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The Cost of Delaying Approval of Golden Rice

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More than 250,000 children go blind every year because of Vitamin A deficiency. Vitamin A intake can be enhanced by consuming Golden Rice—a genetically engineered variety of rice. It was available for commercialization in 2002, but approval has been delayed. We estimate that this delay has resulted in 600,000 to 1.2 million additional cases of blindness.

Between 250,000 and 500,000 children go blind every year because of Vitamin A deficiency, and more than half die within a year of becoming blind. A total of 125 million children under the age of five suffer from Vitamin A deficiency, which has resulted in increased vulnerability to common childhood infections, higher likelihood of anemia, and poor growth.

There is sufficient evidence that people who suffer from these nutritional deficiencies are much less productive, more likely to remain poor, and die young. Many of the people who suffer from Vitamin A deficiency subsist on rice as a staple food. Rice produces beta-carotene that contains Vitamin A. However, it remains in the leaf and is not found in the grain people consume. One avenue to address Vitamin A deficiency is to add Vitamin A to rice, which is the idea behind Golden Rice.

By taking advantage of our better understanding of the genome of rice, and inserting only two genes into the genome of rice, which contains a total of 37,544 genes, a modified variety called Golden Rice was introduced. The more "golden" the rice is, the higher the concentration of beta-carotene, and since the prototype was developed in 1999, improved lines of Golden Rice have been generated.

The objective is to reach the recommended daily allowance of Vitamin A by consuming 100-200 grams of rice containing beta-carotene. A recent study found that a daily intake of 60 grams (one-half cup) of Golden Rice is sufficient in preventing Vitamin A malnutrition. From its inception, the technology has encountered major objections, mostly from environmental groups. In early versions of Golden Rice, there was a concern that it required a large intake of rice to meet daily allowances. However, over time the concentration of Vitamin A in Golden Rice increased substantially, and relatively modest consumption of Golden Rice can lower the risk of Vitamin A deficiency.

Another criticism was that Vitamin A deficiency could be avoided by distributing supplements to the poor, is a nice idea in theory, but has not been put into action. Likely, the real concern of opponents was that Golden Rice would act as a "Trojan Horse" that would lead to large-scale expansion of the adoption of genetically engineered (GE) food in developing countries.

The proof of concept of Golden Rice has existed since the late 1990s, and it was expected that the first commercial variety would be available in 2002. In 2000 a public-private partnership started between the Golden Rice Humanitarian Project and the Syngenta Corporation that aimed to pass the regulatory approval process and bring the product to market. However, the regulatory bodies in India and Bangladesh have not approved thus far, even though there is a large body of evidence that suggests Golden Rice and other GE varieties do not produce greater health or environmental risks than non-GE varieties, clearly the primary reason for the delayed decision is objection from environmental groups.

Assessing the Impact of Delaying the Approval of Golden Rice

To assess the economics of regulating Golden Rice, we quantified the logic of the regulatory process. A regulator can approve the use of a new technology, ban it, or delay the decision in order to obtain new information. In the case of Golden Rice, regulators in countries

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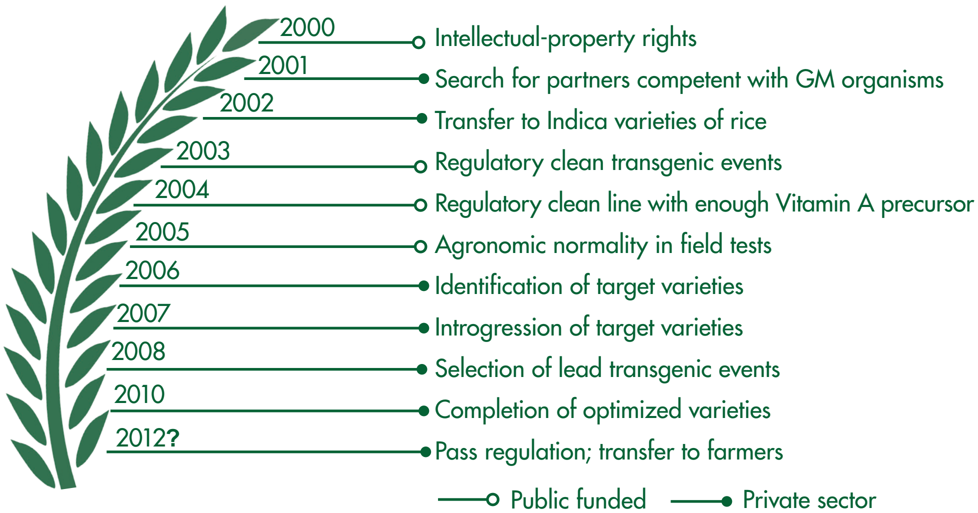
Figure 1. A Decade of Regulatory Hurdles for Golden Rice



