Inquiring Minds

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How should we feed our planet in the future?

By 2050, there will be 10 billion people on the planet. How will we feed them? Since the 1960s, a Green Revolution that introduced new seed types, chemical fertilizers, pesticides, and mechanized farming doubled world agricultural production. But many of the techniques that have brought about abundance also have significant downsides. Chemicals used in pesticides have been harmful to humans and other animals; GMOs and pesticides threaten biodiversity. How should the costs and benefits of new agricultural practices be weighed? What's the role of government? Of international organizations (e.g., the EU)? Where should the burden of proof fall in ensuring a safe, sustainable food supply?

Economist On-line, *The result of our debate about biotechnology and sustainable agriculture* Newsbook**, Nov 12th 2010**

Genetic modification is a part of today's life; don't let it take you by surprise.

Genetically modified organisms (GMOs) are becoming more and more prominent in today's marketplace, so it is important to understand what they are and some of the issues they raise. A GMO plant has been genetically altered using genetic engineering techniques, and is commonly found in crops such as corn, soybeans, cotton and canola. In general, these plants are modified to express a resistance to herbicide, which can be beneficial to farmers, allowing for less work so more crops can be harvested. As of 2006, there were 102 million hectares of GM crops worldwide, and that number has only increased, with a 10% jump from 2007 to 2008 alone. In fact, the United States alone recently neared 60 million hectares.

It is important to be aware that, despite some advantages, there are numerous disadvantages that must be considered.

Food and Fuel

Supporters of GMOs believe such crops help increase yield, which could help curtail skyrocketing food prices. In addition, GMOs could potentially be influential in the gas crisis. Alternatives such as increased use of biofuels (made from GMOs) seem to be a positive advantage because they could lessen the nation's dependence on oil as well as reduce greenhouse gas emissions. Although the use of biofuel has been expanding, many believe the full effects on the environment and elsewhere must be further researched.

The international "food vs. fuel" debate has been another topic of great controversy in and of itself. Critics of biofuel worry that investment into the sector has driven up the price of food. Creating biofuels requires massive amounts of raw material, and although the land used by GM crops is a huge percentage of land farmed, the question remains whether ultimately using it for food or fuel is the best use of it, time and money.

Genetic Pollution

One of the major problems with GMOs is that they have no boundaries. Once planted, they run the risk of contaminating any conventional crops planted nearby. A survey reports that in the Midwest, where there are millions of acres of GM corn and soybean crops, up to 80% of organic farmers reported direct costs or damages resulting from genetic trespass (2). This trespassing can occur in a variety of common, natural ways, which makes keeping the GMOs on their own fields impossible. For example, winds (particularly high winds, but even breezes can be problematic) and water runoff are full of seeds and spores, and can easily bring GMOs to fields where they are not purposely grown.

Often, these seeds and spores will then implant themselves into soil and produce plants that are genetically altered—with the farmer having no idea his crops have been genetically polluted. Other sources of GMO contamination include commingling during harvest and cross-pollination, which is particularly rampant with corn (2). Farmers often hire combines to harvest their food, instead of using their own, and if these have not been cleaned well enough, residual GM grains from previous harvests can contaminate the crop. Something as small as a particle on a tarp is enough to cause contamination. There has been some talk of creating GMOs whose offspring would be sterile, thus eliminating many of these plants; as of yet there has been no great move to implement the modification on a large scale.

Lack of Labels

Unlike the organic certification, there is no such thing as a GMO-free certification. In fact, products are not required by law to state whether or not they contain GMOs. In a world where 92% of the soybean crop is genetically modified and many products use soybean oil or corn syrup (GMOs comprise 80% of the corn planted), the chance of finding GMOs in food is incredibly high (2). Although it is impossible to tell by reading labels in your local grocery aisles, 65% of all their products have DNA-altered ingredients (3). Unfortunately, some organic products may even unknowingly contain GMOs, since U.S. organic rules do not require GMO testing. While all manufacturers are concerned with buying certified organic, not everyone knows about GMO contamination (2). Without requiring GMO labeling, knowing the true content of products can be difficult if information is disregarded or lost along the way.

