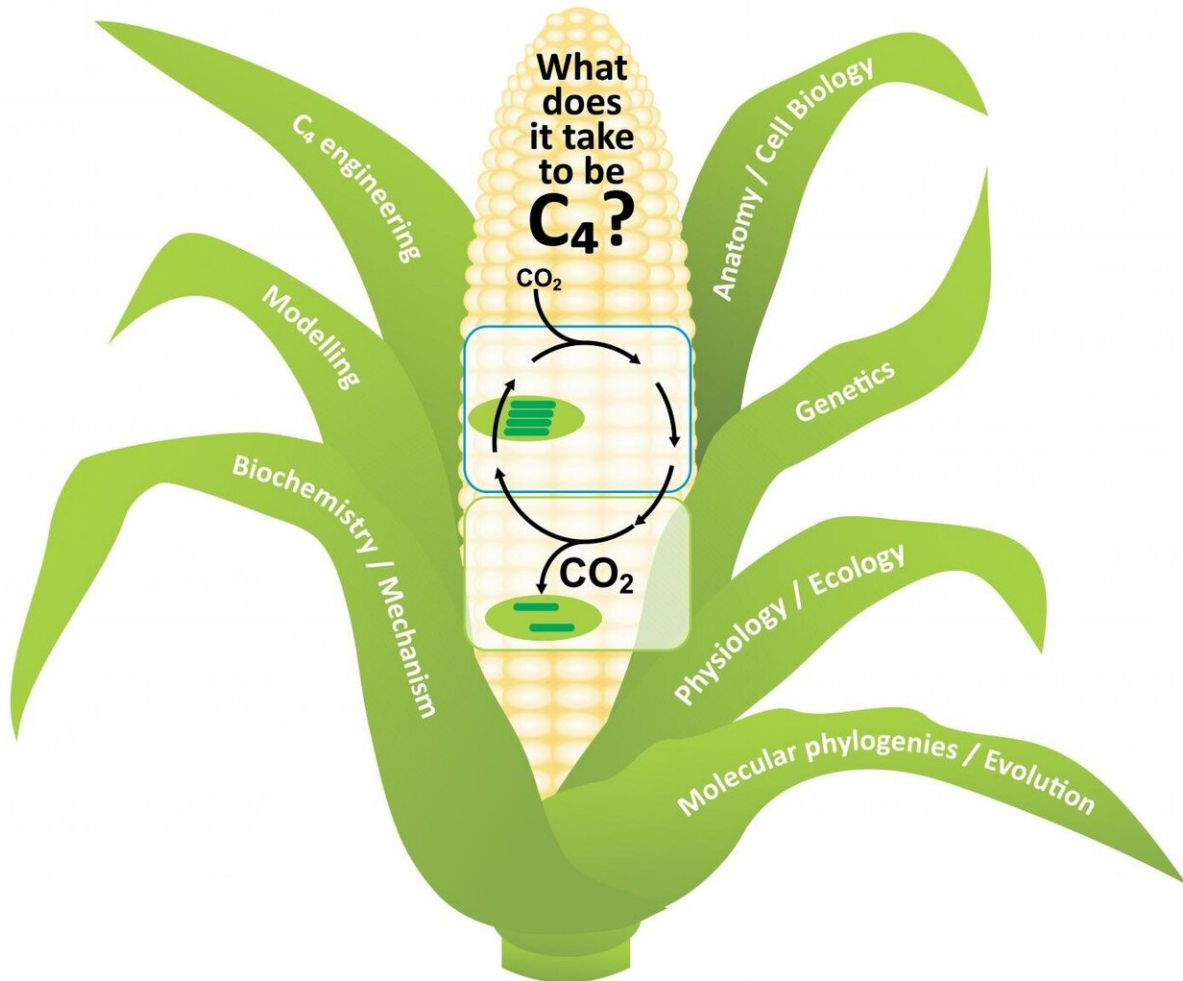


C4 rice's first wobbly steps towards reality

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Changing a plant like rice, from following the C3 photosynthesis path to follow the C4 photosynthesis path, needs an interdisciplinary and international approach. Credit: Carl Davies

An international long-term research collaboration aimed at creating high yielding and water use efficient rice varieties, has successfully installed part of the photosynthetic machinery from maize into rice.

"We assembled five genes from maize that code for five enzymes in the C4 photosynthetic [pathway](#) into a single gene construct and installed it into [rice plants](#)," said lead author Dr. Maria Ermakova, who works at The Australian National University (ANU), as part of the international C4 Rice Project, led by Oxford University.

Rice, one of the main world food staples, uses the less efficient C3 photosynthetic pathway. Scientists predict that the introduction of the more efficient C4 photosynthesis traits into rice can potentially increase photosynthetic efficiency by fifty percent, improve [nitrogen use efficiency](#) and double water use efficiency.

"Although introducing all the genes required to make C4 rice still a long way off, this is the first paper where we assembled a functional C4 biochemistry in rice, which is very exciting," said Dr. Ermakova, from the ARC Centre of Excellence for Translational Photosynthesis (CoETP).

Using [synthetic biology](#), scientists can introduce several genes at the same time, get a plant in just a year and make prototypes to redesign their "constructs" very rapidly, just in a matter of months. In sharp contrast, using the old approach, which inserts one single gene each time, can take several years.

"For me, the most important aspect of this paper is that we have mastered the technology that will help us in our journey towards C4 rice and now we can move forward to the next phase at a higher velocity than ever before," said CoETP's Deputy Director Professor Susanne von Caemmerer, one of the co-authors of this study.



l-r Professor Robert Furbank, Dr Maria Ermakova and Dr Florence Danila.
Credit: Natalia Bateman, CoETP

Using the same kind of technique that Hal Hatch used in 1966 during the discovery of the C₄ pathway, the team of researchers from the Max Planck Institute were able to follow the labeled CO₂ on its way through the pathway.

"This is another key result, as we were able to prove that carbon dioxide is fixed using the C₄ pathway. In other words, we achieved gene expression, but we also got the enzymes involved to be active and functioning in the plant in the right cells," says Professor von

Caemmerer.

"Even though the plants we produced are not yet working very efficiently as C4, we now know that part of their photosynthesis is moving through the C4 pathway," she says.

"The research team include scientists with diverse expertise from microscopy to physiology, plant breeding and modeling," says Dr. Florence Danila, who was in charge of the enzyme localisation using molecular microscopy techniques at the ANU C4 Rice Project Node.

"We started the C4 rice project ten years ago, involving sixteen labs in eleven countries. This particular research has taken us five years to complete, and the coordinated effort of several researchers from multiple organizations around the world, including Washington State University, Oxford University, Cambridge University, ANU and the Max Planck Institute," says Professor Robert Furbank, Director of the ARC Centre of Excellence for Translational Photosynthesis and one of the authors of the study.

"Our next step is to assemble a construct using sixteen [genes](#), so we have lots of work to do. These are the first wobbly steps towards achieving C4 rice. These results show that we can manipulate a whole metabolic pathway. These results show that creating a functional C4 [rice](#) is possible," Professor Furbank says.

More information: Maria Ermakova et al, Installation of C 4 photosynthetic pathway enzymes in rice using a single construct, *Plant Biotechnology Journal* (2020). [DOI: 10.1111/pbi.13487](https://doi.org/10.1111/pbi.13487)

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