Golden Rice

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Many of the poorest areas of the world depend on rice as a staple food. “Rice grain is the world's most important source of human food. It is a good provider of calories and protein, but rice scientists have long recognized its micronutrient deficiencies. Milled white rice contains essentially no Vitamin A, and unmilled brown rice contains [less than 1% of the daily requirement]”1. Vitamin A deficiency has elevated undernourishment to a global issue of extreme importance. In recent years, Golden Rice has been introduced to alleviate this deficiency. “Golden Rice, as its name suggests, is visibly different; the elevated levels of beta-carotene in Golden Rice lend it a distinctive yellow-orange colour”2. Golden Rice is fortified with beta-carotene and consequently has higher levels of Vitamin A than white rice. However, the color of the rice is a double-edged sword; its color signifies increased health benefits, but also distinguishes Golden Rice as a different product that can face issues of social acceptance.

Golden Rice is critical to combating undernourishment because resolving hunger is not just about having enough to eat, but about “having the right combination of nutrients and calories needed for healthy development”3. Golden Rice accomplishes this by increasing Vitamin A from 0 µg/g to “up to 37 µg/g carotenoid of which 31 µg/g is β-carotene [which are] levels that will provide an adequate amount of vitamin A in normal children's diets”4. Of the 925 million people facing undernourishment5, 400 million are Vitamin A deficient, half of whom are children. “Making rice an additional source of Vitamin A readily available in the diet of poor and vulnerable populations is now a possibility using agricultural biotechnology”6.

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5 Food and Agriculture Organization of the United Nations. "Global Hunger Declining, but still Unacceptably High." Economic and Social Development Department (September, 2010).
Vitamin A deficiency is not just an abstract health issue; it also has severe and tangible repercussions for both individuals and communities. Micronutrient deficiency severely limits an individual’s access to and ability to receive an education. The World Food Programme finds that hunger limits people’s ability to “create, study or reach their full potential as human beings”.

This creates serious economic implications. Studies found that within ten developing countries, micronutrient deficiencies decreased physical and cognitive productivity by 4.05% of GDP. This severely detracts from economic development by not only suppressing potential GDP growth, but also by stagnating a nation’s social capital. These decreased levels of education, productivity, and innovation create self-perpetuating poverty traps that are nearly impossible to escape without first tackling the issue of undernourishment.

A “lack of vitamin A causes severe visual impairment and blindness, and significantly increases the risk of severe illness. An estimated 250,000 to 500,000 vitamin A-deficient children become blind every year, half of them dying within 12 months of losing their sight”.

The most austere of all consequences of Vitamin A deficiency is the strikingly high mortality rate, especially in children under five years of age. Up to 30% of deaths in that age group – 2.5 million annually – “could potentially be averted by bringing Vitamin A deficiency under control worldwide”. While this is a global issue, areas hit the hardest include Southeast Asia where rice is a staple crop. Adoption of Golden Rice as a replacement for white rice would be a long-term food style change that can halt this debilitating trend.

Alleviating Vitamin A deficiency is clearly an effective tool for improving individual health, decreasing mortality, and removing barriers to economic development. Rice is the most effective tool because “the greatest vitamin A deficiency occurs in South and Southeast Asia,

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where 70% of the children under five are affected. Here, rice is the staple food, accounting for 80 percent of caloric intake in some countries. However, many of the areas of the world that most require Golden Rice do not have the capacity to engineer the crop. Instead, Golden Rice is produced in highly developed universities and foundations in Europe and the United States.

Golden Rice was developed in the laboratory of Dr. Ingo Potrykus of the Swiss Federal Institute of Technology from the late 1980s-1990s. Initial funding for research and development came from the Swiss Federal Institute of Technology and the Rockefeller Foundation. However, to acquire numerous Intellectual Property Rights (IPRs) and Technical Property Rights (TPRs), the Golden Rice team partnered with the powerful AstraZeneca corporation. “AstraZeneca received an exclusive licence for commercial use and in return supports the humanitarian use via the inventors for developing countries. The cut-off line between humanitarian and commercial use is US$ 10,000 income from Golden Rice.” Yet, with this support, Golden Rice has been blasted as “the worst option for food security” due to its corporate ties.

