Ambika Jayakumar

Genetically Engineered Crops and Malnutrition

According to the World Health Organization, malnutrition accounts for a staggering 45% of all deaths in children under the age of five (WHO). Malnutrition refers to any disorder brought on by improper diet. In developing countries, an improper diet is usually the result of a scarcity of food or a lack of certain nutrients. Scientists, policy-makers and other experts have already agreed that malnutrition must be swiftly addressed; in 2000 the United Nations drafted the Millennium Development Goals, one of which is to “halve, between 1990 and 2015, the proportion of people who suffer from hunger” (WHO). Though the UN has cited some success in meeting this goal (WHO), hunger is still one of the most urgent issues that the world must face. Studies show that the projected yields of major crops simply will not sustain the growing world population: “By 2050, global agricultural production may need to be increased by 60%–110% to meet…increasing demands [for crop production] as well as to provide food security to the ~870 million now chronically undernourished” (Ray et al.). Genetically modified crops have the potential to considerably lessen the effects of malnutrition in developing countries, as progress in the technology has already shown, but the successful implementation of genetic engineering to combat malnutrition will ultimately require major revisions and additions to the current policies regulating the agricultural industry.

The biological makeup of major crops directly influences incidences of malnutrition in developing countries, a correlation that emerges from the pattern of nutritional deficiencies prevalent in developing countries. Two such cases are iron deficiency anemia and zinc deficiency. Both occur most commonly in Africa, the Middle East, Central, South and South-East Asia, and parts of Latin America (Dipti et al.). Poor people in these regions generally subsist on starchy staple crops like rice or cassava, which are low in zinc and iron content, and as most are unable to supplement their diets with other foods rich in nutrients, they are highly susceptible to zinc and iron deficiencies (Dipti et al.). Vitamin A deficiency arises in a similar manner, affecting poor populations in developing countries whose diets consist mainly of one or more of these staple crops (Dipti et al.). These crops are effective in fulfilling purely caloric requirements, but they fail to provide necessary nutritional value. Populations in developing regions are therefore vulnerable to malnutrition because of the lack of nutrients in the crops that comprise their diets.

Genetic modification offers the possibility of altering the nutritional value of any given crop with more precision than has been previously available to scientists. Where traditional breeding methods can modify traits that may be distributed over the entire genome of an organism, genetic engineering can manipulate traits that may be found in just a single or a few genes (Chivian and Bernstein 385). This targeted method of modifying an organism's genetic makeup is often achieved through transgenesis, the process of inserting an external gene into a host organism so that the organism exhibits the properties of this new gene (Chivian and Bernstein 386). Transgenic modification becomes very useful when dealing with crops that are less responsive to traditional cross-breeding methods, like banana and cassava, both of which are major calorie sources for those most susceptible to malnutrition in developing countries (Zhao and Shewry S96). Genetic modification also has the potential to respond directly to modern agriculture's foremost problem by artificially increasing the yield of high-demand crops. In their book *Sustaining Life*, Chivian and Bernstein note that "GM crops are expected to provide greater yields, because they are designed to do so and because of their engineered ability to withstand attack by pests and to grow well under less than ideal conditions" (388). These adaptive features of instilled through genetic modification offer advantages over traditional breeding methods, bringing new possibilities to the agricultural world that might translate to progress against malnutrition.

Yet, modifying crops with tailored adaptive features means very little if large populations continue to lack access to such foods. Combating malnutrition becomes more feasible when agriculturalists can actually add nutrients and minerals like zinc, iron and Vitamin A in appropriate amounts to the major crops already consumed by those most affected by malnutrition. In fact, scientists have already effectively created crops that are artificially "biofortified," or genetically enhanced with specific nutrients. An often-cited example of a successfully biofortified crop is Golden Rice, a variety of rice enhanced with β-carotene, or provitamin A ("Golden Rice Project"). Providing Vitamin A to children whose diets would otherwise lack sufficient levels of the nutrient is a significant triumph, given that "Vitamin A Deficiency (VAD) is a public health problem among preschool-aged children in 118 developing countries around the globe [and] the prevalence of VAD among school-aged children (5-15y) in Latin American, South and Southeast Asian countries varies from 6% in Sri Lanka to 36% in El Salvador" (Dipti et al.). This fairly widespread form of malnutrition can ultimately cause complete blindness. With such serious consequences at stake, genetically modifying a staple crop like rice to include a nutrient that it would otherwise lack is a highly effective and much-needed response to malnutrition. Only a continued survey of the growth and consumption of Golden Rice will tell definitively whether this GMO truly is a success. Nonetheless, as the product's website reports, "the β-carotene in Golden Rice is as effective as pure β-carotene in oil and better than that in spinach at providing vitamin A to children" ("Golden Rice Project"). Already, evidence suggests that Golden Rice can significantly diminish the occurrence of Vitamin A deficiency, a promising beginning that points towards the power of GMOs.

