What we know and don't know about Golden Rice

To the editor:

In the October issue, a letter from Alexander Stein and his collaborators (*Nat. Biotechnol.* **24**, 1200–1201, 2006) discussed the potential impact and cost effectiveness of Golden Rice. What we know about Golden Rice today is that plant breeders have successfully genetically modified rice to express β-carotene; what we also know is that, after a first approach (Golden Rice 1) they obtained rice plants that supply only 15–20% of the recommended dietary allowance for vitamin A; further genetic tinkering has resulted in rice plants (Golden Rice 2) that accumulate levels of β-carotene 20-fold higher.

What we do not know up to now is how much β-carotene-rich rice may contribute to human nutrition in areas where vitamin A deficiency is highly prevalent, such as India and other countries in Southeast Asia and Africa. Until today, no research has been published indicating the nutritional benefit of this new rice whether alone or integrated in meals or consumed for a short or long time. What we also do not know is whether this much-touted transgenic biofortified rice approach is superior to other conventional strategies for preventing and overcoming vitamin A deficiency.

Plant breeders—and agrochemistry companies—estimate the potential of Golden Rice to contribute to overcoming vitamin A deficiency to be much higher than many other experts who build on strategies with proven effectiveness (e.g., increasing dietary diversity, food fortification and vitamin A supplementation[1–3]). In this context, the contribution of Stein and his colleagues to assess the economic impact of vitamin A deficiency adds to the assessment of this technology. In my view, however—and presumably in the view of many other experts with a medical or nutritional science background—the assumption that Golden Rice will play any role in overcoming vitamin A deficiency worldwide is premature, given that this potential has not yet been proven by any scientific research.

Up to now, the Golden Rice project has consumed a lot of money without any hard evidence of nutritional benefits for any people ingesting the crop. The name Golden Rice, prompted by the golden color of the rice grains containing elevated levels of β-carotene, also subtly intimates that the crop has great (golden) nutritional potential. What we can see today, however, is that the more likely recipients of gilt-edged returns from Golden Rice are agrochemistry companies which stand to gain most from bringing the rice to market and getting farmers to grow it. Similarly, for our colleagues in plant breeding research, this rice may become golden, driving research money in their direction.

Studies like that of Stein and his colleagues are possible because an economic analysis requires only assumptions—there is no need to resort to science-based biomedical facts. But even those who wish to boost Golden Rice should appreciate that the case for a technology is undermined if it is based solely on assumptions and nonscientific speculations. In this regard, the letter of Stein *et al.* rather promotes an ideology instead of science.

Solving the vital problem of vitamin A deficiency is crucial for millions of humans worldwide who suffer from immune deficiency and eye problems that can lead to blindness. To address their needs now means optimizing the use of existing strategies, like supplementation, food fortification and improvement of dietary diversity. So-called biofortification through plant breeding may have a future, but it should not replace any of the established concepts.

To properly address the DALY (disease/disability adjusted life years) burden of vitamin A deficiency, one needs to take a portfolio approach rather than one using a single product of plant breeding. The biotech debate on vitamin A deficiency should be centered around maximizing the nutritional benefit of the people who are suffering, rather than focusing on models based on non-science-based assumptions.

What is really embarrassing about debates on the value of Golden Rice 1 or 2 is the pretext that any criticism of the technology or science may worsen the situation of the millions worldwide whose vision and lives are at risk. But the fact is no scientific study has proven the potential of this technology to really contribute to overcoming vitamin A deficiency in humans. There is no place for economic models without a scientifically proven basis.

Future research funding may support a diversity of approaches for addressing vitamin A deficiency and help to select and eventually combine the most appropriate concepts according to the livelihoods of the affected people. The general issue, though—which plant breeders need to accept—is that nutritional deficiencies are rarely focused on one nutrient (e.g., vitamin A, iron, selenium, zinc or others). In most cases, they are complex conditions and there are many sources for the various nutrients. The real challenge is to address these complex problems not by reducing them to single nutrients but by integrating existing and future approaches in the most efficient way. It is this approach—not a single, biofortified crop—that will allow us to reduce the DALYs caused by nutritional deficits and insecurity.

COMPETING INTERESTS STATEMENT
The author declares no competing financial interests.

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