FEEDING THE WORLD WITHOUT GMOS

ENVIRONMENTAL WORKING GROUP

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By Emily Cassidy, EWG Research Analyst

Growing food is essential to our survival, but agriculture takes a major toll on the environment. In the coming decades, humanity will face the challenge of increasing food supplies for a burgeoning population while reducing food production's impact on the planet's land, water, and air.[1] Biotech companies and proponents of conventional, industrial agriculture have touted genetically engineered crops (often called GE or GMOs) as the key to feeding a more populous, wealthier world,[2] but recent studies show that this promise has fallen flat. To date, genetically engineered crops have not substantially improved global food security. Meanwhile, strategies that take advantage of what we already know about using resources and crops more efficiently have shown the potential to double food supplies while reducing agriculture's environmental impact.

THE CHALLENGE

Pressure on the world's food supply is intensifying as a result of population growth, changing diets and government policies promoting biofuels. Researchers estimate that by 2050 the demand for food will be twice what it was in 2005.[3] One big driver of this trend is that as people get richer, they buy more meat, and producing meat requires huge quantities of crops such as corn and soy for animal feed.

Food production occupies about 40 percent of Earth's land area and uses more fresh water than any other human activity.[1] Cutting down forests, plowing up grasslands and draining aquifers to grow still more food would have disastrous environmental effects and ultimately threaten the planet's life support system.

Biotech industry groups and advocates of conventional, industrial agriculture have heavily promoted the notion that genetically engineered crops are the key to increasing crop yields. These are novel varieties created in the laboratory using biotechnology to directly modify a plant's genetic makeup by inserting new genes – often from other species. Traditional crossbreeding, by contrast, relies on sexual reproduction to combine the genes of related species to introduce or enhance desirable characteristics.

Global crop yields have increased just 20 percent in the past 20 years,[4] so doubling the food supply in less than 50 years will likely be one of the greatest challenges of the 21st century. Proponents of GE crops claim that they are essential to "feed the world," but recent evidence indicates that so far, GE crops have not increased crop yields enough to significantly contribute to food security.

In recent decades, in fact, the dominant source of yield improvements has been traditional crossbreeding, and that is likely to continue for the foreseeable future.[5] Relying on genetic engineering to double food supplies by 2050 would require a huge leap in biotechnology and doubling the recent yield trends of crops.

Policymakers and industry seeking to expand the global food supply should instead explore how to make more efficient use of existing resources and the food we already grow, without causing harm to the environment.

WHY GE CROPS DON'T CONTRIBUTE TO FOOD SECURITY

Much of the investment in genetic engineering has been spent on crops that do very little to expand the global food supply. Globally, corn and soybeans account for about 80 percent of the land area devoted to growing genetically engineered crops,[6] and both are overwhelmingly used for animal feed and biofuels. Most of the investment in GE crops ends up feeding cows and cars, not people. Moreover, seed companies' investment in improving yields in already high-yielding areas does little to improve food security; it mainly helps line the pockets of seed and chemical companies, large-scale growers and producers of corn ethanol.

The narrative that GE crops will help feed the world ignores the fact that hunger is mostly the result of poverty. It is true that about 70 percent of the world's poor are farmers[7] and that improving their crop yields could help raise them out of poverty, but what truly limits the productivity of small farmers is the lack of basic resources such as fertilizer, water and the infrastructure to transport crops to market.

If Big Ag companies truly want to guarantee that poor farmers can feed themselves, the cheapest way would be to ensure that they have the right mix of fertilizers and to help with infrastructure improvements such as roads to market. In regions such as Africa, farmers can only afford a tenth of the fertilizer recommended for their crops.[8] Industry-supported research found that it can take more than $100 million to research and develop[9] a single genetically engineered variety, money that would be better spent to address the factors that frequently limit crop yields. By comparison, it typically costs only about $1 million to develop a new variety by traditional breeding techniques.[10,11] In Africa, moreover, traditional crossbreeding has so far outperformed genetic engineering in improving crops' drought tolerance and efficiency of resource use.

WHAT WOULD WORK TO BOOST THE GLOBAL FOOD SUPPLY

There are a number of proven, common-sense strategies that can be put to work with minimal environmental impact:

Resource Use

American growers use a lot of fertilizer. And corn, over 85 percent of which is genetically engineered, requires more fertilizer than almost any other crop, while contributing little to the food supply.[12] Over-fertilizing also leads to water quality problems and increased emissions of nitrous oxide, a greenhouse gas 300 times more potent than carbon dioxide.

