

Biotechnology: applications and arguments for and against

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The use of genetically modified organisms (GMOs) in agriculture is rising, but not without debate. There are many scientists who argue that genetic engineering in agriculture is the best way to solve many issues of poverty, food security, environmental harm, and the need for increasing competitiveness in sales, but others raise ethical issues regarding the health of the people who consume the genetically modified products, the possible harm to the environment, the depredation of the welfare of the farmers and their food security, and the general introduction of engineering into mainstream use in society.

1. 2 Definition of Genetically Modified Organisms

Genetically Modified Organisms, commonly called GMOs, refer to organisms whose genetic material has been altered using recombinant DNA technology, a method used to recombine the DNA of different organisms.

1. 3 Sequence of Discussion

I begin the paper with an introduction to the issues of using biotechnology and generating GMOs in agriculture. I continue with arguments both for and against the use of biotechnology in agriculture. I conclude the paper with information about the current debate on this issue and resources to obtain more information.

2. 0 Prelude to the Issues

The use of genetically modified organisms to enhance the production, yield, and quality of agriculture is under much discussion. Biotechnology companies are actively investigating the research and development of new technologies to improve food security and augment production of goods in

both the developed and developing worlds, while activist groups work to ensure that biotechnology is not used in food production at all for fears of damage to the environment and human health, among other issues. On the other hand, according to Dr. Miguel Altieri, a leading spokesperson in the field, the view that GMOs can enhance food security in the developing world “ rests on two assumptions: that hunger is due to a gap between food production and human population density or growth rate and that genetic engineering is the best or only way to increase agricultural production and so meet future food needs”.¹ While it is clear that there are benefits to using biotechnology to improve crop production, there are also many fundamental and ethical arguments against its use, as is illustrated shortly.

3. 0 The Argument for Biotechnology

3. 1 Applications of Biotechnology to the Goal of Poverty Reduction

Several objectives of using biotechnology in agriculture are associated with the reduction of poverty. Introducing GMOs into agriculture is predicted to increase rural incomes, sustain production in resource-poor areas, and provide more nutritious foods. Supporters of the use of biotechnology in food production believe that developed nations with technology have a social and political obligation to assist these poorer nations.

In India, Vietnam, and Kenya, diseased vegetable crops and trees can benefit from genetically produced bio-pesticides. The cardamom crops in India, potato crops in Vietnam, and banana crops in Kenya are often farmers’ sole source of income, such that diseased crops can have an extremely damaging affect on the farmers’ lives. Problems with a lack of clean and pure seeds

and planting material can be solved by using bio-pesticides, which allow for leniency in the purity of the seeds and planting material. In this way, GMOs can potentially provide a means for high-resistance and high-yielding crops.

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Biotechnology can also contribute to sustaining the production of foods, commonly cereals and maize, in resource-poor areas. Drought, pests, and acidic soil often cause detrimental problems to farming, but insect resistance and aluminum tolerance can circumvent these environmental barriers. The ability to provide a full farming season through using GMOs to assist in the production of larger quantities of food for these farmers helps to ensure a profitable growing and harvesting season. 2

Finally, GMOs can contribute to generating more nutritious foods with higher nutrient content-this technology most commonly being applied to rice. The people in countries such as India and China rely heavily on rice in their diets, but rice alone does not provide the necessary nutrients for a balanced diet.

3. 2 Applications of Biotechnology to the Goal of Financial Security for Farmers

Farmers can make great use of transgenic techniques in their agriculture with the goals of both ensuring food security and increasing the competitiveness of their crops. Biotech companies and supporters of the use of GMOs believe that there exists a political obligation to assist in the security and well-being of farmers who supply goods to more developed countries.

Food Security

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The biotechnology objectives in agriculture that are associated with issues of food security include meeting the demand predictions for staple foods, increasing livestock numbers, and increasing vegetable and fruit yields. Two major constraints that farmers encounter with regard to meeting the demand predictions for staple foods, which must be grown in large quantities, include the presence of pests and the consequential infectious diseases, and problems associated with biotic stress. Pests and disease are often a problem in rice crops in China, and the addition of genetically modified rice varieties with pesticides can assist in the prevention of diseases in these crops. In addition, GMOs are valuable for avoiding abiotic stresses, such as salinity and drought. In India, China, and Thailand, hydration and salinity tolerance in cereals, considered to be staple foods, assist in the security of high yields of these food crops to meet the demand.