Genetic engineering has the ability to visibly prevent cases of malnutrition, but a comprehensive international policy on genetic engineering must accompany its widespread implementation if it can be a solution to malnutrition. This policy should address the idea that genetic modification is not the final solution to any of the agricultural or nutritional issues facing the world. The greatest difficulty with the technology of genetic modification is the uncertainty of its peripheral effects. The alteration of even a single gene of an organism, whether artificial or natural, can have unintended effects on the organism's entire genome (Chivian and Bernstein 386). Thus, GMOs may be able to fight malnutrition, but they may also have detrimental effects on the environment, or unforeseen health consequences, to name just two of the possibilities. The risk of creating an invasive species from a GM crop is of particular worry to environmentalists. For health safety advocates, the potential transfer of antibiotic resistant genes from these mutated crops to humans and livestock is equally distressing (Chivian and Bernstein 385-386). For this reason, policies must be enforced to avoid any such negative consequences. The agricultural industry must strictly regulate and chronicle the growth of GM crops. Genetic engineering can still be a solution to malnutrition, but governments and entities like the United Nations should ensure that this solution does not come at a higher cost.

Genetic modification has a stigma about it that may hinder the success of its widespread use – if indeed it is a viable solution to malnutrition; this is an issue that international government entities must also confront. The negative stigma is a result of a few poignant decisions made by some of the leading GM companies and the obscurity surrounding those companies and their decisions. Monsanto, one of the giants in the industry, is a company that also manufactures herbicides. When the technology of genetic modification presented executives at Monsanto with the possibility of creating crops that could lessen the need for fertilizer use, these executives feared the economic backlash to their fertilizer business. As Arthur Caplan suggests in his essay “Strands of Promise in Genetically Modified Food”, they chose instead to create the Roundup Ready brand of seeds, which allowed both aspects of their industry to continue to profit heavily. “Monsanto's Roundup Ready soybeans, introduced throughout the world in the mid-to-late 1990s, made crops more resistant to herbicides sold by Monsanto. The companies making lots of money from the pesticide and fertilizer revolution that swept through agriculture in the 1950s and 1960s were not ready to gamble on losing that business if GMO technology was used to make plants and agriculture greener, cheaper, safer, and more capable of providing nutritious food without their chemicals.” The lack of transparency between the large GM companies and their consumers only adds to the ambiguity surrounding such business decisions and gives the public more cause to distrust the industry and the technology itself.

The agricultural industry is also under surprisingly lenient regulations when it comes to directly telling consumers what is in their food, which heightens the obscurity surrounding GMOs. Food producers often do not label whether or not a given product contains genetically engineered ingredients because the government does not require them to do so (Caplan). The food industry keeps consumers in the dark about exactly what GMOs are in their food, which only gives consumers a reason not to trust the technology. An analysis of European consumers’ opinions on biotechnology found that “66% of the European citizens interviewed said that they would not buy GM fruit if it tasted better, 53% would be ready to pay more for non-GM food and 66% would not be willing to eat the eggs of hens fed on GM maize” (Tsioumani). The GM industry’s poor reputation is far reaching, and consumers are weary of genetic engineering, even when they are not directly eating GM products. The tainted relationship between consumers and the GM industry has already caused great disruption: in August of this year, the BBC reported that rioters attacked Golden Rice fields in the Philippines because they did not accept GM technology as a solution to malnutrition in that country (McGrath). The public's distrust of genetic engineering will continue to be an obstacle for the implementation of the technology as a response to malnutrition. Governments must work to restore a more realistic consumer view of GM foods by requiring the food industry to be completely transparent about labeling GM products and by creating more awareness in general about the operations of the GM industry. If governments can achieve this, there is a considerable chance that consumers will see the benefits of the technology in addition to its disadvantages, and this will most likely pave the way for the successful use of genetic engineering to combat malnutrition.

Transparency alone will not be enough; the GM industry needs to address, as far as possible, any foreseeable negative consequences of genetic engineering. Therefore, the policies that will regulate the GM industry should also demand the environmental sustainability of agricultural practices. In some aspects, the government already regulates the implementation of GM crops: "Typically, each transgenic event (i.e. independent insertion of a transgene into a crop genome) that is to be commercialized in the United States has to be "deregulated" or approved by a number of government agencies, which, depending upon the specific trait and species, may include the U.S. Department of Agriculture, the U.S. Food and Drug Administration, and the U.S. Environmental Protection Agency. Similar approvals are required from regulatory authorities in other countries" (Century et al.). However, in order to ensure the environmental sustainability of GM technology, genetically engineered crops should be supplemented with sustainable agricultural practices. For instance, governments could mandate that for every hectare of GM crops planted, 0.25 hectares of organic crops must also be planted (Chivian and Bernstein 386). Policies could also encourage or require the use of crop rotation, a method in which varying crops are grown in the same soil in different seasons (Ausubel 113). The practice is known to increase the essential nutrients found in the soil, which would eventually diminish the need for artificial fertilizers that are known to cause environmental damage. Requiring such practices of GM companies would not only promote more sustainable behavior in the agricultural industry as a whole, but it might also help to reverse consumers' distrustful attitude towards genetic engineering. Both organic cultivation and crop rotation are possibilities in supplementing the use of GMOs.

