

Zakia Nasrin
Metro Early College High School
Columbus, Ohio

Biotechnology, the Solution to the Food Crisis in India

Every country has experienced food insecurity, especially over the last few decades. India, being a third world nation with a fast growing economy and population, has been hit the hardest. The current food crisis in India dates back to the times of Imperialism and Colonization by the British. After the establishment of the British government in India, there were “entitlement” (Confronting Agrarian Crisis: Historical Food Insecurity, the Indian State, and the Green Revolution) issues and the taxes prevented farmers from making profit. At the time, quantity of food was not the issue, but rather who had rights to the food. Due to the complications of food entitlements, the West Bengal famine occurred, which consumed the lives of 15 million people.

Once British Imperialism had ended, it was up to the new Indian government to create a networking system to distribute food for impeding the famines that were taking place. Landowners used tactics such as land distribution but these solutions were unsuccessful due to political problems. As a result, food production decreased. By the 1960’s and 1970’s the “Green Revolution” was introduced with hopes of increasing yield. Dr. Norman Borloug, the father of the Green Revolution, discovered ways to increase wheat yield without increasing the required amount of land. The Green Revolution included: types of seeds that yielded more produce, pesticide, more efficient irrigation systems, and improved marketing methods. This was superior to the previous solutions since it helped everyone: farmers could harvest more yields with less cost and more workers were needed to harvest and maintain the farms. However, these new wheat plants were not drought resistant or pest resistant. A new plan was devised to increase yield by the use of technology that included rural workers in the production. The government helped the farmers gain more profit and introduced technologies such as a power grid for irrigation. These efforts provided impressive results: wheat production increased by 4.6 million tons in 2-6 years and rice production by 10 million tons in 4-5 years. India no longer imported produce but exported it. More environmental friendly fertilizer and pesticide were introduced for workers to prevent exposure to toxins. There were numerous other problems that still had not been fixed such as malnutrition and wide distribution of the food: the government was more interested in the marketing aspect of the Green Revolution. India was able to increase the yield but it had not found a way to be more sustainable. The goal in the future is to create a system that utilizes the technology so it is available to everyone and is sustainable in terms of the environment, economy, and health of the country.

Before proposing solutions to the problems, it is necessary to examine the geography, government, economy, and the typical lifestyle of the country. The country of India is variable in its geography as there are the Himalayas in the North, deserts in the West, rolling plains by the Ganges River, and the Deccan Plain at the South. India is fortunate compared to other countries in that there are 558, 080 square kilometers of irrigable land. In fact, half of the total irrigable land in the world is in India, China, and Pakistan (CIA World Fact Book).

The government of India is a federal republic that contrasts with the American government. Under the federal government, there are states and territories that are governed by the constitution. There is separation of powers among the three branches: legislative, executive, and judicial. The Electoral College elects a president. The legislative branch consists of a five hundred forty-five Parliament that is elected by the people and appointed by the President. The judicial branch includes a supreme court with twenty-five justices and one chief justice: all appointed by the President.

India's economy is growing 8.5% each year due to the manufacturing and services industries (BBC). The agricultural industry has grown by 2.5%, which is the main reason of the current food crisis (BBC). A system that includes the educating of farmers of the newest technology and necessary funding does not exist to enhance the development of the agricultural industry. In the past, there have not been many private investors in the industry. Each year from the 1950's there has been a 4-6% shortage on food (Sustainable food production, income generation and consumer protection in India). The agricultural sector of the economy is also facing problems due to the rising cost of food. The poor farmers who make up the sector cannot make enough profits since the consumers who are just as poor cannot afford to pay more. Another problem is that the government pays twice as much for imported foods than for those grown by Indian farmers.

A typical family lives on \$1 per day (BBC). In some parts of India such as West Bengal, not all of the technologies from the Green Revolution are being used. In a study conducted by Arindam Samaddar and Prabir Kumar Das, two typical villages in West Bengal were compared: one that experienced drought and another wet seasons in light of the Green Revolution. In the village called Padulara, ponds and wells built by the government were used for irrigation. Before the Green Revolution, there were three seasons of harvest: one for summer, winter, and autumn based on the Bengali calendar. Rituals were completed to appease the gods and yield more produce. These rituals were completed before land preparations, before and after seeding, and before and after harvest. Other than rituals related to agriculture, there were various ones completed throughout the year. Once the technologies of the Green Revolution were available, the village planted the high yielding variety rice and implemented the usage of pesticide. Due to lack of expertise in the technology of the Green Revolution, the village of Padulara was unable to combine all aspects for the most efficient agricultural system. The second village called Naigachi had access to water throughout the year and information regarding how to better implement the technologies of the Green Revolution.

