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The International Rice Research Institute (IRRI) is the world's premier research organization dedicated to reducing poverty and hunger through rice science; improving the health and welfare of rice farmers and consumers; and protecting the rice-growing environment for future generations. IRRI is an independent, nonprofit research and educational institute founded in 1960 by the Ford and Rockefeller foundations, with support from the Philippine government. The institute, headquartered in Los Baños, Philippines, has offices in 15 rice-growing countries in Asia and Africa, and about 1,180 staff members of some 40 nationalities.

Working with in-country partners, IRRI develops advanced rice varieties that yield more grain and better withstand pests and disease as well as flooding, drought, and other destructive effects of climate change. More than half of the rice area in Asia is planted to IRRI-bred varieties or their progenies. The institute develops new and improved methods and technologies that enable farmers to manage their farms profitably and sustainably, and recommends rice varieties and agricultural practices suitable to particular farm conditions as well as consumer preferences. IRRI assists national agricultural research and extension systems in formulating and implementing country rice sector strategies.

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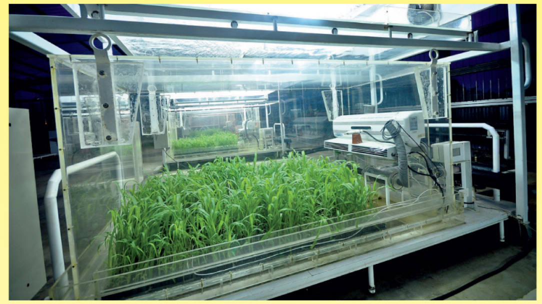

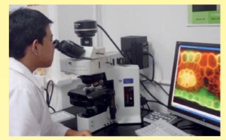

The C_4 Rice Consortium

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The C_4 Rice Project

Using the Sun to End Hunger

The project

The C_4 rice project uses cutting-edge science to discover the genes that will supercharge photosynthesis, boost food production, and improve the lives of billions of poor people in the developing world. The C_4 Rice Consortium, a group of multidisciplinary scientists from advanced institutions around the world, work together to achieve the project's goals. The International Rice Research Institute (IRRI) led the consortium for the first 7 years, and now the leadership has been passed to the University of Oxford, United Kingdom.

What is the problem and why the urgency?

One billion people live on less than a dollar a day and spend half their income on food. Around 925 million people are hungry, and about 25,000 people die from hunger each day. Sixty percent of the world's population lives in Asia, where each hectare of land used for rice production provides food for 27 people, but by 2050, that land will have to support at least 43 people. Climate change will likely result in more extreme variations in weather and cause adverse shifts in the world's existing climatic patterns. Water scarcity will grow. The increasing demand for biofuels will result in competition between grain for fuel and grain for food, resulting in price increases. More than 75% of the world's people will live in cities, whose populations will need to be largely supported by a continuous chain of intensive food production and delivery.

Ultimately, insufficient yields of rice lead to food insecurity, unsustainable agricultural practices, environmental degradation, and social unrest. This vicious circle must be replaced by a virtuous circle in which raised productivity improves food security so that investments in sustainable agriculture are attractive and the environment remains protected.

What is the solution?

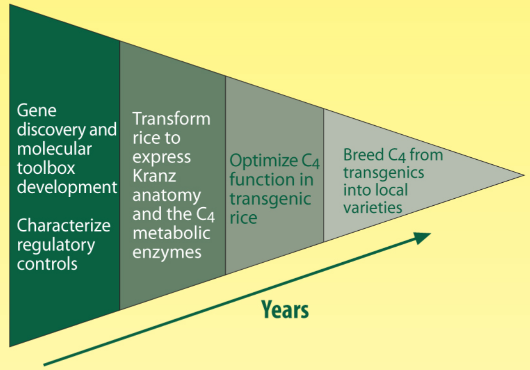
What technology could simultaneously solve those problems and prevent the bleak future outlined above from becoming a reality? IRRI's innovative research suggested that the solution to those challenges would require a more efficient use of solar energy in photosynthesis. Fortunately, an example from evolution of a supercharged photosynthetic mechanism exists—the C_4 system. Converting the photosynthetic system in rice to the more efficient, supercharged C_4 mechanism used by maize would increase rice yields while using scarce resources (land, water, and fertilizer) more effectively.

The C_4 Consortium

However, a technological innovation of this magnitude requires the skills and technologies of a global alliance of multidisciplinary partners from advanced institutions. Thus, in 2008, IRRI formed the international C_4 Rice Consortium.

Timeline for C_4 rice

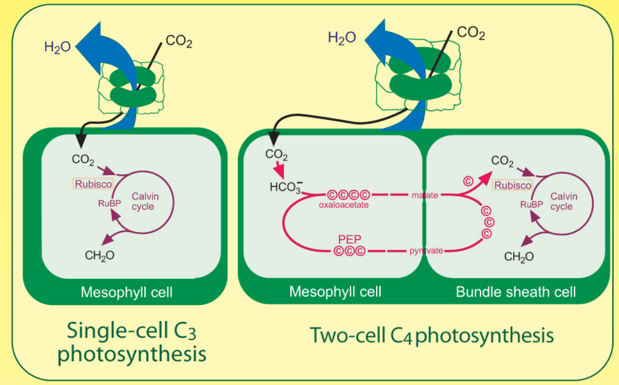
It will take about 15–20 years of coordinated research carried out at IRRI and in the laboratories of the C_4 Rice Consortium to deliver C_4 rice to plant breeders in the developing world.



What is C4 photosynthesis?

Supercharged mesophyll cells concentrate CO_2 around the photosynthetic enzyme Rubisco using a four carbon acid (C_4) cycle. The C_4 mechanism requires spatial separation of fixation of atmospheric CO_2 into C_4 acids, and the donation of CO_2 from the C_4 acids via decarboxylases to Rubisco (C_4 plants). Most plants concentrate the CO_2 in enlarged bundle sheath cells surrounding the veins, a characteristic known as Kranz anatomy. Plants that do not have a concentrating CO_2 mechanism, such as rice and wheat, fix CO_2 into three carbon acids (C_3 plants); their photosynthetic rates in hot environments are about half those of C_4 plants, such as maize. C_4 plants have double the water-use efficiency of C_3 plants and use about 40% less nitrogen to achieve 50% higher yield.

C_4 photosynthesis has evolved naturally more than 60 times in 18 families of higher vascular plants. This repeated evolution of a complex trait indicates that it is either relatively easy to evolve, or it is under intense directional selection pressure. Either way, the repeated evolution of C_4 photosynthesis shows that it should be feasible to construct C_4 rice plants. Thus, the project harnesses all scientific progress in understanding C_4 photosynthesis and all techniques of molecular biology in trying to construct C_4 rice.



Summary

- Our ultimate objective is to use science to help alleviate hunger in the developing world.
- We are a consortium of scientists in the business of using the most advanced biological technologies to discover the cassette of C4 plant genes responsible for the greatest known efficiency of solar energy conversion in plant photosynthesis.
- We wish to create synergies between leading teams across the globe involved in photosynthesis research so as to accelerate the discovery of C4 genes that we believe can alleviate hunger in the developing world.
- We want to construct prototypes of crop plants with enhanced photosynthesis that can be used by plant breeders in the developing world to improve yield and resource-use efficiency in a sustainable manner.
- Our strategy is to develop a global, dynamic, and integrated research agenda for installing a maize-like photosynthesis mechanism in rice, wheat, and legumes by integrating the efforts of an international consortium of scientists to assemble the necessary technologies and knowledge.