Critics of corporate funding of Golden Rice argue that it is essentially propaganda to financially exploit genetically modified organisms (GMOs). These criticisms lack substantiation; “the research was totally funded by public sector and charitable contributions, and was never intended to boost the reputation of biotech corporations. The Golden Rice project was started in 1990 when nobody thought that it might help improve acceptability of the technology [genetic crop modification]. Corporate funding only came into play after the product was developed in order to finance the patent process and global distribution. Though its inception lies in explicitly humanitarian efforts, corporate funding has been a benefit to the Golden Rice project. AstraZeneca funds the development and distribution of the rice, allowing impoverished

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10 Ibid.
12 Friends of the Earth International, Christian Aid, “Biotechnology and GMOs”.
farmers to receive the rice seed free of charge. While this does promote the company’s image, it more importantly increases access to Vitamin A at no cost to consumers.

Vandana Shiva takes issue with the increased cost of farming GMOs because of the required annual seed purchases, going so far as to link these costs to bankruptcy and suicide\textsuperscript{15}. The technology is protected under patent, but farmers making under $10,000 receive the seed for free, which eliminates Shiva’s detrimental cost prediction. While the company is able to sell the rice to developed nations and “get the gold\textsuperscript{16}”, there is little repugnance in such actions. Giving a product for free to those who need it but lack the means to buy it while charging those who can afford the product is one the most equitable standards of pricing according to most political economists and ensures that the crop is going where it is needed most.

In February of 2001, Greenpeace issued a scathing press release condemning Golden Rice as an ineffective source of Vitamin A and accusing its developers of “intentional deception\textsuperscript{17}”. At the time of the Greenpeace article, scientists had engineered Golden Rice to have approximately six $\mu$g/g of beta-carotene\textsuperscript{18}. While this is an improvement over 0 $\mu$g/g, it did prove Greenpeace’s criticism that “an adult would have to eat at least 3.7 kilos of rice\textsuperscript{19}” to meet his or her daily need. However, in the past decade, Golden Rice technology has improved, and the most recent generation of rice contains over 30 $\mu$g/g of beta-carotene and provides an “adequate amount of vitamin A in normal children's diets\textsuperscript{20}”. With these improvements, criticisms of Golden Rice as a legitimate source of Vitamin A are less sound.

These advances have not quelled Greenpeace’s criticism. Recent releases condemn Golden Rice as not worth the research and development dollars because other methods such as

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diversifying diets could be more effective. Although diversifying diets with “fruit, vegetables
and animal products can provide more than enough of the daily requirement of Vitamin A\(^{21}\), the
idea is idealistic. Golden Rice targets the areas where rice is 80% of food consumption.
Enhancing the nutrients in the product that is already consumed the most is the most efficient
solution. Ironically, in the same report that attacks Golden Rice, Greenpeace praises the success
of bioengineered orange sweet potatoes in Mozambique. These sweet potatoes “have
successfully helped over [450,000 families] to produce and consume these more nutritious forms
of this culturally appropriate food staple\(^{22}\). The case of Golden Rice mirrors that of the orange
sweet potato, yet Greenpeace condemns one and praises the other. Greenpeace’s vacillating
vilifications on efficacy and inconsistent standards about biofortified crops undermine the
credibility of their arguments against Golden Rice.

Golden Rice still faces the criticism of being a genetically modified crop imposed on
developing nations by developed nations. Some argue “GM crops are taking us down a
dangerous road, creating the classic conditions for hunger, poverty and even famine. Ownership
and control concentrated in too few hands and a food supply based on too few varieties of crops
planted widely are the worst option for food security\(^{23}\). However, these conditions of
concentrated control exist in the status quo. Implementing Golden Rice minimally impacts this
control, and the humanitarian inclinations of the distributors reduce the risk of withholding
Golden Rice as a coercive tool. Additionally, Golden Rice increases availability to Vitamin A
and “those who stand to benefit in the third world will then be enabled to make their own choice
freely about what they want for their own children\(^{24}\)."