Smarter use of fertilizers

Smarter use of fertilizers would have the dual benefits of increasing the food supply in places that need it most while reducing the damage done to water and air quality. If the fertilizer were used in places with nutrient-poor soils where it would have the greatest impact, instead of over-fertilizing industrial-scale farms in rich countries, global production of major cereals could be increased by 30 percent.[13]

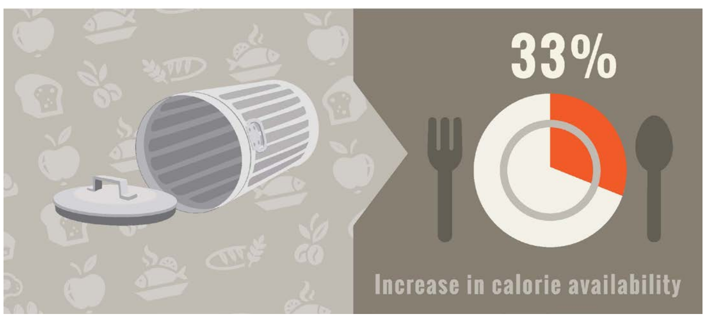
Reducing food waste

By weight, a third of all food grown around the world – accounting for a quarter of calories – goes uneaten, according to the United Nations' Food and Agriculture Organization.[14] The food is scrapped before it reaches market or is thrown away at home. In theory, eliminating all food waste in fields, at grocery stores and at home could increase the global calorie supply by 33 percent.

In the United States, the situation is even worse. About 40 percent of America's food production – 60 million metric tons a year worth an estimated $162 billion[15] – goes to waste. That amounts to about 1,500 calories of discarded food per person each day[16] – enough to feed 170 million people a 2,700-calorie-per-day diet. Reducing waste by just 30 percent would yield enough calories to feed about 50 million people, the same number as live in food-insecure households in the U.S.[17]

Most food waste in the United States and Europe occurs at home or in restaurants and supermarkets. Tossing food is not only a waste of money, it also takes a significant environmental toll: 31 percent of U.S. cropland and 25 percent of U.S. fresh water consumption goes to grow that uneaten food.[16]

Eliminating food waste

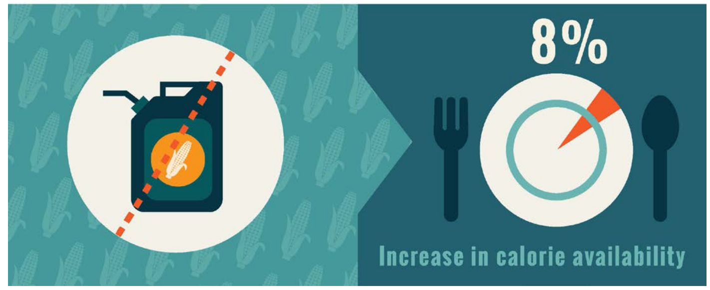


In developing countries, about a third of all food goes to waste, but most of this happens on the farm or is due to lack of storage or inability to get the food to market.[18] Improving infrastructure such as roads, transportation, and storage facilities is essential to reducing food waste in developing countries. Being able to get food to market and store it until it's needed is crucial to increasing the incomes of poor, small farmers.

Reversing biofuels incentives

Using food crops to make biofuels takes calories out of the food system. In 2010, about 5 percent of the calories grown globally were used to make biofuels.[19] In the United States, about 40 percent of corn production goes to produce corn ethanol, largely driven by the federal mandate to blend it into vehicle fuel under the Renewable Fuel Standard.

Eliminating food-based biofuels



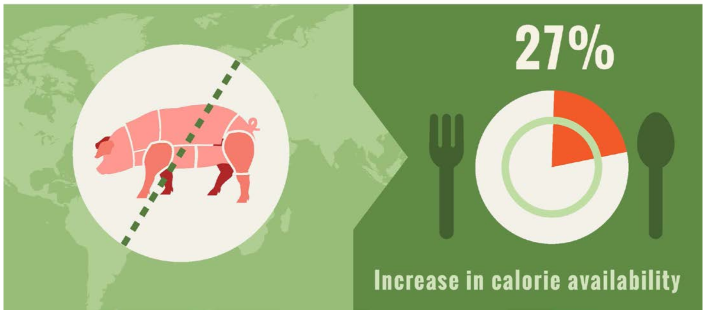
Shifting crops used for biofuels back into food production could increase the global calorie supply by 8 percent, but in many countries the trend is in the opposite direction. They are increasing biofuels mandates, using food crops as feedstock and potentially exacerbating food security concerns. According to a recent analysis by the non-profit World Resources Institute, by 2050 biofuels mandates could consume the equivalent of 29 percent of all calories currently produced on the world's croplands.[19] Reversing course on food-based biofuels policies could alleviate the need to double the global calorie supply.

