# The effect of atmospheric CO2 concentration as specified in APSIM-Sugar, Maize, Soybean and Wheat.

The following sections describe the default state of APSIM-Wheat, Sugar, Maize and Soybean and the modifications made to achieve a response to CO2. The parameters used in the modifications of Maize and Soybean are identical to Wheat due to the lack of better information at this time. The lack of information is probably the reason why the effect of CO2 was switched off in these modules.

## SUGARCANE

#### Default:

No effect

#### Modification:

Transpiration efficiency and radiation use efficiency are modified using parameters developed for Sorghum. The changes to the APSIM-sugar.xml include recalculating the parameters *rue* and *transp\_eff\_cf* for all crop stages according to the following equations.

*rue = rue \* (0.000142\*CO2 + 0.94995)*

*transp\_eff\_cf = transp\_eff\_cf \* (0.0008 \* CO2 + (1-0.0008\*350))*

## WHEAT

#### Default:

CO2 affects radiation use efficiency, transpiration efficiency and critical leaf N concentrations.

**Radiation use efficiency** is based on a CO2 factor (*fc*).

*fc = (C-Ci)\*(350 + 2Ci) / (C + 2Ci)\*(350 – Ci)*

Where *Ci = compensation point (ppm) = (163 – Tmean) / (5 – 0.1\*Tmean)* ; and Tmean is the daily mean temperature. These values appear to be hard-coded into APSIM-wheat. In other words I cannot find parameters that refer to this. I have contacted Pete DeVoil and Neil Huth for more details. The APSIM-Wheat module apparently uses these formulaes when the parameter, *photosynthetic\_pathway* is set to C3 in wheat.xml. I have yet to test this. I found these formulas in a paper Zvi was reviewing.

**Transpiration efficiency** is modified according to the following parameters found in the wheat.xml file.  
*<x\_co2\_te\_modifier units="ppm co2">0 350 700 1000</x\_co2\_te\_modifier>  
<y\_co2\_te\_modifier>0 1.0 1.37 1.69</y\_co2\_te\_modifier>*

**Critical leaf N concentration** is modified according to the following parameters found in the wheat.xml. *<x\_co2\_nconc\_modifier units="ppm co2">0 350 700 1000</x\_co2\_nconc\_modifier> <y\_co2\_nconc\_modifier>0 1.0 0.93 0.9</y\_co2\_nconc\_modifier>*

#### Modfication:

Not needed.

## MAIZE

#### Default:

No effect

#### Modification:

I have added an array to the maize.xml file to convert CO2 concentration to a transpiration efficiency modifier and a critical leaf N modifier using the same parameters as for wheat (see above). I’m yet to work out if CO2 affects rue in the maize module and whether the parameter, *photosynthetic\_pathway* can be used here and set to C4. If I can use this parameter then effect on *rue* will be calculated as follows:

*Rrue = rue \* 0.000143 \* co2 + 0.95; //Mark Howden, personal communication*

## SOYBEAN

#### Default

No effect

#### Modification:

I have added an array to the soybean.xml file to convert CO2 concentration to a transpiration efficiency modifier and a critical leaf N modifier using the same parameters as for wheat (see above). There is a parameter, *photosynthetic\_pathway* which when set to C3 should use the same equations as described for wheat above. I have yet to test this.