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\(^{23}\) Friends of the Earth International, Christian Aid, “Biotechnology and GMOs”.
\(^{24}\) Trewavas, Anthony, “GM Is the Best Option We Have”, The Ethics of Food, (2002), 151.
Genetically modified crops do run the risk of decreasing biodiversity in food crops. The areas that Golden Rice targets already consume 80% of their calories from rice, thus the marginal losses to biodiversity are minimal because in many places, rice is the only crop. Weighing marginal losses to biodiversity against the introduction of healthy levels of Vitamin A into the diets of millions of children is a value judgment. Given that one child dies from Vitamin A deficiency every twelve seconds\(^{25}\), the monumental and tangible health benefits strongly outweigh the potential risk of decreased biodiversity. Those who decry Golden Rice based on its GMO background are “luddite individuals [who] denigrate this remarkable achievement\(^{26}\)”.

Golden Rice is part of a larger question on the role of food aid in development. The two major ideological camps are apolitical humanitarians and development game-changers. Apolitical humanitarians argue that organizations committed to food aid ought to function as neutrally as possible to allow them to offer nourishment without the threats associated with political alignment. By focusing uniquely on providing food, they do not attempt to create change, but just meet current humanitarian needs. In doing so, these organizations are inherently altering the area they are assisting. Donations of food supplies, no matter how altruistic, are effectively a function of an outsider bringing in goods, and have ramifications of adding new people to the society along with food. Apolitical humanitarians seek to make this relationship as altruistic and basic as possible to avoid hostilities from governments because of differing political ideologies. Development game-changers believe that food aid is an inherently political act and, upon entering the market, becomes a tradable commodity. With this commodity status, it is possible for governments and aid agencies to use food as a power-wielding tool to implement social, political, or economic development strategies. Consequently, they aim to use the giver-receiver relationship as an opportunity to create fundamental change within a society.


\(^{26}\) Ibid.
While apolitical humanitarians’ fears of the implications of political alignment are justified, the unique case of Golden Rice does not fully justify these fears. Food aid in the traditional sense consists of large-scale donations from governments or organizations. In these cases, there is real merit in non-political distribution bodies because they are able to access people in need without threat of political retaliation. However, the implementation strategy of Golden Rice is different from this traditional model and does not include bulk transfers of food commodities but instead donations of seed to willing consumers based on community demand. The development that stems from Golden Rice is not implemented by force but fostered by decreasing the drag that is put on individuals by hunger. It is about individual empowerment through improved health, not a political agenda because individuals who are well-nourished and healthy are better able to enact social, political, and economic change. Golden Rice does not force these endeavors but simply enables them. Because of its health benefits, Golden Rice will play a major role in development, and therefore it is necessary to be aware of the implications of its implementation.

Food is the biggest issue in development and “researchers are finding that the biggest reason people die of malnutrition is simply lack of micronutrients27”. Too many development attempts “promote sweeping, ideological solutions to problems that defy one-size-fits-all answers…while the facts on the ground bear little resemblance to the fierce policy battles they wage28”. The innate humanity and essentialness of food means that changes to the way people eat can affect all aspects of their being as well as their community. Food choice is an individual action that when changed en masse can produce macro results. Golden Rice’s function as a food behavior, and not necessarily a commodity, decreases the political nature of its implementation. However, social factors within a community are critical to its acceptance.

28 Banerjee, Abhijit, and Duflo, Esther; "More Than 1 Billion People Are Hungry in the World." Foreign Policy, (May/June, 2011).
“Demand-driven pull factors can be expected to play an important role in achieving the desired dissemination and coverage of the target population,”29 and consequently it is necessary to identify solutions to the sociological demand-side issues in order to harness the benefits of biofortified foods - like Golden Rice - in development. This requires in-depth knowledge of the community and their social relations with food to allow for successful implementation.

