance between the inputs and the outputs of water. In the model, the AUD_T is estimated for the four soil layers described above separately. For the first soil layer (AUD_1) AUD could be estimated by: i) Equation 11 or ii) SMAP images (sm_rootzone).

AUD_1 = AUD_1 $_{x-1}$ + precipitations_Ef – perc_1 – soil evaporation (Eq.11)

For the rest of the soil layer, AUD_X is estimated as follows.

AUD_2 = AUD_2 $_{x-1}$ + perc_1 – perc_2 (Eq.12)
AUD_3 = AUD_3 $_{x-1}$ + perc_2 – perc_3 (Eq.13)
AUD_4 = AUD_4 $_{x-1}$ + perc_3 – drainage (Eq.14)

The AUD_T is the result of the sum of the above mention layers as the root explore deeper soil layers (Eq. 15 to 17) less crop transpiration as showed in equation 18.

SUM2 (PROF_RAIZ > 500) = AUD_2 (Eq.15)
SUM3 (PROF_RAIZ > 1000) = AUD_3 (Eq.16)
SUM4 (PROF_RAIZ > 1500) = AUD_4 (Eq.17)
P_AU = AUD_1 + SUM2 + SUM3 + SUM4 – TRANSP (Eq.18)

The parameters of the above equations and their estimations are divided in inputs and outputs of water for their explanation.

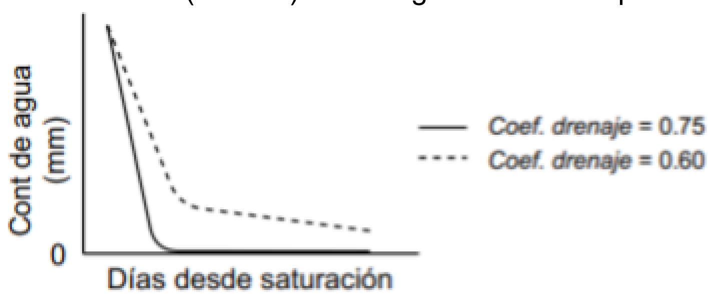
2.3.1 Inputs of water

For the first soil layer the only input of water are daily precipitations obtained by the input clima. For the second soil layer the inputs came from percolation of the upper soil layer and the new available water as a consequence of new soil exploration as root depth. Percolation is the same value of the drainage amount of water of the first layer of soil (see outputs for further explanation).

2.3.2 Outputs of water

2.3.2.1 Superficial drainage

Drainage occurs in both soil layers. It start to be considered when AD_T of a layer is higher that AU_T. The extra amount of water resulting by the difference between AU_T-AD_T will drain according to a drainage coefficient (Coef. Drenaje) that came from “input suelo” and depends on soil characteristics. That coefficient indicates the percentage of water that will drain per day after the soil is saturated (Table 3). In the figure 6 it’s exemplified how this coefficient works.



Drenaje = 0 si Agua disponible ≤ Agua útil
Drenaje = (Agua disponible - Agua útil) * Coef. drenaje si Agua disponible > Agua útil

Figure 6. Variations in the soil water content after the soil it’s saturated. Solid and dotted lines indicate two examples of different soils with different coefficients.

2.3.2.2 Run off

Run off it’s the amount of water that could not infiltrate into the soil after a rainfall. That depends on the soil texture and the amount of rainfall. As seen in figure 7, as the amount of precipitation increases more water is lost do to run off. Soil texture also modifies this relationship and it’s included in a calculation scheme called curve number (CN). This is an “input suelo”. The equation for it’s estimation is described next (Eq.9).

$$\text{Escorrentia} = (PP - (0.2) * S)^2 / (PP + S - (0.2) * S) \qquad \text{(Eq.19)}$$

$$S = 254 * (100/CN - 1) \quad \text{(Eq.20)}$$

PP corresponds to the total amount of precipitation that reaches the soil (Input clima) and in which S (mm) is the potential maximum storage (Eq.10). PP that falls on unsaturated soil infiltrates until the topsoil layer becomes saturated. Since then additional PP starts to run off. Soils with higher CN will have less S and may lose more water as run off. See table 3 for some reference values.

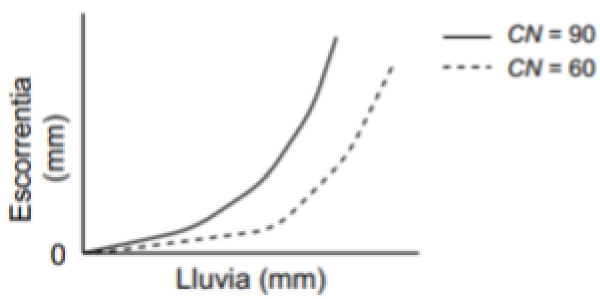


Figure 7. Run off (Escorrentia) as a function of daily precipitation for two curve number (CN).

