Table 2 Timeline for improving photosynthetic efficiency

Time horizon	Change to be made	[a]Increase in ε_c (%)	Major obstacle(s) to implementation
Long-term[b]	Rubisco with dramatically decreased oxygenase activity	30	Determining which molecular features of Rubisco control specificity
	Increase mesophyll conductance	20	Determining which physiological factors control mesophyll conductance
	Conversion of C3 to C4	30	Identifying suite of genes that control morphological and biochemical conversion
Mid-term[c]	Increased rate of recovery from photoprotective state	15	Determining combination of components in PSII photoprotective pathway to be altered
	Introduction of Rubisco with increased carboxylation rate	25	Developing efficient transformation technologies
Near-term[d]	Photorespiration bypass	13	Maximizing bypass flux; introducing into crop plants
	Improved canopy structure	30	Identifying genetic variability
	Rebalancing of RuBP regeneration rate with increased carboxylation	30	Demonstrating proof of concept experiments in crop plants; developing efficient transformation technologies
	Optimize canopy chlorophyll content	30	Developing optimization models; determining metabolically most efficient mode of reducing chlorophyll content

[a]Percent increase in the daily integral of carbon uptake estimated for a sunny day at midlatitudes.
[b]Theoretical basis for what change to make to affect the increase is missing. Not enough is known to determine if answers can be bought.
[c]Important science regarding what components to change to affect the increase is missing. With substantial focused investment, possible in 20-year time frame.
[d]The basic science about what needs to be done is in place and the hurdles for implementation are technical. With adequate investment, possible in 10-year time frame.