Unit : 8 Introduction to Biotechnology
Course : BB 232

Golden Rice : The True Story of the Genetically Modified Plant

Golden Rice, has emerged as the world's first purposefully created biofortified crop. The project began in 1990, when **Potrykus** and his colleague **Peter Beyer**, of the University of Freiburg, started working to genetically engineer a metabolic pathway into a variety of *Oryza sativa*, the world's most commonly consumed rice species, so that the plant's edible kernels would contain beta carotene. Golden rice, the fruit of nine years of research, experimentation and development at IRRI, Philippines . The "gold" was in fact beta carotene, a substance that is converted into vitamin A in the human body. Conventional rice plants already contained beta carotene, but only in their leaves and stems, not in the kernels. Golden Rice also carries the substance in the part of the plant that people eat. This small change made Golden Rice into a miracle of nutrition: The rice could combat vitamin A deficiency in areas of the world where the condition is endemic and could, thereby, "save a million kids a year."

Vitamin A deficiency is practically unknown in the Western world, where people take multivitamins or get sufficient micronutrients from ordinary foods, fortified cereals, and the like. But it is a life-and-death matter for people in developing countries. Lack of vitamin A is responsible for a million deaths annually, most of them children, plus an additional 500,000 cases of blindness. In Bangladesh, China, India, and elsewhere in Asia, many children subsist on a few bowls of rice a day and almost nothing else. For them, a daily supply of Golden Rice could bring the gift of life and sight.

The superfood thus seemed to have everything going for it: It would be the basis for a sea change in public health among the world's poorest people. It would be cheap to grow and indefinitely sustainable, because low-income farmers could save the seeds from any given harvest and plant them the following season, without purchasing them a new. But in the 21 years since it was created, Golden Rice has not been made available to those for whom it was intended.

Golden Rice is a genetically modified organism, and as such is weighed down with all the political, ideological, and emotional baggage that has come to be associated with GMOs—stultifying government overregulation, fear and hostility, and criticism from environmentalist and other activist organizations

and individuals. Greenpeace, for one, was especially vocal in its condemnation of genetically engineered foods, Golden Rice in particular.

In 2016, Golden Rice was a tough call strategically for Greenpeace and some of their associates. George Church, a professor of genetics at Harvard Medical School pointed out that a million lives are at stake every year due to vitamin A deficiency, and Golden Rice was basically ready for use in 2002, so it's been thirteen years that it's been ready. Every year that you delay it, that's another million people dead. That's mass murder on a high scale.

Indeed, some critics would argue that as a proven, viable, agricultural commodity, it is not yet ready even today. Still, the fact is that the crop has been grown, and grown successfully, first in laboratories, then in greenhouses, and finally in open fields since it was invented. The rice has also been subjected to safety studies—toxicity and allergenicity studies—and studies on human consumption, including among American adults and Chinese children. These have found it to be more effective in providing vitamin A than spinach and almost as effective as pure beta carotene oil itself.

Golden Rice is intended to be used in combination with existing approaches to overcome Vitamin A deficiency , including eating foods that are naturally high in vitamin A or beta-carotene, eating foods fortified with vitamin A, taking vitamin A supplements, and optimal breastfeeding practices.

IRRI's work with Golden Rice

IRRI is working with partners in the following direction to develop Golden Rice as a potential new food-based approach to improve vitamin A status.

Develop varieties suitable for Asian farmers

Breeders at the Philippine Department of Agriculture - Philippine Rice Research Institute (DA-PhilRice), the Bangladesh Rice Research Institute (BRRI), and the Indonesian Center for Rice Research (ICRR) are developing Golden Rice versions of existing rice varieties that are popular with their local farmers, retaining the same yield, pest resistance, and grain qualities. Golden Rice seeds are expected to cost farmers the same as other rice varieties. Once PhilRice, BRRI, and ICRR are able to secure an approval from their respective regulatory agencies, cooking and taste tests will be done to make sure that Golden Rice meets consumers' needs.

Help assess the safety of Golden Rice

To help assess the safety of Golden Rice in the environment, field tests and other evaluations will be done in each partner country. Golden Rice will be analyzed according to internationally accepted guidelines for food safety.

Research and development of Golden Rice adhere to scientific principles developed over the last 21 years by international organizations such as the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), the Organization for Economic Co-operation and Development (OECD) and the Codex Alimentarius Commission. These are the same principles that inform the safety assessments of national regulatory agencies, such as FSANZ, Health Canada, and the US FDA, which have already assessed Golden Rice as safe to plant and safe to eat.

Biosafety approval is a prerequisite for inclusion in the rice variety listing of the National Seed Board (NSB). IRRI's partners in the Philippines and Bangladesh have lodged the necessary applications government regulators who will review these data as part of the approval process for Golden Rice before it can be made available to farmers and consumers.

In 2018, Golden Rice received three successive positive food safety evaluations from leading regulatory agencies: Food Standards Australia New Zealand (22

February 2018), Health Canada (16 March 2018), and the United States Food and Drug Administration (24 May 2018).

On 18 December 2019, official notice of the permit, issued by the Department of Agriculture-Bureau of Plant Industry, approving GR2E Golden Rice for direct use in food, feed, or processing (FFP) in the Philippines was published in Manila Bulletin.

Golden Rice regulatory applications are currently under review in the Philippines and Bangladesh, and Golden Rice will only be made available to the public once all necessary permits have been received.

Evaluate whether consumption of Golden Rice improves vitamin A status

After obtaining the necessary permits and approvals, an independent community nutrition study will be conducted to evaluate the efficacy of Golden Rice; in other words, whether or not it improves vitamin A status. The nutrition study is necessary to determine the potential for Golden Rice to be used as a public health approach for reducing vitamin A deficiency.

Explore how Golden Rice could reach those most in need

IRRI is now collecting information to develop strategies to ensure that Golden Rice could reach the farmers and consumers that need it the most. If approved by national regulators and found to be safe and efficacious, IRRI and its partners will work together to introduce Golden Rice as another food-based approach to improve vitamin A status. A sustainable delivery program will also be implemented to ensure that Golden Rice is acceptable and accessible in vitamin A deficient communities.