A recent CBS/New York Times poll states that 53% of Americans say they won't buy food that has been genetically modified; avoiding GMOs is not an easy task, however (3). Without labeling, it is impossible to know the extent of any biotech contamination. And in creating GMOs, the DNA is often spliced with DNA from other organisms that could be detrimental to those with serious allergies or even those who are vegetarians. The Brazil nut was combined with soybeans for a time, until it produced too many allergic reactions (4). Although this particular combination has ceased, there is no telling what others exist, particularly when no one is legally compelled to say anything.

While the U.S. Food and Drug Administration and biotech giants claim there's no evidence that GMOs are anything but safe, food safety advocates want to know: how would we know, if the food is not labeled? (3). Many people are concerned that the lack of long-term testing on GMOs will be detrimental to the population—and the environment—in the years to come. As it stands now, more examples of GMO problems

can be found in Jeffrey M. Smith's book *Seeds of Deception*, including gastrointestinal problems in humans (after similar issues found in the lab, though the GMO was passed) and the telltale sign of wild animals' refusal to eat GM crops.

Even with the difficulties presented by the lack of GMO labeling, many natural retailers try to screen out any products that contain GMOs; check with your local retailer to learn more.

Nirvana Abou-Gabal, "Understanding the Controversy and Science of GMOs"
www.sonima.com/food/science-of-gmos

The subject of genetically-modified organisms (GMOs) is one of the most hotly-debated food and environmental topics in the world today. Just look at the response to Chipotle's recent announcement that the chain would cease to include GMO ingredients on its menu. Health advocates applauded the move as a step in the right direction on the heels of Whole Foods' 2013 commitment to label all genetically-modified products in its stores by 2018. Detractors called it yet another example of a food maker using unsubstantiated claims to sell food and hypocritical, given that the chain will continue to serve soda, which contains high-fructose corn syrup made with genetically-modified corn.

At the crux of the controversy are a number of unknowns about the long-term health effects of ingesting genetically-modified (GM) foods and the impact these plants and accompanying farming methods have on the environment. With some experts saying 60 to 70 percent of food products contain GMOs in recent years, it's clear this issue is central to the future of our food supply. To help answer some commonly asked questions and further a constructive dialogue on the topic, here is a brief overview of the facts we know today.

What Are GMOs?

A genetically-modified organism is a plant or animal whose DNA has been modified without using natural methods of reproduction. Individual genes are transferred from the "source" organism into the DNA of the "target" organism. This produces crops that carry certain traits such as resistance to insect damage or improved nutritional value.

As an example, in the case of the genetically-modified Bt corn, genes from a soil bacterium called Bt, which carry a trait making it resistant to insect destruction is inserted into the plant. As a result, such a corn crop would be safe from the adverse effects caused by insects that might otherwise cause loss or damage.

There are currently no genetically-modified animals approved for sale and consumption in the United States, although the feed of conventionally raised livestock and poultry often contains genetically-modified ingredients.

Are GMOs Safe?

Many proponents of genetically-modified foods state that they are completely safe to eat and that this process has taken place in nature for thousands of years. They cite research such as a review by Snell et al., which carried out a comprehensive analysis of 24 studies on the health effects of animal diets containing genetically-modified feed. The authors determined that, "the studies reviewed present evidence to show that GM plants are nutritionally equivalent to their non-GM counterparts and can be safely used in food and feed." Any differences observed between conventional and GM feed "fell within the normal variation range of the considered parameter and thus had no biological or

toxicological significance."

However, not everyone is convinced. A joint statement developed and signed by over 300 independent researchers asserts that contrary to popular claims, there is "no consensus on GMO safety," and that differences of opinion are present regarding the interpretation of the safety parameters employed by the review's authors. Furthermore, the design of the studies profiled by Snell et al. were called into question.

