

What is Golden Rice?

The term *Golden Rice* refers to a genetically engineered, yellow-orange rice grain that contains beta-carotene. The human body converts beta-carotene into vitamin A. The most recently developed Golden Rice varieties, reported in 2004 and 2005, contain a gene from either maize or daffodil plants and a gene from a common soil bacterium (*Erwinia*).

The enzyme products of these genes lead to the formation of lycopene in the grain — a process completely absent from the polished rice grain — and this lycopene is then converted into beta-carotene and other provitamin A carotenoids (the building blocks of vitamin A) by other enzymes found in the grain. The polished grains from the latest Golden Rice varieties produce up to 36 micrograms per gram of beta-carotene and other provitamin A carotenoids (Paine *et al.*, 2005)¹ — more than a 20-fold increase from the original Golden Rice reported 5 years ago (Ye *et al.*, 2000)².



Ordinary white rice; An earlier version of Golden Rice; The current Golden Rice material. (Picture from Paine *et al.*, 2005)

How can Golden Rice help improve human nutrition?

Worldwide, 125 million children — particularly those in developing countries — suffer from vitamin A deficiency (VAD), causing blindness (up to 500,000 per year according to the World Health Organization) and death. An additional one million people die annually due to vitamin A deficiency and malnutrition. In many of these same countries, rice is the food staple and may provide 80% or more of daily calories.

Polished, white rice — the most consumed form of rice — contains no beta-carotene or other forms of provitamin A, and is also a very poor source of other micronutrients (e.g. iron and zinc). Therefore, the latest varieties of Golden Rice are expected to be a new tool — in addition to existing strategies — in helping to overcome VAD among the poor.

1. Paine *et al.* *Nature Biotechnology* 23, 482 - 487 (2005)

2. Ye *et al.* *Science* 287, 303-305 (2000)

3. Dubock, A. *7th ICABR International Conference: Public Good and Public Policy for Agricultural Biotechnology* (2003) http://www.economia.uniroma2.it/conferenze/icabr2003/papers/Developing_Countries/Dubock.zip

For additional information on Golden Rice (and the Golden Rice Humanitarian Board), visit www.goldenrice.org or contact Dr. Gerard Barry, Golden Rice Network Coordinator, at g.barry@cgiar.org. For more information on other biofortified crop research - breeding food crops rich in micronutrients - visit www.harvestplus.org.

Developed by G Barry

How much Golden Rice is required to prevent VAD?

Combined with existing dietary sources, Golden Rice is expected to have a significant impact in reducing malnutrition and premature death. It has been estimated that when the latest Golden Rice is consumed in normal amounts, along with other foods, that most of the daily requirements for vitamin A could be met. Tests will soon be carried out in humans to determine the amount of vitamin A that may be derived from the beta-carotene in Golden Rice.

When will Golden Rice be available in farmers' fields?

The newest Golden Rice varieties have been developed by the private sector and are southern U.S. varieties that are not suitable as is for Asia. IRRI and other members of the Golden Rice Network (a network that involves public institutions in India, the Philippines, China, Bangladesh, Vietnam, and Indonesia) have begun breeding this trait into varieties suitable for Asia. Testing in the field in Asia, and with farmers, is expected to begin in late 2006. Following the breeding work, the expanded field evaluation, and the necessary biosafety and related requirements, varieties suitable for Asia could be released for more widespread growing within a few years of the field tests.

Will Golden Rice be more expensive than regular rice?

The technology involved in developing Golden Rice was provided free by the inventors (Ingo Potrykus, ETH-Zurich and Peter Beyer, Univ. of Freiburg) using the donation of intellectual property licenses from a number of private companies. As a result, there will be no extra cost to obtain these seeds from IRRI and use them for local purposes (For more details, see Dubock, 2003)³. Farmers may also save the seed.

No company has plans to commercialize a Golden Rice product in developed countries or developing countries. Successful varieties developed by the private sector will be donated for public use (see Paine *et al.*, 2005)¹.