Biotechnology may produce a more efficient method of agriculture even though most of the technology is still under way. It has shown much providence with rice. Since it is a critical part of the diet in Asia, biotechnology has been used to incorporate key nutrients such as vitamin A and protein. Iron has been incorporated to help women who have iron deficiency (Rice Biotechnology). Rice has also been engineered to become drought resistant, pest resistant, and to require fewer resources. (Potential and Limitations of Biotechnology). Herbicide resistance has been tested in plots in America and China. After experimentation, rice can be engineered to become resistant to stemborer, viruses, bacteria, and other diseases. Technology is underway to produce rice that can survive under water and rice can already be tolerant to drought and salinity. Some of the strains of Golden Rice are still being tested to ensure that the genes are stable and that there are no unforeseen side effects.

Countries like the United States have implemented the approved technology into the agricultural systems as 60% of all processed foods contain genetically modified ingredients. (The Debate Over Genetically Modified Foods). Ninety-four percent of all land used for biotechnology is in North and South America and all of the technology is first developed in North America and spread to the other parts of the world. (The GMO Experience in North and South America- Where to from Here). Farmers have readily used the varieties of corn and soybean that are genetically modified. These implementations have lessened the amount of pesticide usage, tilling of soil, and other costs saving an average of \$40 per hectare in the United States in 2002. Consumers also saved \$652 million due to lower costs of the products.

There are still doubts about the consequences of implementing biotechnology into agriculture among scientists and consumers. One of the main concerns is the idea that humans are interfering with processes of nature: that is humans are "interfering with evolution." However, humans have been using the forces of natural selection for centuries. In prehistoric times, farmers have been saving seeds of crops

that are more successful so that there are more yields. Even so, biotechnology is changing the DNA structure of the crop, which is different from human selection. Biotechnology crossbreeds different species of plants creating unseen modifications that could be dangerous. There is a probability of humans becoming sick after decades of consuming the food. Other concerns are environmental side-effects. When the genetically modified crop is released, organisms may be harmed after they interact or there may be difficulty in killing the crops if needed.

Precautions are necessary to address the concerns about side-effects of the biotechnology. Only after extensive research and analysis of the effects of the crops after release into the environment, should the produce be allowed for commercial usage. Even though the cost of the initial seeds would be expensive, the management costs would make it affordable. Consumers could pay tax for genetically modified crops as insurance. If any problems arise, there would be sufficient funds for developing solutions.

India utilized some of the available biotechnology; the field of biotechnology has been expanding. Currently, 15% of the biotechnologies used in India are used for agriculture and it has been predicted that it will double by 2010 (Biotech in India). Since India is the second largest food producer in the world, there is a demand for efficient methods of agriculture. Scientists are able to utilize the biodiversity for advancement of research. Occupying only 2.4% of the world's land, it has the highest biodiversity (Biotech in India). Despite popular belief about the failure of modified cotton in India, many farmers have seen the benefits. Some have increased cotton yield by 30% after using the modified crops (Yields and Incomes with GM Crops). Golden rice has the potential to help the 500 thousand children who have vitamin A deficiency since it yields 20 times more vitamin A than the cultivated rice (Golden Rice Fully Licensed to India). One seed of the golden rice can eventually yield 20,000 tons of rice that is enough to feed 100 thousand people in two years (Experience from the Humanitarian Golden Rice Project).

The government of India has created organizations to advance the field of biotechnology. The creation of the Department of Biotechnology has helped lay out the foundations of regulations for research and development of the technology. At the state level, the government of Tamil Nadu has dedicated land for biotechnology. The government of Andhra Pradesh created policies to help biotech companies flourish. The state of Maharashtra has dedicated thousands of institutions for research and contains the most prominent work. Karnataka plans to have the first capital fund for biotechnology. This will help with necessary subsidies that the field will require.

