Table II Estimate of Energy Required in NADP-malic Enzyme Type C_4 Species (e.g., Maize) per CO_2 Fixed Considering Bundle Sheath Leakage of CO_2, Carbohydrate Synthesis, a Low Level of PCO Cycle Activity, and Nitrate Assimilation

Function	ATP	NADPH
1. C_3 pathway per net CO_2 fixed	3	2
2. C_4 pathway, allowing for 25% overcycling	2.5	0
3. ATP per C in triose-P converted to carbohydrate (sucrose)	0.08	0
4. Rubisco oxygenase[a] where v_o is 3% of the net rate of CO_2 fixation (A)	0.14	0.09
5. Nitrate assimilation[b]	0.02	0.11
Total	5.7	2.2

This analysis of energy requirements assumes no dark-type mitochondrial respiration is occuring in the light.

[a] The activity of Rubisco oxygenase used is that from measurements on the rates of incorporation of $^{18}O_2$ into glycolate and CO_2 fixation in leaves of 3-month-old maize plants (de Veau and Burris, 1989). The ATP and NADPH requirement was calculated considering that the true rate of O_2 evolution with respect to Rubisco (J_{O_2}) = $v_c + v_o$, that the net rate of CO_2 fixation with respect to Rubisco (A) = $v_c - 0.5\ v_o$, and that for each O_2 reaction with RuBP approximately 3 ATP and 2 NADPH are consumed in the PCO cycle and conversion of the products to RuBP (Krall and Edwards, 1992).

[b] Based on a C/N ratio in maize of 35/1, assuming all nitrate is assimilated in leaves in the day, and that carbon loss by respiration in the dark is 20% of carbon gain in the light (see Edwards and Baker, 1993).

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