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In India, biotechnology can help to avoid the major problem associated with the keeping of livestock, i. e., the probability of diseased animals, including cattle, pigs, and sheep. In addition, embryo technology can sidestep issues of productivity in dairy cattle. Both of these uses for GMOs lead to an increase in both livestock number and productivity. 2

Biotechnology is also useful for securing a stable food supply by increasing vegetable and fruit production. Pests and diseases infect these crops, often completely depleting their production. Examples of crops are tomato and potato crops in Vietnam, as well as papaya crops, which can become infected with the ringspot virus. 2

3. 2. 2 Increasing Competitiveness

The use of biotechnology in agriculture can also assist farmers' competitiveness on the global market, specifically by sustaining productivity exports, regulating food safety and quality control, and adding value to exports.

Biotechnology is useful in sustaining exports by increasing the yield of crops, such as coconut crops in the Philippines, banana crops in countries such as India, China, and Vietnam, and potatoes, rice, maize, wheat, cassava, and beans in other developing countries. 2

In addition, GMOs can contribute to food safety and quality control with respect to food exports by controlling pesticide residues and ensuring the competitive quality of exports. 2 Improved quality can include characteristics such as texture, taste, appearance, and nutritional value, and the ability to delay the ripening of fruits and vegetables can greatly approve the longevity of some produce. “ Specific improvements for producers are an increased flexibility during production, harvesting, storage, distribution, and transport stages, leading to a reduction of overall production costs” and a greater guarantee of quality product at the time of selling. 3

3. 3 Applications of Biotechnology to the Goal of Environmental Protection

The introduction of technology into the environment can be hazardous and brings up ethical issues associated with protecting the environment through the use of technology (also see section 4. 2). However, many supporters of GMOs claim that biotechnology in agriculture can enhance protection of the

environment, specifically by reducing pesticide use and enabling the efficient use of water.

Pesticide misuse on cotton and rice crops in China and on vegetables in Malaysia is a common problem when farmers are misinformed of use of pesticides, or when pesticides are overused in attempt to deter crop failure due to pests. Transgenic crops can potentially reduce the need for and usage of pesticides by assisting pest extermination and preventing weed growth. GMOs such as *Bacillus thuringiensis* (Bt), a natural soil bacterium, can be used to kill insects by allowing the plants to produce their own toxin against pests, sidestepping the problem of farmers who are mis- and overusing pesticides. In addition, herbicide tolerant crops ideally require fewer herbicide applications, because the crop is genetically “programmed” to more efficiently utilize the particular chemical product. 4 Finally, transgenic herbicides can be applied to pre-treat the land, so that weeds are altogether prevented, and farmers can weight the options and costs of using more chemicals versus dealing with weed growth during harvest. 3

4. 0 The Argument Against Biotechnology

4. 1 Uncertainty of the Safety of Humans After Consumption

Although there is a lot of anticipation and excitement about the beneficial effects that can potentially result from the use of biotechnology in agriculture, there is also a lot that is unknown about the uses of transgenics and their impending consequences. Specifically, examples of these issues include the lack of available public information and knowledge about the content and effects of GM foods, the possible inactivation of many nutrients

present in naturally-grown foods, and the introduction of allergens through the use of GMOs. These are all social, ethical, and legal issues based on the morality of tampering with foods in a way that will have an unknown effect on human health.

As just stated, one major issue regarding the allowance of the free use of GMOs in agriculture is associated with the unknown potential health effects of consuming chemically treated foods. Consumers assume that the foods they buy are safe, even though many contain compounds that are potentially toxic or allergenic. The general public has a large misunderstanding about genetically modified (GM) foods because companies do not boldly advertise their use of transgenic components in their products. For this reason, people often consume GM foods without even knowing it.