These same scientists are concerned that despite the common claim that "trillions of GMO meals" have been consumed in the United States without any adverse effects, no epidemiological studies (observational studies used by researchers to test the relationship between factors and determine the existence of correlations) in human populations have been carried out to support this declaration. The authors go on to state that "as GM foods and other products are not monitored or labeled after release in North America, a major producer and consumer of GM crops, it is scientifically impossible to trace, let alone study, patterns of consumption and their impacts. Therefore, claims that GM foods are safe for human health based on the experience of North American populations have no scientific basis."

There is also growing concern regarding the chemicals that certain GMO foods are treated with, particularly in the case of "Roundup Ready" crops. Roundup is the brand name for the herbicide glyphosate, produced by Monsanto, an American agrochemical and agricultural biotechnology corporation responsible for most of the transgenic varieties of crops in the world today. Many GMOs such as soy, corn, canola, alfalfa, cotton, and sorghum are designed to be resistant to the effects of Roundup. These patented breeds of plants make it possible for farmers to spray crops with the herbicide to kill weeds without threatening their harvest. Unfortunately, an agency of the World Health Organization has cautioned that glyphosate "probably" causes cancer, which naturally raises alarm bells about the safety of these foods.

Of course, this is not to say that genetically-modified foods are categorically unsafe. However, it is apparent that research on this topic is young, emerging, and far from being conclusive.

What About the Environment?

It is equally important to understand the effects of GM crops on our environment. Proponents of this technology will argue that GMOs increase yields while decreasing the use of chemical pesticides (a seemingly win-win situation). However, it has been shown that this is not necessarily the case. A study examining the history and sustainability of U.S. staple crop production, such as soybean, maize, rapeseed, and cotton, in the American Midwest showed that, "relative to other food secure and exporting countries (e.g., Western Europe) [which unlike the U.S., are highly conservative when it comes to GMOs], the U.S. agroecosystem is not exceptional in yields or conservative on environmental impact." Another study has determined that herbicide and insect-resistant crops has led to a 527 million-pound increase in herbicide use in the United States between the years 1996 and 2001, while only decreasing insecticide use by 123 million pounds. In other words, while the use of insecticides has decreased, the use of herbicides has increased much more substantially, likely due to the proliferation of glyphosate-resistant weeds.

The development of such "super weeds" is another growing concern. Indianapolis-based Dow AgroSciences, a division of Dow Chemical that specializes in

biotechnology and agricultural chemicals, has recently gained approval bring its Enlist weed control system to market. Enlist weed control is the company's answer to weeds that have developed a resistance to Monsanto's Roundup herbicide (they infest over 70 million acres of farmland in the U.S.), and is designed to be used in tangent with GM corn and soybeans. Enlist contains the chemical 2,4-D (a highly controversial chemical) in addition to glyphosate. The prevalence of these herbicide-resistant weeds and the industry built around solving this problem raises many questions: What happens when weeds eventually become resistant to Enlist? Is it sustainable for us to continue to rely on increasingly potent (and controversial) herbicides in support of this technology? Are we imprisoning the farmers who adopt these modern methods into a perpetual technology trap?

Other highly important environmental issues include the potential for GMOs to cross-pollinate with other crops and plants in the ecosystem, the challenge of maintaining biodiversity in the era of industrial crop production, the role and potential benefits of agroecology, the effects of GMOs on farmers (particularly in the developing world), and of course, the ethics behind the commoditization of nature, a worldview which certainly shapes much of the agribusiness industry. All of these issues must also be addressed as we evaluate the risks and potential benefits of this technology.

There are no easy answers to the question of GMOs, and it appears that they will continue to be a part of our food landscape in the foreseeable future. However, much is at stake. Objective, independent research, and constructive discussions among all stakeholders (corporations, farmers, legislators, researchers, environmental groups, and the public) must take place if a responsible solution is to be reached. In the meantime, those who wish to exercise caution by avoiding GM foods can do so by buying organic when possible (by law organic foods cannot contain GMOs), and by supporting local farmers who do not employ this technology.

