

Chapter 20

Genetically Modified Foods: Golden Rice

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Abstract An interactive classroom exercise for guiding discussions of ethical concerns about agricultural biotechnology.

Keywords Golden rice • Ethics • Genetic engineering • Foods • Crops

The Background

The World Health Organization (WHO) estimates that vitamin A deficiency affects 230 million children around the world, and at least one million children per year are dying of diseases related to this deficiency. Ingo Potrykus and his research group, with financial support from the Rockefeller Foundation, developed a variety of rice that contains beta-carotene, the plant pigment that is the precursor of Vitamin A. This rice supplies enough beta-carotene in a typical serving to supply 10% of the daily requirement for Vitamin A. Potrykus and Rockefeller have provided this variety of rice to the International Rice Research Institute (IRRI) in the Philippines, which will breed improved rice varieties using their traditional rice breeding methods and make the seeds freely available to farmers in the developing world.

IRRI has been doing rice breeding for decades, and has been on the front lines of the Green Revolution, developing and releasing new rice varieties with improved productivity (and increased dependence on fertilizers and pesticides). The institute's services are provided without charge to the farmers it serves and are supported by philanthropic foundations in the developed world (including the Rockefeller Foundation). Many people regard this development as an example of how biotechnology can be used to help developing nations, while others consider it

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a smokescreen to divert attention from the fact that biotechnology companies are trying to dominate the food supply.

Several questions surround golden rice, including when, if ever, it will be ready for commercial use and whether it might have unpredictable, untoward health effects on those who eat a lot of it.

Your Assignment

A charitable organization appeals to the WHO to stop Rockefeller Foundation from releasing golden rice, on grounds that it isn't a good strategy for dealing with malnutrition. The WHO will soon convene a hearing, the WHO Panel of Arbitrators, to determine whether to block the development of golden rice. The organization has invited four groups to advise it on this matter.

The four groups are: (1) Friends of the Earth, (2) Philippine Partnership for Development Farmer-Research Scientists (MASIPAG), (3) People from Developing Nations; and the (4) International Rice Research Institute (IRRI). The first two groups argue that the technology should not be pursued because they think golden rice is an expensive high-tech experiment, a gambit that is unlikely to solve the real causes of hunger in developing countries. The second two groups see golden rice as a viable solution to some problems, and argue strenuously for its development.

You will be assigned to serve either on one of the four teams, or on the WHO arbitration board.

General Instructions for Advisory Groups

Consider your group's position and generate moral and/or scientific reasons supporting your position. Plan to include both factual statements ("Many children suffer from vitamin A deficiency") and moral principles ("We should provide aid"). Formulate a strategy for briefly presenting your position to the WHO panel in a persuasive manner, and be prepared to answer questions from the panel about your position. You will have only 5 min to present your position, so choose one representative to speak for your group.

The Groups

Panel: WHO Arbitrators: You will be asked to decide whether to block distribution of the golden rice. Use your time to decide what additional facts you need to make a good decision, and what moral questions need to be answered. After you hear testimony from each interested group, you should ask the groups any questions that you think remain unanswered. After all the testimony is complete, you will have time to make your decision. Please select a representative to present your decision, and support it with your moral reasons.

Friends of the Earth: You represent an organization dedicated to protecting the environment and promoting sustainable development. You think that golden rice, as well as all genetically modified plants and animals, pose unknown threats to the environment and human health. In your view, the introduction of genetically modified organisms continues because of the power wielded by large agribusiness companies. You will argue that golden rice should not be released because of the environmental risks it poses, and you will urge the WHO to resist the influence of Monsanto and other large biotech firms.

Philippine Partnership for Development Farmer-Research Scientists (MASIPAG): MASIPAG was formed in 1986 as a collaboration between farmers and agricultural researchers to improve rice farming practices. The organization hopes to make rice farmers independent of loans and chemicals through training in sustainable agriculture. You will argue that poor Asian farmers are not likely to benefit from golden rice. Instead, you see golden rice as a chance for the biotechnology industry to improve its image.