In addition, while many biotechnology companies advertise the use of transgenics in agriculture as beneficial to human health by improving the nutritional content of food, genetic engineering also has the potential to remove or deactivate many nutritional substances present in naturally-grown foods: “ Recent research shows that GE [(genetically engineered)] herbicide resistant soybean have lower levels (12-14 percent) of isoflavones, [which are] key phytoestrogens . . . that occur naturally in soybeans and may protect women from severe forms of cancer.” ¹ These genetic modifications boost the activity of a gene that makes critical amino acids, but the resulting shift in amino acid levels shifts the metabolism of the plant to alter the levels of the aforementioned phytoestrogens. This effect is clearly seen in GM

soybeans, even when the chemical residue data is within the Environmental Protection Agency (EPA) tolerance limits. 4

Finally, the use of GMOs in agriculture brings to question the compromise of human safety because of wide

Finally, the use of GMOs in agriculture brings to question the compromise of human safety because of wide reports of increased allergenicity after consumption of GM foods. For example, a protein was expressed in a crop used for animal feed in order to increase the content of the amino acid methionine. This “ protein was subsequently shown to be an allergen, as are a number of related [proteins of this type] from other species.” 5 Another example of the use of biotechnology introducing an allergen into a food product is the use of a Bt protein in GM maize, which also shows the general features of allergenic proteins. 6 These are simply two examples of how the application of biotechnology can introduce allergens into crops. Since research is still just beginning on many GMOs, the allergenic effects of the use of biotechnology in agriculture remains unclear and under investigation.

Antibiotic resistance is the ability of a bacterium or microorganism to withstand the use of an antibiotic because of its ability to synthesize a protein that neutralizes the antibiotic. 7 While it is thought that the use of genetically engineered pesticides and herbicides on crops might only have the effect of reducing pests and weeds, it can actually have an opposing effect as well. The generation of “ superbugs” and “ superweeds,” pests and weeds resistant to the GM pesticides and herbicides, respectively, can result. Not only can the crops that are sprayed acquire these characteristics, but

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hybrid crops can arise when crops cross. This can cause resistance in crops that were not previously sprayed with GMOs, and can also cause multi-tolerant crops when two crops that are sprayed with different chemicals cross. The result of this second cross is a crop that is resistant to multiple herbicides (i. e., superweeds) or pesticides (i. e., superbugs), which are even more difficult to control. In addition, this resistance can give these weeds and bugs a selective advantage over the naturally-tolerant weeds and bugs, allowing them to propagate efficiently. 5

5. 0 Conclusions

While there are many points both in favor and against the use of GMOs in agriculture, some people believe that the question simply comes down to whether or not it is ethical to engineer in agriculture, which has always been managed by farmers themselves in conjunction with local biological cycles and ecological balances. Activists against the use of technology worry about future generations, and how the use of biotechnology in agriculture now will affect food production in years to come. They raise concerns that regulations are too loose and poorly enforced, and the eventual effects of the use of GMOs remain unknown. In addition, important issues revolve around whether or not it is ethical for well-fed people of developed nations to regulate access to agricultural technology in developing nations. According to Dr. Altieri, “because the true root cause of hunger is inequality, any method of boosting food production that deepens inequality will fail to reduce hunger.

Conversely, only technologies that have positive effects on the distribution of wealth, income, and assets, that are pro-poor, can truly reduce hunger.” 1

Therefore, questions regarding the use of biotechnology in agriculture should better address the needs of poorer nations.

Many people are still under-informed about potential benefits and negative effects of using GMOs in agriculture, and are therefore not ready to form an opinion on the issue. For this reason, there are many forums on the internet and published books to help interested people learn more. In addition, several documentaries present these issues, an example being *The Future of Food*, a documentary by Deborah Koons. 9

The issues regarding the use of biotechnology in agriculture are important and affect everyone, and should not be overlooked. People in favor of the use of biotechnology in agriculture argue that it is unethical not to help poorer nations when more developed nations have the technology to do so. On the other hand, activists against the use of GMOs in agriculture maintain that more harm than good comes from the introduction of GMs into food production.