Jayson Lusk, "Agricultural and Food Controversies," *HuffPost,* Jan. 25, 2015

Most of us have heard that eating beef is one of the worse things we can do for the planet. Yet as we ponder the choice of arugula over Romaine hearts, we may also hear that these vegetables are sprayed with more pesticides than grain crops. So perhaps we move on to organic until we learn that organics too use pesticides, and that the production method may not make the most efficient use of our scarce resources. And so it goes, comparing the carbon footprint of local to free range, asking waiters whether there's a GMO in our soup, all while speculating whether the Farm Bill is the cause of obesity.

Where is one to turn to adjudicate the conflicting messages we hear about food and agriculture? Large agribusinesses have a lot to say on these issues, but their predictable messages about feeding the world easy to dismiss. Journalists and non-profits with earnest, academic sounding names might appear a bit more credible, but their constant drum roll of fear and paranoia, undoubtedly appealing to a certain donor and book-buying base, also makes it hard to take their pronouncements at face value. With strong emotions and vested interests on all sides, it is no wonder food and agricultural issues have become so political. And controversial.

Having the privilege and opportunity to talk to thousands of college students around the country, I'm often surprised at the air of certitude that permeates food debates. That certitude often stems from knowledge that is deep but not wide. It is cultivated from

a narrow perspective of writings that blanket bookshelves and newsstands. Many fail to realize that there are thousands of scientists across the nation working on precisely those food and agricultural issues that are of such social concern.

I'm referring to our system of Land Grant Colleges and Universities that officially began with President Abraham Lincoln's pen stroke. From Maine to Florida, Texas to Minnesota, and California to Oregon are agronomists, nutritionists, economists, food scientists, entomologists,and animal scientists, among others, studying how to make our food system safer, more resilient, more productive, and more sustainable; extending that knowledge to farmers, policy makers, and when they can, consumers. While Land Grants are sometimes charged with being in the pockets of big agribusiness, any serious look at their activities will reveal robust and active research on organic and no till cropping systems, local foods and farmer's markets, obesity prevention, and food security in the US and abroad.

In that tradition, a multidisciplinary team of agricultural scientists, led by my friend and sometimes co-author, Bailey Norwood at Oklahoma State University has entered the fray with a new book, *Agricultural and Food Controversies* published by Oxford University Press in their accessible, easy to read What Everyone Needs to Know series (officially released on December 5th). Rather than striking a defensive or muckraking tone, as so often is the case in this genre of writing, Norwood and colleagues embrace the controversies, interpreting them as a sign of a healthy democracy struggling to deal with pressing challenges.

They reveal what the best science has to say on topics ranging from food pesticides and GMOs to the carbon footprint of beef production and the well-being of farm animals. They weigh in on synthetic fertilizers, local foods, and farm policy. Theirs is a respectful discussion of the positions taken up by different advocacy groups, but there is no hesitation in drawing conclusions where logic and science warrant. The book is an indispensable guide for understanding how the government regulates pesticides and GMOs and for seeing how competing interests can seem to have their own sets of seemingly conflicting "facts" on both sides of an issue.

While perhaps not coming right out and saying it, the authors show that many of our fears about modern agricultural technologies are overblown. Much of what has come to be accepted as the received wisdom about food and agriculture just ain't so. As the authors ironically note, however, it is precisely our fears and worries that have led to improvements in food safety, quality, and affordability. They also recognize that debates about food pesticides, GMOs, and carbon footprints are often surrogates for deeper, often unacknowledged conflicts over competing values and worldviews. As such, one shouldn't expect the controversies surrounding modern food and agriculture to quell anytime soon. But, at least we can begin to acknowledge what the debate is really about.