People from Developing Nations: Some (though not all) of you may be desperately poor and may have children exhibiting symptoms of vitamin A deficiency. No solution to this critical health problem is immediately available, and you will argue that golden rice is desperately needed because the effects of malnutrition are so severe.

International Rice Research Institute (IRRI) Scientists: IRRI is an organization that does research in plant breeding and development of new rice varieties for farmers in Asia. Products of IRRI development are freely distributed to farmers and local plant breeders. You will argue that distributing golden rice will benefit malnourished children.

The following sections are for instructors to use as a guide to this case study exercise.

Purpose

This case is designed to explore the social and political ramifications of biotechnology, providing provocative and meaningful information about both biotechnology and conceptual bioethics. The goal is for students to understand arguments for and against new agricultural applications of biotechnology. The exercise is intended to illustrate the raw power of biotechnology to alter the lives of billions of people, either for good or ill. With the power to change the world comes a great deal of responsibility, for where there is the potential to do truly great things there is also potential for disastrous consequences. The students will discuss the social and environmental issues that must be considered with regard to biotechnology.

Procedure

The exercise has been used successfully, with university faculty, in a single hour-and-a-half session. With college students, however, we recommend a minimum of four one-hour class periods.

Class Period #1

The instructor gives an introduction to golden rice, handing out the one-page description of the exercise. Students are assigned to one of the five groups. We recommend that the instructor divide students randomly by, for example, asking them to count off from one to five. The group of students numbered “one” is assigned to the role of the WHO, the group of students numbered “two” is assigned to the role of Friends of the Earth, and so on.

The rest of this class period is spent giving instructions, meeting in groups, choosing a spokesperson for the group, and beginning to formulate strategy for the final presentation. The instructor also directs all students to read all of the supporting documents, paying special attention to the documents supporting their group’s position. The arguments provided in these materials are not exhaustive; there are other arguments that can be made. It is up to the instructor’s discretion whether to encourage students to do additional research on the web, or in their groups, to discover other arguments. Instructors should carefully monitor the groups, as some groups may need more assistance than others in extrapolating arguments from the information provided.

Class Period #2

Groups meet to discuss the readings, marshal the arguments for their position, and plan their final presentation. The WHO group discusses its decision and takes a preliminary vote, which it keeps secret from the other groups. The purpose of the vote is simply to inform members of the WHO how the respective members of the WHO are disposed. The WHO group also plans its behavior during final presentations. For example, it may wish to assign one student to be responsible for posing one question to the Friends of the Earth after the Friends have presented their arguments on the third day. Another student may be assigned to pose a question to IRRI, and so on.

Class Period #3

Final presentations from each group. Each presentation must be no longer than 5 min. At the end of each presentation, the WHO is entitled to ask one question of each group, and the group’s spokesperson must respond, taking no more than 2 min to do so.

After all four groups have made their presentations, the WHO recesses to another room. Taking no more than 10 min, it discusses the arguments one last time and votes. It then returns to the room and announces its decision.

Class Period #4

This period is spent discussing the exercise, and permitting students to vent feelings of frustration. Students in groups that lost the argument may feel disenfranchised. They may feel that the WHO did not adequately appreciate the weight of their arguments, did not understand the gravity of their concerns, and so on. The instructor can use this time for productive discussion of democratic institutions, the place of minority opinions, the difficulty of governing, the importance of open and transparent decision-making, and so on.

With the instructor's consent, students may use information not included in these materials. However, they must seek the instructor's approval before the debate about using the information. At that time they must also present documentation showing the information's source so the instructor may determine its admissibility.

Background Materials

These materials are reproduced to aid students in researching the arguments made by their respective groups. Students should be instructed to pay careful attention to specific factual claims as well as to any indication of the moral values that their groups endorse.

Panel: World Health Organization (WHO)

Objectives and Functions (<http://www.washingtonpost.com/ac2/wp-dyn/A59811-2001Aug24>)

WHO is defined by its Constitution as the directing and coordinating authority on international health work. Its aim is "the attainment by all peoples of the highest possible level of health." The following are listed among its responsibilities.

