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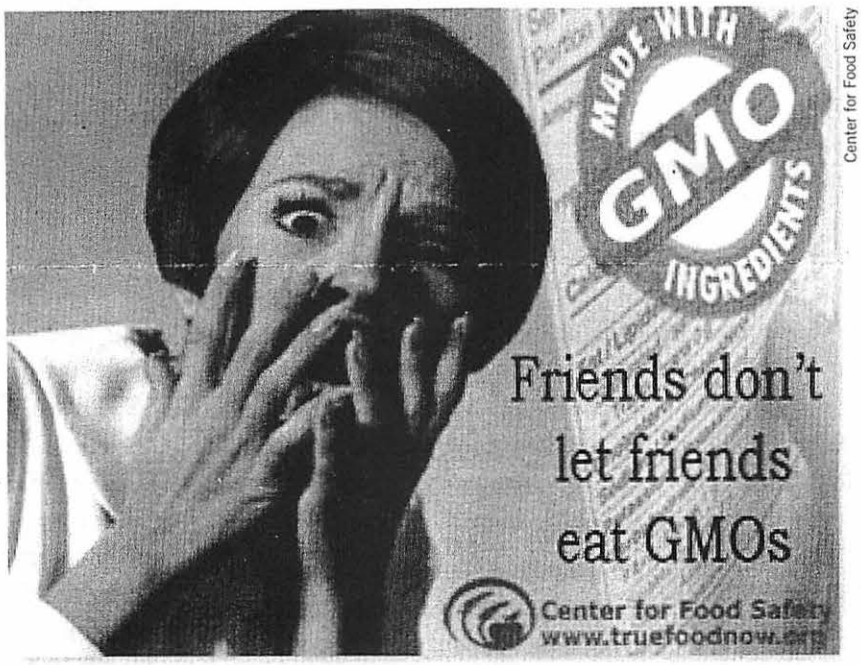

Center for Food Safety

The Genetic Engineering of Food and the Failure of Science

By Don Lotter, Ph.D.

"It is beginning to dawn on biologists that they may have got it [genetics] wrong. Not completely wrong, but wrong enough to be embarrassing..... For, suddenly, cells seem to be full of RNA doing who-knows-what."

—THE ECONOMIST, "RNA: REALLY NEW ADVANCES," JUNE 14, 2007.

The search for solutions to hunger, poverty and climate change has brought new intensity to the debate over genetically modified crops. Biotechnology is expected to be a central building block in the State Department's food security strategy, and prominent legislation in the Senate could mandate biotechnology research be a permanent part of US foreign aid. Meanwhile high profile defeats for the biotech industry are mounting. [editor's note]

A major conflict over this issue has developed. On one side are scientists, universities and corporations who have invested nearly 25 years and tens of billions of dollars in the genetic engineering of crop plants. On the other side is a flood of evidence that the process of food plant transgenics (genetic engineering) is deeply and fatally flawed and has been resting on a theoretical foundation that has crumbled away as the science of genetics reinvents itself.

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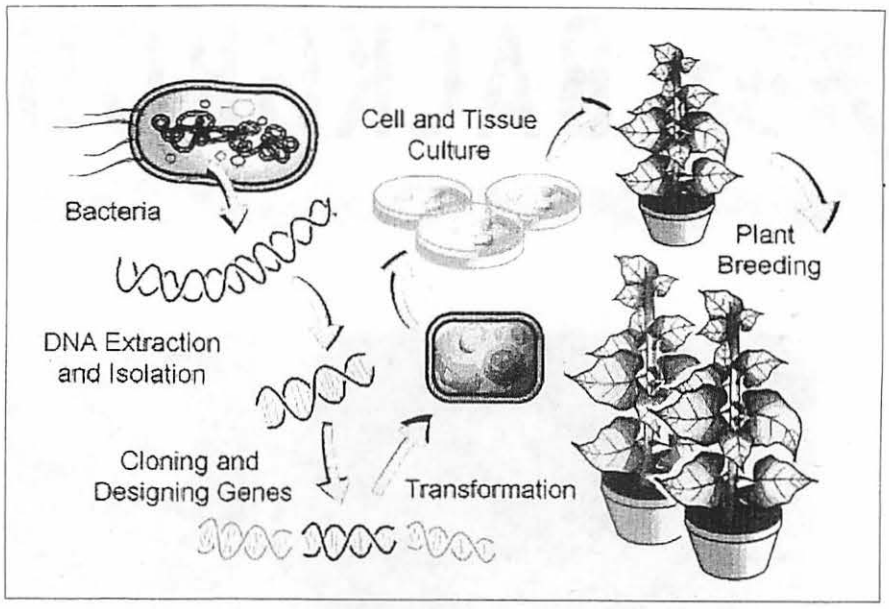
This Food First backgrounder summarizes two papers by Don Lotter in the International Journal of the Sociology of Agriculture and Food in May 2009: The Genetic Engineering of Food and the Failure of Science. Part 1: The Development of a Flawed Enterprise and Part 2: Academic Capitalism and the Loss of Scientific Integrity.