Changing diets

Small changes in what we eat can lessen the burden on resources and potentially increase food availability. Today meat production occupies about three-quarters of all agricultural land, and on average it takes about 10 calories of animal feed to produce just one calorie of meat.[12] Shifting from grain-fed beef to a diet emphasizing chicken or grass-fed beef could reduce the amount of land devoted to growing animal feed such as corn and soy.

In an analysis published in 2013, the author found that in theory, shifting all crops grown for animal feed to human food could increase food availability by 54 percent.[12] Cutting global meat consumption in half could increase food supplies by 27 percent. In a less drastic scenario, calorie availability could increase by 20 percent if just the United States, western Europe and Brazil switched half of their animal feed and biofuels crops to human food.[20]

Cutting global meat consumption in half



Reducing meat consumption in countries that eat large amounts, the U.S. among them, would also have health benefits, because eating large quantities of meat is associated with obesity,[21] heart disease[22] and some cancers.[23,24] Lowering the total calories we consume could also lessen the environmental burden of food production.

If everyone in the U.S., western Europe and Brazil cut meat consumption and biofuel production in half.

THE UNFULFILLED PROMISE OF GENETIC ENGINEERING

Research on genetically engineered corn began in the 1970s, but it wasn't until the 1990s that GE corn and soybeans were commercialized for widespread use. Today, the most widely grown genetically engineered crops are corn, soybeans, canola, cotton and sugar beets. In 2010, corn and soybeans alone accounted for about 80 percent of the land area dedicated to genetically engineered crops.[6] According to the Center for Food Safety, about 75 percent of processed foods in American grocery stores contain GE ingredients.[25]

Seed companies and proponents of industrial agriculture regularly claim that genetically engineered crops hold great potential to improve yields and stave off crop failures caused by crippling droughts and climate change. Yet the evidence of the past 20 years shows that they have fallen short of delivering these promised benefits.[26]

The debate over crop yields

In Africa, GE crops have been unable to compete with traditionally bred varieties. In the United States, they have increased the use of Monsanto's Roundup herbicide, which led to the appearance of resistant "superweeds."[27] And in 20 years of U.S. experiments with GE corn and soy, they have not increased yields.[28] Recent data shows no yield difference between acres growing GE varieties and traditionally bred corn and soy.

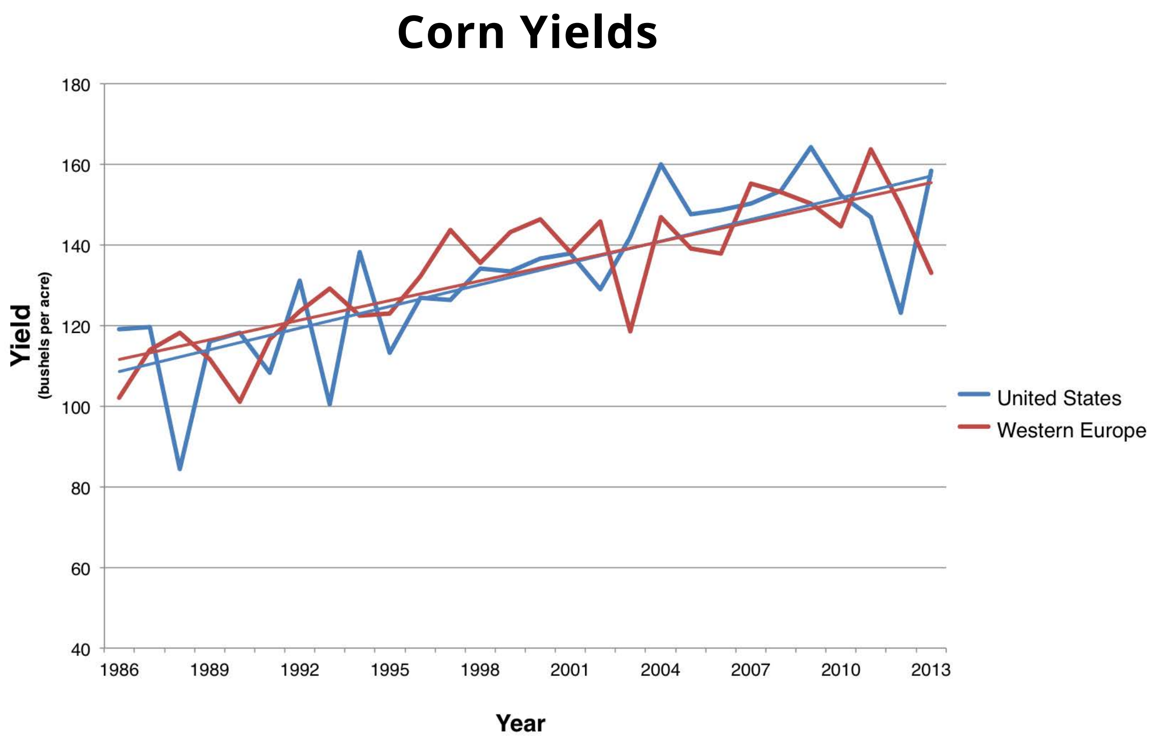
One recent paper found that average yields of genetically engineered corn in the United States from 1986 to 2011 were slightly lower than corn yields over the same period in western Europe, where GE crops aren't grown, although the difference was not statistically significant.[28] The paper was led by Jack Heinemann, a professor of genetics at the University of Canterbury in New Zealand.[28] More recent data from the United Nations Food and Agriculture Organization[29] for 2012 and 2013 (Figure 1) also show that yields are still are not significantly different.[30] Similarly, the trend from 1996 (when GE corn was first commercialized in the U.S.) to 2013 shows no significant difference in yield.[31]