Monsanto, a biotech company originated in the United States, has worked in India to become a successful company. The goal of the company is to continuously develop seeds that produce more yields with little resources. They have had success with modifying crops such as corn, wheat, oilseeds, and cotton. The company has helped reduce the usage of pesticide by 15% that not only is environmentally friendly but also saved billions of dollars. Argentina has had a profit of \$20 billion dollars by using the modified crops (Documented Benefits of Biotechnology).

The remnants from the Green Revolution may be used to introduce the idea of biotechnology to the villages and farmers in India. For example, there were significant modifications to the agricultural management system in the two villages in West Bengal. The villagers had to correctly time the planting and harvesting, manage weeds, and implement irrigation systems. Other changes impacted the economy and culture of the village. The usage of the crops was modified as the villagers started to produce more for profit rather than just the required needs. Cultural rituals were still practiced for assistance from the gods but the caste system started to disappear. Women also had a more significant role in the families and helped in decision-making.

One of the reasons of the incomplete success of the Green Revolution was due to the separate sectors; the agricultural sector did not cooperate with the other sectors. In a country where there is harmony between the different sectors, then there is more sustainability. Because the industrial sector is expanding so quickly, it would be best to use the resources from that sector to help with agriculture. Companies will be needed to produce more efficient methods of farming such as irrigation systems. This would also provide jobs for the thousands of graduates, 10,000 being women (Goldman Sachs Announces India's First Graduates of 10,000 Women). Workers will be needed to communicate with branches of biotech companies in other countries and teach farmers, in underserved communities, about the available technology.

The government of India can cooperate with the government of countries like the United States to implement biotechnology to create a sustainable system. Both governments are willing to use the available technology to solve the food crisis. If policies in the United States continue to allow companies like Monsanto to research and develop new seeds, then it can be shared with India. However, the technology would have to be perfected and made cost effective first. Once it is cost effective, farmers in India would be able to afford the seeds. The price of food would decrease as maintenance cost decreases; there would be more buyers in India. The engineered seeds would also contain the nutrition that the high yield variety did not.

As the population of the world continues to increase, there is no change in amount of available land. India alone has more than a billion people and continues to add more people than any other country. (International Briefs: Population Trends in India). It is crucial to develop sustainable methods of agriculture. Such a method would incorporate all aspects of a country: the economy, the environment, and health of the people. The economy would benefit, as farmers would be able to afford lower prices, lowering the cost of food. The environment would benefit with decreasing the usage of pesticide and increasing yield of produce per acre; the land would be used efficiently. People would benefit as they receive their daily needed nutrients. Farmers would also be educated about efficient techniques and the available technology. India has shown promising growth in the field of biotechnology and science. They implemented the technology of the Green Revolution and received decent results. Because genetic engineering was not perfected at the time, it only provided solution for one problem: limited resources. However, today scientists have produced seeds that not only intake little resources but also provide the necessary nutrition. It is the duty of countries like the United States to help India and other developing nations. In the globalized world, if the poor and the rich, the suburbs and cities, the educated and uneducated, developed and undeveloped do not cooperate then, the problem will not be solved. India does not have all the resources needed to develop a completely sustainable system, but with the help of countries like the United States, such a task would be possible. In the process, the whole world would reap the benefits since other countries would also develop the same system. There is no more time to hesitate and debate whether biotechnology is the best solution; this is the time to act before the available land and resources become diminished.

Bibliography

"5 steps to boost Indian agriculture." *Breaking news, Latest India news, World news, Indian stock market news, Business News, Cricket score, Sports news, Bollywood news, Bollywood videos : Rediff.com*. 19 Sept. 2009. <<http://www.rediff.com/money/2004/may/03spec.htm>>. Adlakha, Arjun. "International Brief Population Trends: India." (1997).

"Asian Development Outlook 2006 - India - ADB.org." Asian Development Bank (ADB) - Fighting Poverty in Asia and the Pacific - ADB.org. 02 Sept. 2009. <<http://www.adb.org/Documents/books/ADO/2006/ind.asp>>.

"BBC NEWS | South Asia | Is India facing a food crisis?" BBC NEWS | News Front Page. 02 Sept. 2009. <http://news.bbc.co.uk/2/hi/south_asia/7327858.stm>.