- To assist governments, upon request, in strengthening health services
- To establish and maintain such administrative and technical services as may be required, including epidemiological and statistical services
- To provide information, counsel and assistance in the field of health; to stimulate the eradication of epidemic, endemic, and other diseases
- To promote improved nutrition, housing, sanitation, working conditions and other aspects of environmental hygiene
- To promote cooperation, among scientific and professional groups, which contributes to the enhancement of health

- To propose international conventions and agreements on health matters; to promote and conduct research in the field of health
- To develop international standards for food, biological and pharmaceutical products; and
- To assist in developing an informed public opinion among all peoples on matters of health

Mission Statement

The objective of WHO is the attainment by all peoples of the highest possible level of health. Health, as defined in the WHO Constitution, is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Group: Friends of the Earth (FOE)

Friends of the Earth is an international organization concerned with environmental and social issues. Friends of the Earth members view golden rice as a smokescreen used by biotechnology companies to convince the world that biotechnology is necessary to combat hunger and malnutrition, and to distract people from the risks of biotechnology. In a statement on golden rice, the group asks, “Is Golden Rice a triumph of biotechnology that could eradicate unnecessary suffering? Or is it merely a PR maneuver by a threatened industry that would thrust an unproven, unwanted, and perhaps even harmful technology upon the developing world?” (Friends of the Earth 2000).

One reason for the group’s suspicion about golden rice is that vitamin A deficiency is usually correlated with general malnutrition. Presumably, general and widespread malnutrition can be addressed most effectively by addressing food security issues like ensuring that the poor have land on which to grow a varied diet or enough money to buy healthy foods. Golden rice therefore seems to Friends of the Earth like an excessively technical solution to a problem that might best be solved with traditional, low technology efforts to improve food security and combat poverty.

Friends of the Earth estimates that \$100 million has been spent to develop golden rice (Friends of the Earth 2000). Critics of golden rice point out that the charitable organizations that funded the development of golden rice might just as well have funded low-tech solutions to vitamin A deficiency, such as already-existing programs to distribute vitamin A capsules. While vitamin A capsules are neither problem-free nor a complete solution to malnutrition in the developing world, distribution programs are already in place, while golden rice is still in the research and testing phase. Moreover, the risks of capsule distribution are fairly well-known compared with the less-understood risks of biotechnology.

Other options exist as well. Friends of the Earth reported that many agricultural and public education programs exist in areas where malnutrition is a problem, including an advertising campaign in Thailand to encourage people to grow a variety of vitamin-A rich foods, and the use of natural predators to control pests in food crops in Africa. Friends of the Earth sums up: “One must wonder how many other low-tech, sustainable, people-centered solutions to hunger and malnutrition go unfunded thanks to government and biotech industry obsession with the hugely expensive technology of genetic engineering” (Friends of the Earth 2000).

Group: MASIPAG: Philippine Farmer Scientist Partnership

Students in this group represent an indigenous group of farmers in the Philippines whose name translates into English as the Farmer Scientist Partnership for Development. MASIPAG believes all of the following claims: That golden rice is a technofix solution to a problem that requires a more fundamental restructuring of the global agricultural system. That golden rice only helps biotechnology companies and the governments friendly to them to continue the Green Revolution path, a path ensuring that “malnutrition will even reach greater heights, as people will have more unbalanced diets, based on only a few foods” (Genetic Resources Action International (GRAIN) 2001).

While those pushing golden rice have declared that the seeds will be distributed to poor farmers free of charge, MASIPAG believes that the technology will bear other costs. MASIPAG cites the case of Mr. Afsar Ali Miah, a Bangladeshi farmer, who lived through the Green Revolution and now observes that “Nothing comes in free anymore, without its consequence, especially if it is driven by profit motives.” Ali Miah interprets the Green Revolution as follows:

At that time, the technology was started with all out support from the government and many farmers responded positively, making use of the packaged technology of modern high-yielding varieties, together with pesticides, and chemical fertilizers and a certain amount of credit. But when the uncertainty and fear of the new crop varieties were mitigated, the government slowly started withdrawing support and the farmers were left to deal with poor soil, lost seeds, and declining diversity in the field, and dependency on pesticides and fertilizers. In the process, farmers lost control of their food system. According to Mr. Ali Miah, “Because of pesticides, people are no longer eating what little edible green leafy vegetables (and fishes) there are left in the fields anymore. If we allow this golden rice, and depend for nutrition on it, we might further lose these crops, our children losing knowledge of the importance of other crops such as green leafy vegetables”. (Genetic Resources Action International (GRAIN) 2001)

MASIPAG believes that the roots of Vitamin A deficiency are in the industrialization of agriculture. MASIPAG argues that as the diverse crops of yesteryear are replaced with monocultures, the diversity of nutrients will be increasingly narrowed, citing Ardhendu Chatterjee of the Development Resource and Service Center (DRSC) in Calcutta, India:

The problem of malnutrition is linked not with rice per se, but with the way rice is produced now [Personal communication with Ardhendu Chaterjee, Director, DRCSC, 21 July 2000]. “In the past [writes Chaterjee], integrated rice-fish-duck-tree farming was a common practice in wetlands. This does not only meet peoples’ food, fodder and fuelwood needs, but it provides superior energy-protein output to that obtained from today’s monoculture practice of growing high-yielding varieties. These fields also serve as the hatcheries for many fishes and aquatic organisms, which multiplied and spread to other wetlands. In the rainy season, these lowland rice fields often become connected to the water bodies like lakes and rivers. Agrochemicals applied in the paddy pollute these water-bodies and hence affect the entire food chain, thereby causing a decline in the overall fish, shrimp and frog supply – a resource freely available to the poor. Aquatic weeds which are rich in vitamin A are also becoming scarce.” Sadly this is a scenario fast becoming common in most of Calcutta and over the whole Asian region. (Genetic Resources Action International (GRAIN) 2001)

MASIPAG believes that there are alternative, better, ways to provide vitamin A. The organization encourages integrated and sustainable forms of agriculture, including backyard or “kitchen” gardens, arguing that local, small-scale gardens can supply ample amounts of fruits and vegetables, foods that go a long way toward meeting micronutrient needs. MASIPAG notes that groups promoting gardens in West Bengal have had great success with this strategy.

After just two seasons of her garden, Kobita Mondall relates that, “We have already consumed all that we can, have given some to the neighbors and sold some in the market, and still we’re getting something from our backyard.” Kobita’s garden consists of a 300 square foot plot near their home, planted with more than 30 kinds of fruits and vegetables. (Genetic Resources Action International (GRAIN) 2001)

Hence, MASIPAG concludes as follows:

While many doubt the ability of golden rice to eliminate vitamin A deficiency, the machinery is being set in motion to promote a GE strategy at the expense of more relevant approaches. The best chance of success in fighting vitamin A deficiency and malnutrition is to better use the inexpensive and nutritious foods already available, and in diversifying food production systems in the fields and in the household. The euphoria created by the Green Revolution greatly stifled research to develop and promote these efforts, and the introduction of golden rice will further compromise them. Golden rice is merely a marketing event. But international and national research agendas will be taken in by it. The promoters of golden rice say that they do not want to deprive the poor of the right to choose and the potential to benefit from golden rice. But the poor, and especially poor farmers, have long been deprived of the right to choose their means of production and survival. Golden rice is not going to change that, nor will any other corporately-pushed GE crop. Hence, any further attempts at the commercial exploitation of hunger and malnutrition through the promotion of genetically modified foods should be strongly resisted. (Genetic Resources Action International (GRAIN) 2001)

Group: People from Developing Nations

Dr. Florence Wambugu is a scientist who has worked to bring the benefits of agricultural biotechnology to her home country of Kenya and to other countries in Africa. Dr. Wambugu herself developed a genetically engineered virus-resistant

sweet potato. This development has significant potential to improve the nutritional status of Kenyan farmers, whose sweet potatoes are often shriveled and sparse due to the ravages of viruses.