Table 3. Reference values of Coef. drenaje and CN for four different types of soils textures (Jones et al., 2003).

Soil type	Soil depth (layers)	Coef. drenaje	CN
Silty clay	0-60	0.1	89
Silty clay	60-210	0.25	86
Silty loam	0-60	0.2	81
Silty loam	60-210	0.35	78
Sandy loam	0-60	0.4	74
Sandy loam	60-210	0.5	69
Sand	0-60	0.4	75
Sand	60-210	0.55	67

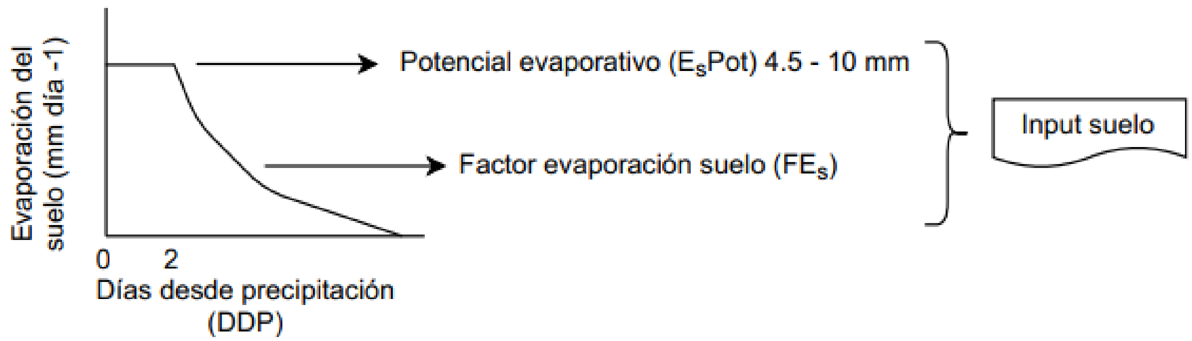
2.3.2.3 Soil evaporation

Soil evaporation is estimated by the amount of the evaporative demand of the atmosphere (ET0) that do not correspond to crop transpiration. This relation is obtained by resting the surface area that is cover by crop leaves (CT) and multiplied both factor by a coefficient (1.10).

This relation is valid for wet soils only (more that 90% of soil available water; section 2.3) and is presented in Eq.21. When the soil starts to get dryer a factor of dryness is affected (FE_S) this factor depends on soil characteristics and is an input cultivo (Eq. 22). The value that it takes goes from 1.7 to 8.2.

$$E_s = (1- C_T) \text{ X } 1.10 \text{ X } ET0 \qquad \text{(Eq.21)}$$

$$E_s = (FE_S \text{ X } DD90\%^{\,0.5}) \text{ X } (1- C_T) \text{ X } 1.10 \text{ X } ET0 \qquad \text{(Eq.22)}$$



Evaporación del suelo (Es) = E_SPot si DDP ≤ 2

Evaporación del suelo (Es) = FE_S*$DDP^{1/2}$ si DDP > 2

Figure 8. Amount of soil evaporation as a function of days since the last precipitation (DDP). E_sPot is the potential soil evaporation and the FE_s is the coefficient that describes the soil evaporation as the soil dries.

2.3.2.4 Crop transpiration

Crop transpiration is linked to the evaporative demand (ET0). The proportion of ET0 that correspond to transpiration is defined by the CT of the day of simulation i. This percentage is affected by a KC and by the effect of stomata closure (CEH_r) related to water content.

$$TRANSP = CEH\_r \text{ X } (CT\_i \text{ X } KC) \text{ X } ET0_{(i)} \qquad \text{(Eq.23)}$$

Table 4. KC values for different crop species.

Crop	KC
Maize	0.99
Soybean	1.04
Wheat	0.96

2.3.2.5 Precipitation

Precipitation is an input clima. Nonetheless, it needs to be corrected by an efficient coefficient that accounts for the effective infiltration of the precipitation that reaches the surface. Table 5 resumes this relation that depends on the amount of the precipitation.

Table 5. Precipitation efficiency for different precipitation values (Blaney and Criddle (1950)).

Precipitation (mm)	Efficiency coefficient
0-25	0.95
25-50	0.90
50-75	0.85
75-100	0.65
100-125	0.45
125-150	0.25
>150	0.05

3 Water stress coefficients C_E

Crops responds to soil water content limiting the growth. The %AU could be used as an estimator of stress of the crop. This affects the EUR_{Pot} and the C_T. Those effects are summarized below.

3.1. Water stress effects on EUR_{Pot}

The EUR_{Pot} it´s not only affected by temperature (see section 1.3) but also by water. The relation it´s described in the figure 10 in which exist an threshold value (UD_r) since the value of CHER (%) became smaller affecting to a greater extend the EUR_{Pot} (see Eq.5 in section 1.3). Both UD and Unc_r are input cultivo parameters. The shape of the response curve solid or dotted line will depend on the crop characteristics in their response to water deficit (Dotted line more tolerant).