Yield statistics for soybeans tell a similar story. Figure 2 shows no statistically significant difference between the U.S. and western Europe in average soybean yields from 1986 to 2013.[32] From 1996 to 2013 there was some divergence in the trend lines, but the differences still weren't significant.[33] Moreover, there is no indication that the rates of US yield improvements accelerated after 1996, when planting of GMO corn and soybeans increased dramatically.

Proponents of GE crops also claim that they will be better able to withstand drier climates, which will be

FIGURE 1.

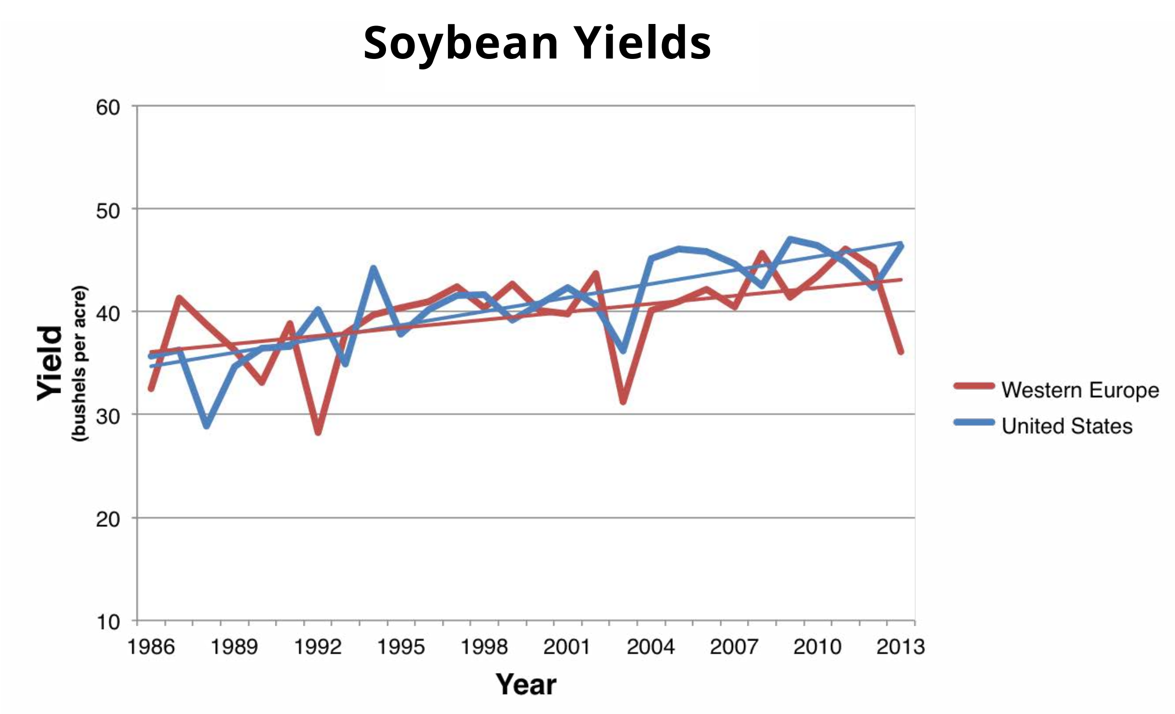
AVERAGE CORN YIELDS IN THE UNITED STATES AND WESTERN EUROPE, 1986-2013



Source data: United Nations Food and Agriculture Organization http://faostat3.fao.org/

FIGURE 2.

AVERAGE SOYBEAN YIELDS IN THE UNITED STATES AND WESTERN EUROPE, 1986-2013



Source data: United Nations Food and Agriculture Organization http://faostat3.fao.org/

essential to increasing food supplies on a warming planet. But it turns out that traditionally bred crops are outperforming GE crops in places where it matters most.

A recent case study described in Nature News in September 2014 highlighted efforts by the Drought-Tolerant Maize for Africa Project to improve crop yields in dry regions of the continent,[8] where drought can reduce yields by up to 25 percent. Since 2006, Nature News reported, researchers at the project have developed 153 new crop varieties using traditional breeding techniques and found that they had up to 30 percent better yields than genetically engineered varieties, even in nutrient-poor soils.[8]

A great variety of GE crops are being researched and commercialized today, and each may have different social and environmental effects. Genetic engineering's contribution to higher yields is difficult to disentangle from improvements achieved by traditional crossbreeding and changes in farm management practices. One recent study conducted by agricultural economists at a German University found that overall, genetic engineering has improved yields of certain crops by 22 percent,[34] but New Zealand geneticist Jack Heinemann said this meta-analysis did not properly control for confounding factors such as changes in farm management practices.[35] Over half of the studies used in the meta-analysis were based on GE cotton grown in India, and researchers at the International Food Policy Research Institute found that the yield increases there were much smaller than seed companies claimed. Increased fertilizer use, improved irrigation and other changes also helped increase cotton yields during this time.[36] Controlled field trials would be needed to determine whether these management practices were a factor.

Herbicides and "superweeds"