Source: Transgenic Plants for Food Security in the Context of Development

where Vitamin A deficiency is a major problem (e.g., India and Bangladesh) have decided to delay the choice.

The rationale for such a decision is that the gains from improved knowledge through delay are greater than the cost of the delay. The benefit from delay is the perceived cost of uncertainty about the outcome of a technology that may be reduced by delaying approval. In the case of a regulatory decision, this perceived cost quantifies the magnitude of the political pressure by people opposing the technology.

The costs of delay are the net benefits from adoption of Golden Rice that are lost. These net benefits are the sum of the discounted net benefits of reduced incidents of Vitamin A deficiency-induced health problems minus the cost of the introduction and adoption of the technology.

To derive the foregone benefit, had Golden Rice been adopted in India in 2002, we assume a gradual adoption of Golden Rice and estimate that the overall adoption would be around 30%, which is modest. The unit of measurement of foregone benefit is the disability-adjusted life year (DALY). These disabilities include blindness, measles, and mortality of children and pregnant women.

We estimated the number of DALYs lost because of the lack of availability of Golden Rice since 2002 to be between 1.4 and 2 million. We assume a very low value of a DALY (USD $500) in our initial calculation. The cost of the introduction of Golden Rice includes maintenance and breeding as well as social marketing of the new variety, which are much smaller than the benefit from improved health because of Golden Rice.

Based on these conservative assumptions, we estimated that the net present value of a 10-year delay in the introduction of Golden Rice to be USD $707 million. Note that $500 per DALY is a very conservative assumption. In the United States, it may be something like USD $20,000 or higher. If we increase the DALY to USD $2,000, the net loss is approximately four times as high.

The delay of approval by more than 10 years reflects that the cost of the various perceived risks associated with the introduction of Golden Rice is greater than the perceived benefits by a significant amount. Our calculation of these accumulated perceived risk costs estimates them to be at least USD $1.7 billion since 2002. The annual perceived cost of risk associated with the adoption of Golden Rice in India, alone, is estimated to be USD $199 million. The transition from annual cost was calculated based on a discounting factor that took into account the uncertainty about the magnitude of the risk. These estimated perceived costs of introduction provide an economic rationale for the delay. Of course, much of these costs really reflect the political pressure against its adoption.

An alternative approach to assess the policy-making process is to recognize that every year, between 250,000 and 500,000 children go blind, and in India alone, more than 70,000 die because of Vitamin A deficiency. If we assume global adoption of 20%, from 2002 until today, we could have prevented 600,000 to 1.2 million cases of blindness, and in India alone, about 180,000 deaths of children.

The Perceived Cost of Golden Rice

Whether viewed in monetary terms or the costs of blindness and death avoided, the delay of the introduction of Golden Rice was very costly. We know that the scientists fighting river blindness, a disease that affects millions of people and blinds about 300,000 in Africa, are justifiably treated like heroes. Thus, the perceived costs of Golden Rice must be very high to delay its introduction.

But where are these costs coming from? A 2012 publication of Greenpeace titled "Golden Illusion: The Broken Promises of 'Golden' Rice," states: "if introduced on a large scale, golden rice can exacerbate malnutrition and ultimately undermine food security." The concern is that Golden Rice may accelerate the adoption of other GE crops in developing countries, which is perceived by Greenpeace and others to be very dangerous.

