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The Golden Rice Controversy: Useless Science or Unfounded Criticism?

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Earlier this year, scientists disclosed in the journal *Nature Biotechnology* the development of a new Golden Rice, a genetically engineered form of the crop capable of producing 23 times more provitamin A (beta-carotene) than a prototype announced in the year 2000 (Paine et al. 2005). However, rather than celebrate the potential of this breakthrough to alleviate suffering and reduce the number of deaths caused by malnutrition—in the millions, many of them children in developing countries—Greenpeace greeted the development with claims that Golden Rice is "not effective" and "superfluous" (Greenpeace 2005; see Maxeiner 2005 for a critical response). Organizations like Greenpeace rightly see this advance as threatening their anti-biotechnology campaign, which lacks a scientific basis and has relied mainly on the manipulation of people's perceptions.

For several years, a few countries with intensive agriculture have been adopting transgenic crops at a rapid pace. More recently, the technology has also gained significant momentum in developing countries. South Africa's insect-resistant maize and cotton programs have proved very successful and are growing steadily. In India, despite reports of one failure—purely agronomic and not involving any biosafety issues—the adoption and registration of new transgenic varieties are strongly on the rise. In total, in 2004, developing countries accounted for almost 28 million hectares (ha), or 34 percent, of all land dedicated to transgenic crops (James 2004). Farmers' eagerness to adopt the technology, together with their success stories, is bad news for those antitechnology campaigners who base their arguments purely on scaremongering tactics.

Although opposition to genetically modified (GM) crops has been fierce since they were first released into the environment in the 1980s, the United States and a few other countries have managed to develop science-based biosafety regulatory systems. These have allowed the technology to flourish—as more than 80 million ha planted with transgenic crops worldwide in 2004 attest—for the benefit of farmers, consumers, and companies. Meanwhile, strong opposition in Europe managed to push through an extended de facto moratorium that has only recently begun to thaw. This process is progressing only under laws seemingly designed to deter the use of transgenic crops rather than to encourage adoption of the technology. For example, under the present Gene Technology Act in Germany, farmers growing GM crops in a region are jointly and severally liable for economic damage that neighboring farms incur if their crops are contaminated by GM material, even if the source of the material cannot be identified with certainty and the GM crop farmers have adhered to all regulatory requirements. The legal threshold level of admixture is arbitrarily set at 0.9 percent, but if a farmer has signed a contract to deliver produce that is free of GM material, then neighboring farmers of GM crops are fully liable for the loss in value caused even by admixture levels below 0.9 percent. In the present situation, German insurers are not prepared to sign contracts with farmers willing to grow GM crops, because the level of liability cannot be calculated. This policy creates an insurmountable hurdle to the spread of GM technology in the country.

One argument brought up by opponents of Golden Rice is that it might interfere with existing vitamin A supplementation and fortification programs and campaigns. This argument is used to suggest that we should opt for the status quo. Such an attitude disregards the potential of Golden Rice to provide viable, sustainable alternatives. Moreover, in adopting this position, opponents are ignoring the huge number of individuals—mainly in remote rural areas—not covered by most outreach activities. In India, a country with ongoing supplementation and fortification programs, 57 percent of children under six years of age show subclinical vitamin A deficiency, according to UNICEF. Another pertinent fact, which opponents seem to deliberately overlook, is that existing programs require millions of dollars per country every year to keep them going. These programs are not sustainable.

Initiatives promoting a more varied diet have met with limited success. This is because fruits and other food sources of provitamin A are not available throughout the year. Moreover, many of these food sources do not grow in the areas where they are most badly needed. Most of all, people affected by vitamin A deficiency usually cannot afford to buy a varied diet. One strong argument for rice as a staple is that most alternative provitamin A–rich crops are perishable. Hence, subsistence farmers would be poorly advised to use up their scarce resources to grow perishable crops that will not allow them to feed their families throughout the year.