Golden Rice is not the first attempt at improving access to Vitamin A in the developing world. In Mozambique, replacing the staple white, nutrient-devoid sweet potato with a biofortified orange sweet potato offered similar health benefits as Golden Rice. Learning from the mistakes of the orange-fleshed sweet potato (OFSP) is critical for successful implementation of Golden Rice. The World Bank found the most successful strategy of implementation to be “demand creation and empowerment through knowledge”30. This spread of information about the product is absolutely critical to familiarize communities with the new food. “Developing countries are more likely to be threatened by internal conflicts”31 and consequently have an increased requirement of stability. This can cause trepidation in the face of new introductions because the large forces that deliver aid have so much power in shaping the area. Therefore it is necessary for the organizations providing the new food, whether it is the orange sweet potato or Golden Rice, to offer as much information as possible about the orange color to decrease skepticism of foods engineered abroad.

Hesitation over new products is heightened when dealing with food because of strong traditions and preferences in the area of intended implementation. Initial trials in Mozambique tried to introduce the orange sweet potato without considering the context of the community and “putting the orange-colored food on the table was like putting a blinking neon light in a

cemetery. Most people wouldn’t go there\textsuperscript{32}. Societies and communities maintain unique food traditions about growing crops, food preparation and the type of ingredients used and consequently, community consultation is necessary. During a November 11, 2011 presentation at Williams College, Biju Rao, Lead Economist in the Development Research Group of the World Bank stressed the importance of social analysis in development projects\textsuperscript{33}. This requires a working knowledge of the community and their traditional practices. For implementation, the strongest strategy is involving community leaders in the process\textsuperscript{34}. This increases the efficacy of implementation - proportion of people who accept Golden Rice - while also using an established and trusted forum to disseminate information about the rice.

Frequently this means working within “culturally appropriate food staple[s]\textsuperscript{35}” to embrace preexisting traditions and preferences. One Golden Rice strategy targeted Indian villages that used turmeric in their recipes because the color of the rice dish was similar to Golden Rice. The community had already embraced the rich golden color of the dish after cooking so there was minimal opposition to switching to Golden Rice, especially given its health benefits. Localized strategies like this are the most effective when coupled with education. For the OFSP, education “generated demand [that] combined with market development stimulated production, enhanced producer income and spread the health benefits of OFSP to a wider population, all of which would contribute to farmers’ willingness to retain OFSP and expand production\textsuperscript{36}”. This success came from reducing the apprehension associated with orange foods. By educating community members about the health benefits and implications of Vitamin A, people were able to make well-informed choices about their food products and nearly all

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  \item \textsuperscript{32} Thurow, Roger, \textit{Enough: Why The World’s Poorest Starve in an Age of Plenty}, (Perseus, 2009), 389.
  \item \textsuperscript{33} Rao, Biju, World Bank Development Research Group, \textit{Localizing Development: Does Participation Work?}, Presentation to Williams College CDE, (November 9, 2011).
  \item \textsuperscript{34} Ibid.
  \item \textsuperscript{36} The World Bank, “Gender in Agriculture Sourcebook”, \textit{Mozambique: Promoting Orange-Fleshed Sweet Potatoes}, (2008).
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chose the biofortified potato\textsuperscript{37}. Golden Rice is the sweet potato’s twin in this regard. Successful implementation must incorporate community-based education about the benefits of Golden Rice. In doing so, consumers are able to take an active role in their food choices and acceptance of Golden Rice can spread as a grassroots development effort.

Despite the potential challenges to implementation, there is hope for the future of Golden Rice. After twenty years of research, scientists have successfully created a product that can save lives and eyesight by alleviating Vitamin A deficiencies in the developing world. Golden Rice has weathered controversies on corporate funding and genetic engineering to prove itself a serious contender in development. Gleaning lessons from the orange sweet potato, it is necessary to understand community traditions and preferences to successfully implement Golden Rice. By harnessing localized strategies to gain acceptance, Golden Rice has the potential to save hundreds of thousands of lives in coming years. While it may not be a silver bullet, the future of Golden Rice glows brightly.

\textsuperscript{37} Mazuze, Feliciano, “Analysis of Adoption and Production of Orange-Fleshed Sweet Potatoes: The Case Study of Gaza Province in Mozambique”, \textit{Michigan State University Department of Agricultural Economics}, (2004).