However, the reality is quite different. A growing, large body of literature indicates that GE varieties have produced a significant amount of real benefit throughout the world, and its curtailment is a source of potential social loss.

Agricultural biotechnology applies the tools of modern biology to agricultural production. Genetic engineering has been a crucial element in developing medicine that is based on better understanding of biological processes, and is serving the same role in agriculture. For years, we have been modifying varieties by crop breeding, but GE technology increases precision and enables altering only a few genes.

Because of strict regulation, the adoption of GE has been limited. GE varieties have been introduced in corn, soybean, and canola mostly in the U.S., Canada, Brazil and Argentina, and to a large extent with cotton. There is significant adoption of GE varieties in papaya, and some application in rice and tobacco. Even though GE has been introduced in few crops, its impact on agricultural production is immense because it has increased productivity substantially. Furthermore, its impact on productivity has been higher in developing versus developed countries. Because of limited adoption in most of these regions, its potential has not been realized.

Without adoption of GE, soybean prices are estimated to have been 33% higher and corn prices 13% higher. Even though these crops are used to support livestock, the poor are consumers of meats, and they are affected significantly when there are food shortages.

The food crisis of 2008 is a good indicator of the consequences of high food prices. Without the contribution of GE varieties, we would see much more frequent food shortages. Our research suggests that if GE was adopted by European and African countries and introduced in grains, food prices would decline much more substantially, and the land footprint (total land acreage in production) would decline because of higher yields.

The higher yields associated with GE varieties have a significant positive environmental effect because of the reduction in use of fertilizer, water, and energy in agriculture. Some of the land-saving effect is because of the ability to use double-cropping to produce soybeans.

GE also benefits the environment because it allows certain toxic chemicals to be replaced, and there is evidence that it has already saved lives in developing countries. Of course, it encounters some problems with pest resistance and changes in use of herbicide, but the overall environmental effect is quite positive. Because GE provides a powerful mechanism to develop new varieties in a systematic manner, it can play an important role in providing strategies to adapt to climate change, which can significantly benefit developing countries that may face some of its most dire consequences.

GE was introduced in cotton in India in 2002, and has been adopted by over 90% of cotton farmers. As we know, adoption of technologies in India and other developing countries tends to be slow, and the high rate of adoption is one indicator that farmers perceive it to be beneficial. Studies have shown that farmers, including very poor ones, gain a significant share of the benefit as a result of high aggregate adoption. In some cases, it increases their income by 50% or even more.

The drastic increase in cotton yield because of GE increased the Indian share in world cotton production and benefitted its economy. The high rate of adoption of GE cotton and other varieties (when available) in India and other developing countries suggests that if Golden Rice would have been introduced, it would have been widely adopted.

If Golden Rice had been adopted, it might have led to further acceptance of GE technology and adoption of other traits in rice. While some groups may be concerned about it, based on evidence from China and the cases of cotton and corn, it seems that GE would increase the productivity of the rice sector and free up land and other resources for alternative uses.

Conclusion

Our analysis suggests that the delayed introduction of Golden Rice for over a decade has been very costly both in monetary terms as well as the hundreds of thousands of cases of blindness and child deaths. Political pressure by opponents to GE technology is likely to be one of the main causes for this delay. The irony of the situation was not lost on some of the individuals who opposed GE technologies. For example, Patrick Moore, one of the co-founders of Greenpeace, recognized that the poor have paid the majority of the price of the fight against GE technologies, and founded an organization called the "Allow Golden Rice Society." Golden Rice is an extreme case that illustrates global social loss from the heavy regulation of GE technology, and reevaluation of policies assessing these technologies is needed.

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For additional information, the authors recommend:

"Allow Golden Rice Now." www.allowgoldenricenow.org/component/content/article?id=29

Greenpeace. 2012. "Golden Illusion: The Broken Promises of 'Golden' Rice." Amsterdam:Greenpeace International. www.greenpeace.org/international/Global/international/briefings/agriculture/2012/GoldenRice/GoldenIllusion.pdf.