In the United States, widespread adoption of GE corn and soy since 1996 has increased the use of Monsanto's Roundup, a herbicide that is primarily composed of the chemical glyphosate. From 1996 to 2011, glyphosate use increased by 527 million pounds, or about 11 percent.[27] That led to the appearance several species of glyphosate-resistant weeds. In an effort to control these "superweeds," the biotech industry has been genetically engineering still newer crops that withstand more toxic herbicides, posing new environmental and human health threats to farms and surrounding areas.

RETHINKING GE CROPS

Genetically engineered crops are likely to remain a part of the food system, but they come with unintended environmental consequences and are far from being a silver bullet to meet the challenge of increasing food demand.

Crop yields have only increased about 20 percent in the past 20 years, so relying on yield improvements to double food supplies by 2050 would require not only a leap of faith but also a giant leap in biotechnology. According to research at the University of Minnesota, yields of major staple crops such as corn, wheat, rice and soybeans are not increasing fast

enough to meet the growing demand for food.[37] In order to double food supplies, the recent rate of yield improvements would have to roughly double.

In spite of the attention they have received, GE crops have not so far significantly contributed to food security. Although they cannot be ruled out as a part of the global food system, investments in these technologies should not overshadow traditionally bred varieties that are likely to drive much of the yield improvements for the foreseeable future.

Meeting global food demand will also require policymakers to explore how to make better use of what we already grow. Recent research shows that there are several important ways to more than double food availability and reduce agriculture's environmental footprint without counting on dramatic technological advances. These strategies include smarter use of fertilizers, reducing food waste and small changes in what we eat.

CONCLUSION

Relying on increased yields from genetically engineered crops alone will fall short of meeting the future demand for food. It also diverts attention from more promising opportunities to improve food security. The alternative strategies of smarter resource use, improving the livelihoods of small farmers, reducing food waste and changing diets could double calorie availability and reduce the environmental burden of food production, all without relying on GE foods.

Seed companies and proponents of conventional, industrial agriculture say GE crops hold the key to feeding the world, but the evidence of the past 20 years does not support those claims. The world's resources would be better spent focusing on strategies shown to actually increase food supplies and reduce the environmental impact of production.

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