I believe Golden Rice will demonstrate that any legitimate concerns about genetic engineering in any crop will be related to the specific traits being introduced, and not to the technology itself. Golden Rice and the underlying technology have been widely discussed ever since Ingo Potrykus and Peter Beyer came up in 1999 with a rice plant capable of producing provitamin A. Provitamin A is normally produced in the green tissues of every plant and converted to vitamin A in the human body. Nobody has been able to come up with a scenario whereby the provitamin A–enriched grains of Golden Rice could pose a menace to the environment or to human health. What's left in the opponents' camp is a perceived risk of the technology as such, rooted in unfathomable, yet-to-be-articulated dangers.

Meanwhile, real threat does exist: it is the threat of widespread micronutrient deficiencies killing millions of children and adults all over the world.

Opposition to GM crops is often based on the apparently reasonable argument that the public has a right to know and to decide. This argument remains simplistic at best if the decisionmaking process is not knowledge based but rather consists of a summary rejection with a political undertone. This position has led to politically motivated moratoria and the construction of insurmountable regulatory hurdles. These hurdles have not only hit large corporations but also seriously affected developments coming from the public sector, leading to the loss of investments and opportunities. While development of a transgenic plant in the laboratory might cost a few hundred thousand dollars, fulfillment of regulatory requirements has amounted to several million dollars in some documented cases. And this process must be repeated in every country where regulatory approval is sought. The lost opportunities are being felt especially in developing countries, where agricultural production could profit immensely from new resistance and adaptation traits in many crop plants (Cohen 2005).

In some cases, opposition has led to the development of policies that exclude agricultural biotechnology in national research and development funding strategies. These days, more funds seem to go into biosafety research than into product development, with the result that few product development projects capture the public interest. For example, further development and deployment of Golden Rice have suffered severely because of lack of support from the European Union.

The introduction of Golden Rice into target countries has been seriously delayed by the lengthy processes necessary to obtain permits to deploy seed for field testing. The main cause of these drawn-out procedures is that receiving countries have been influenced by the technology-rejecting position of several countries, most of them in Europe. The European position reverberates in distant nations: Zambia, for example, rejected US donations of genetically modified maize, despite the severe grain shortage caused by a devastating drought in central and southern Africa; other nearby countries hit by the grain shortage also rejected the US-approved transgenic product.

A driving force in establishing bureaucratic barriers is the fear of losing export markets for agricultural produce because of potential "contamination"—a misnomer for the adventitious presence of transgenic crops—of export commodities. Socioeconomic studies are showing not only that the feared potential losses have been exaggerated but that huge advantages have been ignored. In a study of Asian countries published by the World Bank, the authors concluded that—in terms of health and direct economic improvements—export losses could amount to as little as one-half percent of potential gains. Total economic gains from Golden Rice could be in the range of several billions of US dollars for countries in Southeast Asia (Anderson et al. 2004). This kind of insight is slowly turning the tide, and is further underpinned by scientific data that do not foresee any deleterious effects to mankind or to the environment from the use of nutritionally enhanced rice (Lu and Snow 2005).

Some arguments by opponents of GM technology demonstrate a lack of basic knowledge of plant breeding. One such argument suggests that transgenes promote the use of monocultures. Transgenes, as opposed to many conventionally obtained traits, are mostly monogenic and are easy to breed into any locally adapted variety. The Golden Rice trait, for example, can be introduced into any local variety within two years, thus making it easy to preserve the cultivation of traditional varieties with added value (i.e., containing beta-carotene and thus having health-promoting characteristics).

Golden Rice has often been criticized for being a technical fix that does not address the real needs of farmers and their living conditions. Critics of Golden Rice go on to give their unqualified support to existing supplementation and fortification programs and to the growing of nontraditional vegetables in farmers' fields. While low-tech approaches are successful to a certain degree, these lifestyle-modifying interventions are often unsustainable. The genetic engineering step required to generate Golden Rice, on the other hand, involves a technological intervention. Its beauty is that it makes it possible to deliver a traditional crop plant with an added trait. A new variety of seed that can be grown, harvested, and replanted is the most down-to-earth and familiar solution known to any farmer. The only difference is that this new variety could, besides delivering daily calories, help solve a life-threatening problem. It is a solution that, apart from initial outreach activities, will require no additional inputs. Golden Rice is a sustainable solution.

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