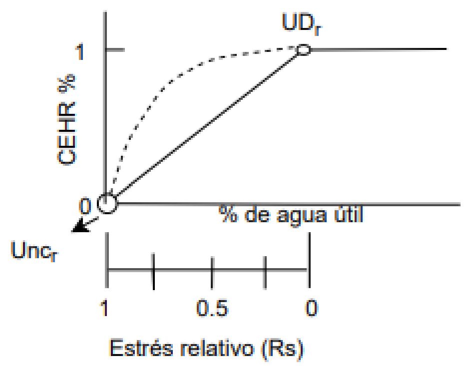


Figure 10. Effect of %AU on CEHR. UD_r indicates the threshold of response in which the coefficient starts to decline affecting EURPot. Unc_r indicates the point in which the crops stop growing. And Rs the relative stress.

The equation that describes this relationship is the following.

$$CEHR = 1 - ((e^{Rrs * cof.formaR} - 1) / (e^{coef.formaR} - 1)) \qquad (Eq.22)$$

Where Rrs is the relative stress equation 13 and cof.forma is the parameter that describes the shape of the curve. Both are “input cultivo”; those values for different crops could be found in table 5.

$$Rrs = (\%AU - Unc_r) / ((UD_r - Unc_r)/100) \qquad (Eq.23)$$

3.2 Water stress effects on canopy expansion

Under water stress the daily canopy expansion is being affected producing a reduced increment of daily C_T. This relationship depends on the %AU of the soil in which exist a threshold value (UD) since the value of CHE (%) became smaller affecting to a greater extend the C_T (figure 11). so under rain feed conditions a new equation it´s added to the model for take into account these relationships (Eq.12). in the equation, the daily value it's multiplied by the CEH and added to the value of CT of the day before.

$$C_T\% = C_T\text{-}1 + (C_{Ti} * CEH) \qquad \text{(Eq.24)}$$

The magnitude of the CEH will depend on the relative stress (Rs) and shape of the curve (dotted line Fig.11). Rs is the relative value of stress between the two limits (UD and Unc respectively). CEH is calculated as follows.

$$CEH = 1 - ((e^{Hrs * cof.formaH} - 1) / (e^{coef.formaH} - 1)) \qquad \text{(Eq.25)}$$

Where Rs is the relative stress (equation 16) and cof.formaH is the parameter that describes the shape of the curve. Both are "input cultivo"; those values for different crops could be found in table 5.

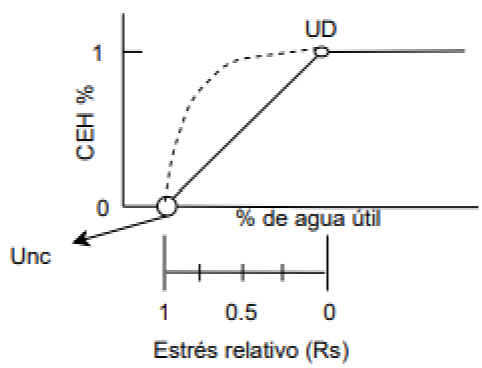


Figure 11. Effect of %AU on CEH. UD indicates the threshold of response in which the coefficient starts to decline affecting %CT. Unc indicates the point in which the crops stop growing. And RS (relative stress).

$$Hrs = (AU\_up\_IC – P\_au) / ((UD - Unc)/100) \qquad \text{(Eq.26)}$$

```
c_forma_pc = 1.3
au_up_pc = 0.60
au_down_pc = 0.15

% estrés hídrico relativo para IC
hrs_IC = (au_up_IC-p_au)./(au_up_IC-au_down_IC);

% coeficiente de estrés hídrico para IC
ceh_pc = 1 - (exp(hrs_pc*c_forma_pc) - 1)/(exp(c_forma_pc) - 1);
ceh_pc(p_au > au_up_pc) = 1;
ceh_pc(p_au < au_down_pc) = 0;
```

Table 5. Reference values of Coef.forma and threshold for CEHR and CEH estimation for different crops.

Crop	Coef.forma H	Coef.forma R	Unc	UD	Unc_r	UD_r
Maize	2.9	6.0	0.4	0.72	0	0.69
Soybean	3.0	3.0	0.15	0.65	0	0.50
Wheat	5.0	2.5	0.20	0.65	0	0.65

3.3 Water stress effects on harvest index

HRS_IC = (%AU - Unc_r) / ((UD_r - Unc_r)/100) (Eq.23)

4 Catastrophic events coefficients (δ_i)

4.1 Floods

Sat??

