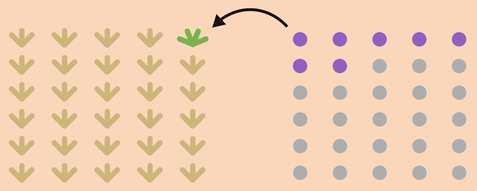
Plants use photosynthesis to absorb carbon dioxide (CO_2) for nutrition and growth. Almost all plants, including primary food and biofuel crops, use C_3 photosynthesis, while some plants use C_4 photosynthesis, which is more efficient in hot and dry environments. Understanding how to add C_4 features into C_3 plants could help increase their efficiency, yields and resilience to harsh environments.

C_3 VS C_4 PLANTS

Advantages and promises for more sustainable crops

More efficient carbon fixation

C_4 plants make up a small proportion of plant species on Earth, yet they are responsible for a significant part of the global intake of CO_2 via photosynthesis.

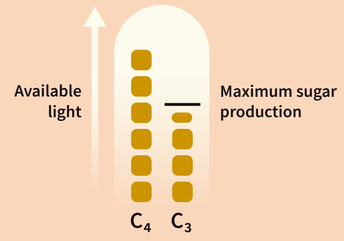


Only around **3%** of known plant species are C_4

yet they take in about **23%** of terrestrial CO_2

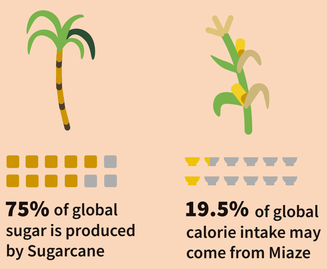
Better use of light

C_4 plants continue to turn CO_2 into sugars and increase biomass as available light increases, but C_3 plants can only use a fraction of it.



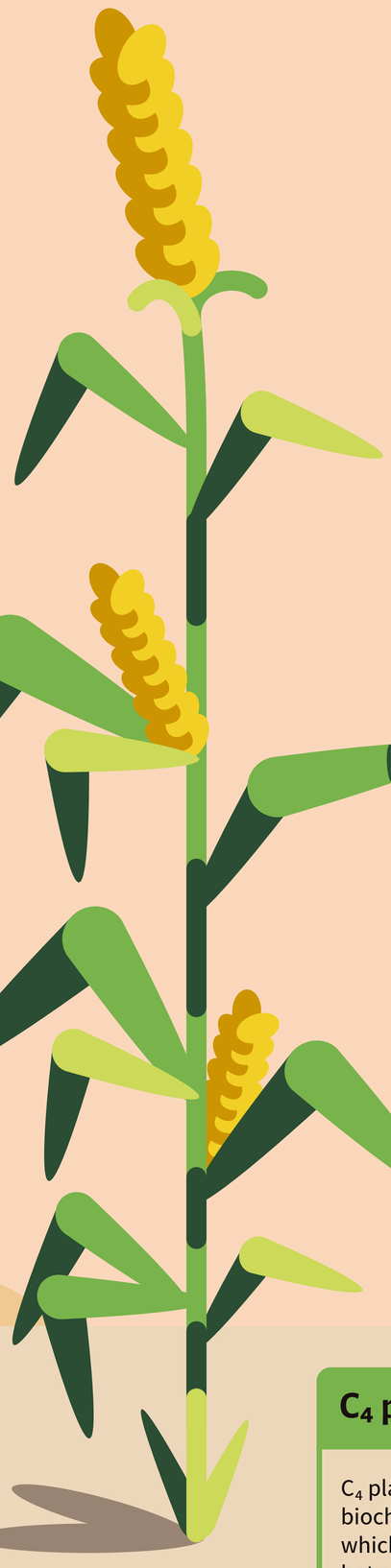
Key food sources and resources

C_4 plants include key food crops like Maize and biofuel crops like Sugarcane. Millet, an increasingly popular C_4 crop, is also an important sources of nutrition in developing nations.



