

Lancaster 253 University

TURBO-CHARGING PHOTOSYNTHESIS Sophie Young

C4 is a turbo-charged form of photosynthesis

 C_4 is a type of photosynthesis found in some of our most productive crops, such as maize and sugarcane.

C₄ is called a 'carbon concentrating mechanism' as it 'shuttles' carbon dioxide through the cells of the leaf and concentrates it around Rubisco, the central enzyme of photosynthesis. This makes photosynthesis more productive by largely avoiding a wasteful process called **photorespiration**.

Where are C_4 plants found?

The most widespread C_4 plants are **grasses**, and they are dominant species in savanna and grassland ecosystems in hot climates. C₄ shrubs are also common and can be dominant species in scrubland, such as those shrubs in the genus Atriplex.

However, C₄ trees are very rare, and there are only a few species, which are only found in Hawaii. We do not know why C_4 trees are so rare [2].



What is **photorespiration**, and why is it a problem?

Photorespiration happens when Rubisco catalyses the addition of oxygen, instead of carbon dioxide, to a molecule called RuBP, and so photorespiration, rather than photosynthesis, occurs.

Photorespiration reduces the efficiency of photosynthesis, so can make plants less productive. Photorespiration by soybean and wheat crops in the US accounts for a total loss of **148** trillion calories, enough to feed photorespirat **203 million people** for a year [1].

Why do we care about C_4 photosynthesis?



More food: Engineering C_4 photosynthesis into non- C_4 crops like rice could make them up to 50% more productive.

RuBP



Future-proof crops: C₄ photosynthesis helps to future-proof crops, as they need less water and fertilizer, and grow better in higher temperatures compared to more common C_3 crops.



C₄ plants have shaped our evolution: if C₄ trees had been historically more widespread, there may have been forests where there is currently grassland and it is too hot and dry for trees. Many species evoyed on grassland, including humans.

[1] Walker, B. J. et al. The costs of photorespiration to food production now and in the future. Ann. Rev. Plant Biology 67(1), 107–129 (2016) [2] Young S.N.R. et al. Why is C4 photosynthesis so rare in trees? J. Experimental Botany doi:10.1093/jxb/eraa234 (2020).

Find out more:



@jeunesophie

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Rubisco