"CIA - The World Factbook -- India." *Welcome to the CIA Web Site — Central Intelligence Agency*. 19 Sept. 2009. <<https://www.cia.gov/library/publications/the-world-factbook/geos/in.html>>.

Coffman, Ronnie. "Potentials and Limitations of Biotechnology in Rice." (2004).

"The Debate Over Genetically Modified Foods (ActionBioscience)." ActionBioscience - promoting bioscience literacy. 02 Sept. 2009. <<http://www.actionbioscience.org/biotech/sakko.html>>.

Demeke, Mulat. "Initiative on Country Responses to the Food Security Crisis: Nature and Preliminary Implications of the Policies Pursued Soaring Food Prices." *Easy Pol*.

Embassy of India. "Biotechnology in India a Promising Future." *India Economic News* 2.13.

Federoff, Nina. *Mendel in the Kitchen: a Scientist's View of Genetically Modified Foods*. NW: Joseph Henry, 1999.

"Golden Rice fully licensed to India." *Breaking News for Food and Beverage in Asia*. 02 Sept. 2009. <<http://www.ap-foodtechnology.com/Formulation/Golden-Rice-fully-licensed-to-India>>.

"'Green Revolution' Trapping India's Farmers In Debt : NPR." NPR : National Public Radio : News & Analysis, World, US, Music & Arts : NPR. 02 Sept. 2009. <<http://www.npr.org/templates/story/story.php?storyId=102944731>>.

"India and the global food crisis - BusinessWeek." *BusinessWeek - Business News, Stock Market & Financial Advice*. 02 Sept. 2009. <http://www.businessweek.com/globalbiz/blog/eyeonasia/archives/2008/04/india_and_the_g.html>.

"IRC- Agriculture and Biotechnology." *India Resource Center*. 02 Sept. 2009. <<http://www.indiaresource.org/issues/agbiotech/index.html>>.

Khush, Gurdev S. *Rice Biotechnology*. Vol. 6. Oxon: C.A.B International, 1991. Google Books. Sept.-Oct. 2009.

"Press - Announces India's First Graduates of 10,000 Women." *Goldman Sachs*. 02 Sept. 2009. <<http://www2.goldmansachs.com/our-firm/press/press-releases/current/announce-india-first-graduates-10k-women.html>>.

Mazumdar, Kedarnath. Moymonshingher Itihash O Moymonsingher Biboron. 2005.

"Monsanto ~ Corporate Responsibility ~ Sustainable Agriculture." Monsanto ~ Home. 02 Sept. 2009. <<http://www.monsanto.com/responsibility/sustainable-ag/default.asp>>.

"Monsanto ~ Corporate Responsibility ~ Sustainable Agriculture." Monsanto ~ Home. 02 Sept. 2009. <<http://www.monsanto.com/responsibility/sustainable-ag/default.asp>>.

"Monsanto ~ Our Products ~ Benefits of Our Products ~ Documented Benefits of Biotechnology." Monsanto ~ Home. 02 Sept. 2009. <<http://www.monsanto.com/products/benefits/biotechnology.asp>>.

Peterson, Garry. "The Risks and Benefits of Genetically Modified Crops: A Multidisciplinary Perspective." Ecology and Society 4.13 (2000). Ecology and Society. The Resilience Alliance. 1 Sept. 2009. <<http://www.ecologyandsociety.org/vol4/iss1/art13/>>.

"Pros and cons of biotechnology. Vitthal Narayan Patil. Biotechnology in India | Conversations About Plant Biotechnology." Monsanto ~ Home. 02 Sept. 2009. <<http://www.monsanto.com/biotech-gmo/asp/farmers.asp?cname=India&id=VitthalNarayanPatil>>.

Samaddar, Arindam. "Changes in Transition: Technology Adoption and Rice Farming in Two Indian Villages." (2005).

"THE STATE OF FOOD AND AGRICULTURE 2003-2004." FAO: FAO Home. 02 Sept. 2009. <http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/006/y5160e/y5160e00.htm>.

"Sustainable food production, income generation and consumer protection in India." Agro-chemicals News (1999).

Traxler, Greg. "The GMO Experience in North and South America- where to from here?" N. pag.

UNICEF - UNICEF Home. 02 Sept. 2009. <http://www.unicef.org/infobycountry/india_44409.html>.