Dr. Wambugu and others from developing countries argue that biotechnology can drastically improve agriculture in their homelands (Wambugu 2001). They view the opposition to biotechnology in agriculture as a predominantly privileged kind of activism. In their view, American environmentalists are neither vitamin A deficient nor otherwise malnourished, so they tend to underestimate, or even totally ignore, the potential nutritional benefits of biotechnology. In a statement she published in the *Washington Post*, Dr. Wambugu claimed that the critics of biotechnology are insensitive to the needs of Africans: “These critics, who have never experienced hunger and death on the scale we sadly witness in Africa, are content to keep Africans dependent on food aid from industrialized nations while mass starvation occurs” (IRRI Retrieved May 6, 2009).

Dr. Norman Borlaug, the recipient of the 1970 Nobel Peace Prize, succinctly endorses Dr. Wambugu’s main point:

The affluent nations can afford to adopt elitist positions and pay more for food produced by the so-called natural methods; the 1 billion chronically poor and hungry people of this world cannot. New technology will be their salvation, freeing them from obsolete, low-yielding, and more costly production technology. (Borlaug 2000)

In response to the critics of golden rice who argue that biotechnology will only benefit agribusiness corporations, Gregory Conko of the Competitive Enterprise Institute points out that it is a common phenomenon that new technologies may take some time to “trickle down” to the needy, but once they do, the benefits are real. “Wealthy consumers are usually first to benefit from innovations – from automobiles to antibiotics. Today, those once exorbitantly priced luxury items can be found across the globe and in use by many of modest means. The reason is that costs tend to fall over time due to economies of large-scale production, after R&D expenditures are recouped” (Conko 2001).

Applying this general analysis to biotechnology, he points out that we can expect more and more biotechnology products to benefit those in the developing world: “Once developed and commercialized, the technological knowledge used by for-profit endeavors is easily applied to far less profitable products. Many patented genetic discoveries are already being used to create extraordinarily promising plants solely for use in developing countries” (Conko 2001).

If this analysis is correct, there is no reason to be skeptical of the potential benefits of golden rice for the developing world.

Group: International Rice Research Institute

Students in this group will defend a nongovernmental organization involved with developing golden rice. Part of IRRI’s mission is to deliver agricultural products, largely free of charge, to developing country farmers. Believing golden rice may

help IRRI achieve its objectives, it believes further that golden rice is just the first of many biotechnologies that may assist IRRI's clients, who are among the poorest people of the world (<http://www.irri.org/media/press/press.asp?id=113>).

IRRI's mission statement reads as follows:

IRRI is a nonprofit agricultural research and training center established to improve the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes. It is dedicated to helping farmers in developing countries produce more food on limited land using less water, less labor, and fewer chemical inputs, without harming the environment. (<http://www.fumento.com/>)

In January 2001, IRRI received its first research samples of golden rice. The sample came from the co-inventor, the German scientist, Dr. Ingo Potrykus. IRRI, aware of criticisms of the technology, read with interest Dr. Potrykus's interview with Michael Fumento of *American Outlook* magazine (Fumento 2001). Here is the substance of that interview:

- AO:** Do you believe biotech companies have “overhyped” the value of golden rice?
- Potrykus:** I did not follow the advertisements of the industry, but it is difficult to overhype the value of golden rice.
- AO:** How many companies had to grant you licenses for golden rice to be distributed?
- Potrykus:** As our partner AstraZeneca [now its spin-off, Syngenta Crop Protection] took care of many IPRs [intellectual property rights], we ultimately needed free licenses from only four companies.
- AO:** Isn't it true that golden rice not only contains added iron but has been engineered to make the iron already present in rice more readily absorbed by the human body? Has Greenpeace or the Union of Concerned Scientists [UCS] made any mention of this?
- Potrykus:** This is true and the opposition has, so far, ignored this. However, the golden rice we can currently give out has only beta-carotene. For the iron traits we again first have to settle the [licensing problems].
- AO:** I have heard that research is already being conducted on a new and improved version, which will express vitamin A at a higher level. Is there any truth to that? Also, what about the claims that people must have a diet rich in fat and protein in order to absorb beta-carotene?
- Potrykus:** The golden rice that everybody is talking about is the first prototype, and we are, of course, continuously working on its improvement. It is true that uptake of beta-carotene requires fat (though not protein), but there is oil in rice endosperm [the nutritive, starchy mass in the center of grains] that will be studied to see whether it alone is sufficient for efficient uptake.
- AO:** To your knowledge, has Greenpeace, other advocacy groups, or any other biotech company, misrepresented your words on the nutritional value of golden rice?