From the beginning, the entire crop transgenics enterprise has been based on the now-discredited "one-gene one-protein" theory that one gene leads to the production of one protein. The fatal blow to this one-gene one-protein model came in 2003 with the shocking results of the Human Genome Project which showed that humans have vastly fewer genes than previously believed. As a result of this, the project scientists now report that the genomes of higher organisms (including plants); are not what scientists had believed them to be, and that "genes appear to operate in a complex network, and interact and overlap with one another and with other components in ways not yet fully understood." They conclude that these findings challenge scientists "to rethink some long-held views about what genes are and what they do."



To quote renowned cellular biologist Barry Commoner, commenting on the results of the Human Genome Project: "The fact that one gene can give rise to multiple proteins ... destroys the theoretical foundation of a multibillion dollar industry, the genetic engineering of food crops."

It is quite stunning to read scientific reports, mostly from Europe, that are uncovering the serious genetic and protein integrity problems arising from crop transgenics. It challenges the imagination as to how this technology and its products could possibly have gained regulatory approval and continued scientific acceptance in the US. These flaws fall into three main categories: the production of unknown or defective proteins; the transfer of transgenes to bacteria and viruses within the food consumer's intestine; and ecological issues.

Numerous scientific studies show that the process of the genetic engineering of plants is associated with genome-wide mutations, large-scale rearrangements or deletions of plant chromosomal DNA as well as insertion of superfluous DNA.[1] The main change to food resulting from this genomic disruption is that novel proteins are produced – proteins that have never been in the human digestive system. These are often common food proteins that have a changed configuration such that the human body does not recognize them and reacts as if it is a disease. Allergies are just one of the outcomes.

Of the many studies documenting these serious problems with transgenic foods, one example stands out, not only for its health effects, but also for what happens to scientists who discover these problems. For example, in the late 1990s, one of Europe's top genetic engineers, Dr. Árpád Pusztai, found that the process of genetic engineering of the potato caused test rats to develop potentially precancerous cell growth in the digestive tract; inhibited development of the brain, liver, and testicles; caused partial atrophy of the liver; enlarged pancreas and intestines; and immune system damage. Pusztai's subsequent termination from his senior position at a UK research institute following the release of his research results is discussed in my paper along with other examples of bias against and mistreatment of scientists whose research does not support transgenics. Pusztai's paper in The Lancet, considered the top medical journal in the world, remains a landmark in food transgenics.[2]

A 2007 paper by a Spanish scientist in the scientific journal Critical Reviews in Food Science and Nutrition, surveyed the literature on toxicology studies done on transgenic foods. The author, José L. Domingo, wrote that it is "quite amazing to note" the paucity of toxicology studies on transgenic foods, and asked "where is the scientific evidence showing that GM plants/food are toxicologically safe, as assumed by the biotechnology companies involved in commercial GM foods?"[3]

Commenting on the lack of safety data on transgenic foods in the Journal of Medicinal Food,[4] David Schubert, head of the Cellular Neurobiology Laboratory at the Salk Institute in California, wrote in 2008:

"There are, in fact, no data comparing the food safety profiles of GM versus conventional breeding, and the ubiquitous argument that 'since there is no evidence that GM products make people sick, they are safe' is both illogical and false. There are, again, simply no data or even valid assays to support this contention. Without proper epidemiological studies, most types of harm will not be detected, and no such studies have been conducted."

Problems with transgenic foods don't end with toxicology. In an inexplicable lapse, genetic engineers mistakenly assumed that, upon passage through the human stomach, all DNA in transgenic food would be inactivated. However, DNA from GM foods can actually insert itself into a completely different species when a part of the foreign gene package used to make the process of genetic engineering work, encounters a "DNA hotspot." These "hotspots" make it easier for foreign DNA to "jump" from one species to another—meaning it is possible for genes from GM corn to "jump" to the bacteria naturally present in our stomachs. This is a very serious flaw with health implications that have not been adequately researched.