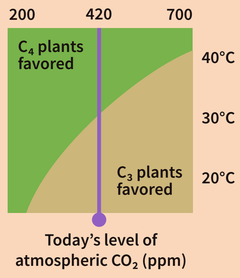
75% of global sugar is produced by Sugarcane

19.5% of global calorie intake may come from Miaze



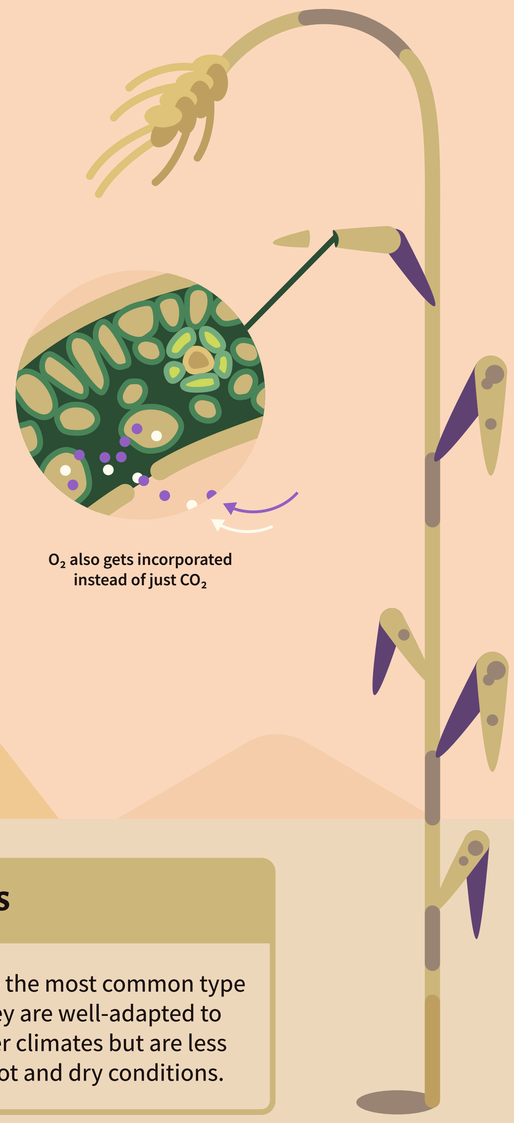
Adapted to high temperatures

C_4 are better adapted to higher temperatures. At the current CO_2 concentrations in our atmosphere (420 ppm), C_4 plants are favoured above 30°C.



Reduced Photorespiration

Plants can take up O_2 instead of CO_2, leading to a wasteful process called photorespiration. Compared to C_3 plants, which waste a large fraction of the produced energy due to O_2 presence, C_4 plants have reduced rates of photorespiration.



O_2 also gets incorporated instead of just CO_2

CO_2 gets concentrated in the bundle sheath cells

Better use of water

C_4 plants need less water than C_3 plants and can conserve soil moister to grow for longer in arid environments.

C_4 crops can help save up to **33%** more water

Optimised leaf anatomy

C_4 plants have unique leaf anatomy and biochemistry that improves their efficiency. They pump CO_2 increasing its concentration where it is needed, in a way, turbocharging photosynthesis.

C_3 plants

C_3 plants are the most common type on Earth; they are well-adapted to cooler, wetter climates but are less efficient in hot and dry conditions.

C_4 plants

C_4 plants have evolved a more complex biochemical pathway for photosynthesis, which allows them to be more efficient in hot and dry conditions

Why aren't all plants C_4?

The evolution of the C_4 pathway is a complex process involving a series of genetic and physiological adaptations over many generations. The C_4 pathway may only be more advantageous in certain environments.

Converting C_3 plants to C_4

Engineering features from the more efficient C_4 photosynthesis onto major C_3 crops like wheat and rice could increase yields by around 20%, offsetting future declines due to climate change.

20% more wheat yield in the USA

GAIN4 CROPS

Rewiring photorespiration using natural and synthetic pathways to sustainably increase crop yield

This project has received funding from the EU's Horizon 2020 research and innovation programme under the Grant Agreement 862087.

Visit the project at
www.gain4crops.eu

Sources

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