- Potrykus:** Greenpeace has a strategy to convince people that golden rice provides so little beta-carotene that it is useless. This group and its allies base their argument on 100% of the recommended daily allowance [RDA], thus hiding the fact that far lower values are effective against mortality, morbidity, and blindness. The golden rice that the public will receive will provide true benefits at just 300 grams [10.5 ounces] per day.
- AO:** Greenpeace and the UCS claim that the timing of the announcement of golden rice was “suspicious,” intended to give the agbiotech [agriculture biotechnology] multinationals a needed publicity boost. Can you refute this?
- Potrykus:** This is so stupid. When we initiated our work 10 years ago, agbiotech definitely had no acceptance problems.
- AO:** Do you see golden rice as “the answer” to nutritional problems in the underdeveloped world where rice is a staple, or is it merely a tool to be used alongside others?
- Potrykus:** Golden rice is meant only to complement traditional interventions and to improve the vitamin A intake in poor populations. That said, it will probably be the cheapest and most sustainable solution.
- AO:** Do you see a role for golden mustard, golden canola, or other transgenic plants in providing more vitamin A and more nutrition in general to people in underdeveloped countries?
- Potrykus:** Of course I see a role for further food crops providing beta-carotene. We’ve already had discussions with scientists who want to introduce the trait into wheat, maize (white maize of Africa), cassava, sweet potato, banana, and so on. Naturally, the work with mustard and canola helps also. What I want is not only the addition of beta-carotene but nutritional improvement in general. That is why I have also added the iron trait, and I am working on a high-quality protein trait.
- AO:** Do you concur with the assertion that simply by raising nutrition levels of underdeveloped nations, we can help them become less poor, leading to overall better nutrition?
- Potrykus:** Yes, I certainly do.
- AO:** What do you think of Greenpeace’s insistence that it reserves the right to take “direct action” against golden rice test plots?
- Potrykus:** If Greenpeace does this, they will be guilty of a crime against humanity.
- AO:** What measures were taken in the past to address vitamin A deficiency, and what were the problems with those alternatives? Do you think that Greenpeace’s suggested plan of mass distribution of vitamin pills make sense in terms of distributing them to hundreds of millions of people?
- Potrykus:** There is a need for distribution, fortification, dietary diversification, and education. All of these are important. These interventions have used an impressive amount of funds that have been spent over the last 20 years and have been very helpful. But we still have 500,000 blind children and millions of vitamin A deficiency deaths every year.

The problem with vitamin A pill distribution is that it does not reach many of those who need it.

AO: Greenpeace has declared the rice to be “fool’s gold.” How do you respond to their accusation that it would take an incredible amount of golden rice consumption to give children the recommended daily allowance of vitamin A, plus prevent blindness?

Potrykus: This is not true. The golden rice that will finally be given out to the public will be effective on 300 grams of rice in the diet per day.

AO: In many parts of the world, people who eat rice value its whiteness. It has a special meaning to them. Will they eat rice that is not very white? Hasn’t this been a barrier to previous efforts in adding supplements to rice?

Potrykus: This is a problem in some parts of the world, although probably not in India. People will have the freedom to decide whether they want healthy children or white rice. We are, however, working on a solution for the color problem, and we believe that we know how to solve it.

AO: Critics insist that \$100 million was spent researching golden rice, but others claim that this figure was total Rockefeller Foundation spending on rice research over 10 years to hundreds of scientists. Can you clarify this?

Potrykus: The total cost for golden rice development was \$2.6 million, spent over 10 years in the lab of Peter Beyer and myself. These funds were from the Rockefeller Foundation, the Swiss Federation, the National Science Foundation, and the European Union. The investment was approximately one-fourth of 1% of the money spent on traditional interventions. Compared to the \$100 million plus Greenpeace spends per year, this was a very small investment.

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