Ecological and agroecological issues are also a substantial concern with transgenic crops, including the buildup of weed resistance to herbicides due to the massive increase in their use; transgene transfer to other crops and to wild relatives via pollen; and the ecological effects of pesticide crops.

Thorough scientific scrutiny of this truly radical technology in the early stages of the development of crop transgenics in the 1980s would likely have resulted in non-approval. A central factor in this failure to adequately regulate has been the early dominance of the biotechnology industry over the highest levels of the federal regulatory agencies, which led to a "hands-off" policy regarding regulation of transgenic foods. Instead of a period of scientific scrutiny and debate, these crops were given the green light, resulting in the investment of billions of dollars and thousands of professional careers worldwide. Many countries have either modeled their transgenic foods regulatory protocols partly or wholly on that of the US. This early industry pressure and scientific community compliance to a premature green light for transgenic crops is now coming back to bite the biotechnology industry and scientific community, and bite them very seriously.

The distortion of transgenics science and the loss of scientific integrity due to university dependence on industry funding is discussed extensively in Part 2 of my papers. While I cannot delve into this area in this short backgrounder, these problems can be summarized as:

- bias towards research that might make money for industry (patentable products and processes) and away from a focus on "public-goods" research;
- tolerance by the scientific community of bias against and mistreatment of scientists whose work results in negative findings for transgenics, including editorial decisions by peer-reviewed journals;
- monopolization of expert scientific organizations on transgenics by pro-industry scientists;
- deficient scientific protocols, bias, and possible fraud in industry-funded and industry-conducted safety testing of transgenic foods;
- increasing politically- and commercially-driven manipulation of science within both the universities and the federal regulatory bodies such as the FDA; and
- manipulation of the information environment and media by pro-transgenics forces.

"Genetic engineering is needed to feed a hungry world" is one of the main public relations thrusts of the biotechnology industry. However, in addition to the serious genetic flaws and food safety issues, transgenic crops have been shown in study after study to produce no more food than their nontransgenic counterparts.[5] Furthermore, most developing countries do not want their future food security tied to crops patented by large corporations from developed countries—a scenario that could drain economy via royalty payments.

In 2008 over 400 agricultural experts from some 40 countries, sponsored by the UN, the World Bank, and the World Health Organization, finalized a framework for future food security. Significantly, transgenic crops were not included in that framework, known as the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD).[6] It is well established in research that current state-of-the-science methods utilizing non-transgenic crops—essentially a combination of sustainable agricultural and classic Green Revolution methods–can quite adequately satisfy world food needs into the future without the need for transgenic crops.

Despite this worldwide movement towards non-proprietary, sustainable solutions to the world's food problems, the US government (Bush administration) refused to sign the IAASTD framework. The US government plus a number of US non-governmental organizations

including the Gates and Rockefeller Foundations are now intensively promoting transgenic crops around the world.

US science funding must be restructured to provide support for non-proprietary, ecological approaches to ensure the integrity of both our scientific process and our food supply. Simultaneously, federal regulatory bodies need a complete overhaul to restore their independence. Finally, transgenic crops need comprehensive scientific re-evaluation for a possible national rollback.

Notes

1 Latham, J.R., et al. 2006. The Mutational Consequences of Plant Transformation. *J. Biomed. Biotechnol.* Vol. 2006:1-7. Article ID 25376

2 Ewen, S.W.B. and A. Pusztai. 1999. Effect of diets containing genetically modified potatoes expressing Galanthus nivalis lectin on rat small intestine. *The Lancet.* 354: 1353-1354

3 Domingo, José L. 2007. Toxicity studies of genetically modified plants: a review of the published literature. *Critical Reviews in Food Science and Nutrition* 47(8): 721-733

4 Schubert, D.R. 2008. The Problem with Nutritionally Enhanced Plants. *J. Medicinal Food,* 11(4): 601

5 Gurian-Sherman, Doug. 2009. Failure to Yield: Evaluating the Performance of Genetically Engineered Crops. *Union of Concerned Scientists.* www.ucs.org

6 Heinemann, J. 2009. Hope Not Hype: The future of agriculture guided by the International Assessment of Agricultural Knowledge, Science and Technology for Development. *TWN.* www.twnside.org.sg

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