Each of these scenarios presents challenges to policy makers, governments, and scientists. But these challenges should not diminish the great potential for genetically modified crops to combat malnutrition. Malnutrition afflicts too many people in developing countries to ignore the enormous impact on the prevalence of this disease that the successful use of GMOs could have. Beyond ensuring that the public has a full knowledge of the use of genetic modification, the GM industry's greatest task in using GMOs in any capacity is addressing its possible consequences. There is no way of knowing how the use of genetically engineered crops will affect the environment or human health, but if the government is proactive in regulating the technology, GMOs could quite possibly change the world for the better – combating malnutrition may just be the beginning.

Works Cited

Ausubel, Ken. *Seeds of Change: The Living Treasure: The Passionate Story of the Growing Movement to Restore Biodiversity and Revolutionize the Way We Think About Food*. San Francisco: HarperSanFrancisco, 1994. Print. This book is centered around the biology behind some of the modern failures of agriculture, and a possible solution to those failures: seeds. Although the book does not really address genetic engineering, it does talk about other methods (not necessarily involving new technologies) that can help combat the world's food issues. This will be useful as a counterpoint or addition to my argument about technology and food.

Berman, Judit, Changfu Zhu, Eduard Perez-Massot, Gemma Arjo, Uxue Zorrilla-Lopez, Gemma Masip, Raviraj Banakar, Georgina Sanahuja, Gemma Farre, Bruna Miralpeix, Chao Bai, Evangelia Vamvaka, Maite Sabalza, Richard M. Twyman, Ludovic Bassie, Teresa Capell, and Paul Christou. "Can the World Afford to Ignore Biotechnology Solutions That Address Food Insecurity?" *Plant Molecular Biology* 83.1-2 (2013): 5-19. *Academic OneFile*. Web. 24 Oct. 2013. This article is a fairly in-depth analysis of how genetically engineered crops may combat what is known as food insecurity. I will most likely take certain statistics and facts directly from the article, and also use it as a foundation for arguments more specific to my chosen topic.

Caplan, Arthur L. "Strands of Promise in Genetically Modified Food." *The Chronicle of Higher Education* 60.02 (2013): n. pag. *Academic OneFile*. Web. 24 Oct. 2013. This article offers a probable explanation of why genetically modified foods are often negatively viewed and how this has prevented the technology's success. The article also presents a brief look at the misuse and disadvantages of genetically modified foods, which will be a good basis for more possible research.

Century, Karen, T. Lynne Reuber, and Oliver J. Ratcliffe. “Regulating the Regulators: The Future Prospects for Transcription-Factor-Based Agricultural Biotechnology Products.” *Plant Physiology* 147.1 (2008): n. pag. Web. 6 Nov. 2013.

Chivian, Eric, and Aaron Bernstein. "Chapter 9: Genetically Modified Foods and Organic Farming." *Sustaining Life: How Human Health Depends on Biodiversity*. Oxford: Oxford UP, 2008. 383-405. Print.

Dipti, Sharifa Sultana, Christine Bergman, Siti Dewi Indrasari, Theja Herath, Robert Hall, Hueihong Lee, Fatemeh Habibi, Priscila Zaczuk Bassinello, Eduardo Graterol, Julie P. Ferraz, and Melissa Fitzgerald. “The potential of rice to offer solutions for malnutrition and chronic diseases.” *Rice* 5.16 (2012): n. pag. Web. 30 Oct. 2013.

"Golden Rice Project." *The Golden Rice Project*. N.p., n.d. Web. 6 Nov. 2013.

McGrath, Matt. “‘Golden rice’ GM trial vandalised in the Philippines.” *BBC News* 9 Aug. 2013: n. pag. Web. 6 Nov. 2013.

Ray, Deepak K., Nathaniel D. Mueller, Paul C. West, and Jonathon A. Foley. “Yield Trends Are Insufficient to Double Global Crop Production by 2050.” *PLoS ONE* 8.6 (2013): n. pag. Web. 6 Nov. 2013.

Thomson, Jennifer A. *Genes for Africa: Genetically Modified Crops in the Developing World*. Lansdowne: UCT, 2002. Print. I hope this book will be especially relevant to my argument, because it not only gives a good background about genetically modified crops, but it also directly relates the use of this technology to its possible benefits in agriculture and food production (specifically in Africa).

Tsioumani, Elsa. “Genetically Modified Organism in the EU: Public Attitudes and Regulatory Developments.” *RECIEL* 13.3 (2004): 279 – 288. Web. 6 Nov. 2013.

World Health Organization. "Millennium Development Goals (MDGs)." *WHO*. WHO, Oct. 2013. Web. 5 Nov. 2013.

Zhao, Fang-Jie and Peter R. Shewry. “Recent developments in modifying crops and agronomic practice to improve human health.” *Food Policy* 36.1 (2011): S94-S101. Web. 8 Nov. 2013.