4.2 Frost

Lower temperatures could affect crop growth. Depending on the moment and the duration of the stress a different stressor is applied (Eq. 27 to 32). DDS are days from sowing, FCCH is the frost stressor coefficient and DH is the duration of the timing of low temperature (T°).

FCCH (DDS < 20) = 1 (Eq.27)
FCCH (DDS > 20) = FCCH_1 (Eq.28)

FCCH_1 (T°< 0 & DH > 3) = FCCH_2 (Eq.29)
FCCH_1 (4 > T° > 0 & DH >1) = FCCH_3 (Eq.30)

FCCH_2 (80 > DDS > 20) = 0 (Eq.31)
FCCH_2 (100 > DDS > 80) = 0.5 (Eq.32)
FCCH_2 (120 > DDS > 100) = 0.3 (Eq.33)

FCCH_3 (80 > DDS > 20) = 0.3 (Eq.34)
FCCH_3 (100 > DDS > 80) = 0.2 (Eq.35)
FCCH_3 (120 > DDS > 100) = 0.1 (Eq.36)

CDH (helada = si) = biomacum * FCCH (Eq.37)
CDH (helada = no) = biomacum * 1 (Eq.38)

The effect of low Temperature also has indirect effect on yield throughout a reduction on daily biomass production. This is considered in Figure 4 In which as the temperature became lower, EUR_{pot} is affected producing a reduction in the daily growth.

4.3 Hail

Once a meteorological event of hail and the % of damage is identified, the % of reseeding is estimated based on the figure 12 and the Equation 15. The % of damage is an “input clima”.

FCG (DDS < 20) = 0 (Eq.39)
FCG (90 < DDS > 20) = 0.6 (Eq.40)
FCG (DDS > 90) = 0.8 (Eq.41)

CDG (granizo = si) = %COB * FCG (Eq.42)
CDG (granizo = no) = %COB * 1 (Eq.43)

5 Appendix

The inputs required for crop simulation are described below.

5.1 Input suelo

Those values are obtained by the “Carta de suelos” available online.

https://gn-idecor.mapascordoba.gob.ar/maps/294/view

Variable	Name	Unit
Profundidad máxima del suelo	Soil depth	mm
Capacidad campo	CC	mm mm-1
Punto de marchitez permanente	PMP	mm mm-1

Potencial evaporativo del suelo	E_sPot	mm
Factor evaporación suelo	FE_s	
Coeficiente drenaje	Coef. Drenaje	%
Agua util total	AU_T	mm
Agua disponible	AD_T	mm
Porcentaje de agua útil	%AU	%
Capa del suelo uno	C1	--
Capa del suelo dos	C2	--
Agua util de C1	AU1	mm
Agua util de C2	AU2	mm
Agua disponible de C1	A.disp1	mm
Agua disponible de C2	A.disp2	mm
Curva número	CN	%

5.2 input clima

Variable	**Name**	**Unit**
Temperatura máxima	Temperatura máxima	°C
Temperatura mínima	Temperatura mínima	°C
Precipitaciones	PP	mm
Radiación solar diaria	Radiación solar	Mj m-2
Déficit de presión de vapor	DPV	Pa
Radiación fotosintéticamente activa	PAR	Mj m-2
% de daño producido por granizo	%Daño	%

5.3 input manejo

Variable	Name	Unit

5.4 input cultivo

Variable	Name	Unit
Cobertura total	C_T	%
Cobertura máxima	C_{Max}	%
Cobertura inicial (%C_T).	C_{in}	%
Cobertura incremento diario (%C_T)	C_{crec}	% día-1
Cobertura decrecimiento diário (%C_T)	C_{sen}	% día-1
Días desde siembra dónde se alcanza C_{Max}	DDS_{max}	Días desde siembra
Días desde siembra en dónde comienza a disminuir el %C_T	DDS_{sen}	Días desde siembra
Eficiencia en el uso de la radiación potencial	EUR_{Pot}	g MJ m-2
Eficiencia en el uso de la radiación actual	EUR_{Act}	g Mj m-2
Temperatura base para EUR	T°base EUR	°C
Temperatura optima EUR uno	T° optima EUR 1	°C
Temperatura optima EUR dos	T° optima EUR 2	°C
Temperatura crítica para EUR	T° crítica EUR	°C
Indice de cosecha	IC	%

Crecimiento diario de raíz	Cre. raíz diario	mm dia-1
Eficiencia transpiratoria	Ef.tanspiratoria	Pa
Umbral de no crecimiento radiación	Unc_r	%AU
Umbral de daño radiación	UD_r	%AU
Umbral de no crecimiento déficit hídrico	Unc	%AU
Umbral de daño déficit hídrico	UD	%AU
Coeficiente de estrés hídrico para EUR	CEHR	%
Coeficiente de estrés hídrico para expansión foliar	CEH	%