Assessing the positive and negative claims about genetically engineered crops

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Genetic engineering in general, and genetically engineered (GE) crops in particular, stir strong feelings from both critics and supporters. The National Academies of Sciences, Engineering, and Medicine have just released a report, "Genetically Engineered Crops: Experience and Prospects," that examines the evidence behind positive and negative claims about GE crops, and the research challenges that lie ahead.

The 20-person committee that authored the report was convened in September 2014, heard presentations from 80 experts, received over 700 comments from members of the public and reviewed hundreds of peer-reviewed articles – assessing not only the research, but who funded it.

The committee was chaired by Fred Gould, a member of the National Academy of Sciences, William Neal Reynolds Distinguished Professor of Entomology at North Carolina State University, and co-director of NC State's Genetic Engineering and Society Center.

We sat down with Gould to learn more about the report and why it's important.

The Abstract: Why did the National Academies convene this committee? What questions are challenges was the committee tasked with addressing?

Fred Gould: The National Academies have conducted a number of assessments of genetic engineering (GE) since the 1970's, but now, almost 20 years since the first widespread planting of GE crops, the Academies wanted a comprehensive review of what we have learned since the introduction of these crops, and what the future may hold for this technology. In carrying out its study, the committee was well aware of the controversial nature of genetic engineering in the United States and globally. There have been many claims, of positive and negative effects of existing GE crops and one main task of the committee was to examine the evidence related to these claims.

The Abstract: Many in the scientific community feel the safety of GE crops is so well established as to be unassailable. Others feel that research highlighting

risks associated with GE crops are swept under the rug. What did the committee do to try to address these divergent points of view? Is it even possible to accommodate both viewpoints?

Gould: Indeed, prior to and during our first public committee meeting, we received comments from individuals and groups who felt that there had already been so many reports from authoritative committees about the safety of currently commercial GE crops that one more report on this topic was pointless. At the same time, we received comments from other groups and individuals who claimed that past reports had ignored studies that found problems with the safety of foods from GE crops and had not accounted for ecological and social problems caused by GE crops. The latter group was concerned that our committee would also ignore these studies and issues.

Our committee took on all of these comments as constructive challenges. We held a number of public meetings as well as 15 webinars that were open to the public. In total we heard presentations from 80 people who had very different experiences and perspectives on GE crops. Additionally, we encouraged members of the public to send us comments and questions through our website. We received over 700 responses to this request. I think that all of this input challenged our 20 committee members to think more broadly and deeply about the issues.

The Abstract: One point that critics of GE crops often bring up is that much of the relevant research is funded or otherwise supported by industry groups. Did the committee address this issue? And, if so, how?

Gould: Over the past 40 years the public has become well aware that research funded by industry on drugs, tobacco, and other biomedical topics can be slanted to favor a desired outcome. It makes sense that people would be concerned about safety testing of the food they eat if it was solely conducted by or funded by the industries that stand to profit from sales of GE crops. We worked hard to examine the studies that have been published in the peer-reviewed literature on the safety of GE crops and foods. Some of these studies were conducted by industry scientists or were funded by industry, but others were done independently. We went through all of the references in our report on current GE crops to find the affiliation of the authors of studies and whenever possible, the source of funds used to conduct the studies. We have put all of this information on our website so that it is accessible to anyone who is interested in knowing the origin of specific studies referred to in our report.

The Abstract: This is a threshold question: how did the committee define GE crops? I mean, given that farmers and scientists have been breeding plants to emphasize specific characteristics for millennia, what constitutes genetic engineering, as opposed to plant breeding?

Gould: In the 1990s when GE crops were first being developed, the USDA and EPA were able to make clear distinctions between crops developed through GE technologies and those developed by conventional breeding. They regulated the GE crops but did not typically regulate those derived through conventional means. In the 30 years since the first US regulatory framework was developed for GE crops, the technology has changed so much that the USDA is no longer able to use its regulatory authority to assess a large class of GE crops. Both the USDA

and EPA are trying to determine how they should regulate GE crops in the future.

Our committee also struggled with this issue. While most of the early GE crops were either resistant to a herbicide or produced a protein that was toxic to insects, some future engineered crops may only have small changes to DNA that alters a single amino acid in a protein already produced by the crop, or they may have an entirely new metabolic pathway. The committee concluded that it was not how a genetic change was made or even the amount of DNA that was altered that should be the focus of regulation. In the end, it is the plant characteristics that should be regulated. If a plant has intended or unintended novel characteristics that could potentially result in harm to the environment or human health, then it needs to be thoroughly tested. But if modern, high throughput methods for assessing a plant's DNA, RNA and chemical metabolite composition show that there are no signs of intended or unintended alterations that could cause harm, there is no need for further testing. The committee concluded that these criteria applied as much to what are considered conventionally bred plants as to GE plants.

The Abstract: How broad is the range of crops that are currently the focus of GE research efforts?

Gould: In the past, only a handful of crops were the focus of GE. Because of new technologies and accompanying declines in the cost and time involved in engineering plants, more crops are now included in the research agenda. These include apples, plums, flowers, forest trees, plantation trees, and even mushrooms. A number of crops that are more important to resource poor farmers are gaining more attention. These include cassava, sweet potato, peanuts and sorghum. There is little in the way of profit motive involved in such research, so it is typically funded by philanthropic groups or governments. Whether such funding will be

sufficient and sustained is not clear.

The Abstract: Did the committee reach a fundamental conclusion on whether GE crops are "good" or "bad"?

Gould: No, the committee did not reach such a conclusion. Not surprisingly, the committee found that the social and economic effects of GE crops depended on whether the GE trait and the genetics of the cultivar it was put into matched the needs of the farmers and the farm environment. GE crops have provided economic benefits to many small-scale farmers who were early adopters, but long term and widespread gains will depend on institutional support and sustainable access to profitable local and global markets for the GE products. We must ask, over time, what proportion of the potential additional benefits from GE crops will go to small scale farmers, consumers with meager resources, and to the providers of the technology and those who manage local and global trade. Like other technological advances in agriculture, genetic engineering on its own is unlikely to address the big challenges that face resource-poor farmers.

The Abstract: If there's no straightforward answer on such a fundamental question, what is the value of the report? Why is it important?

Gould: Good question. Maybe the greatest value in the report is pointing out that there is no straightforward answer. There has been a polarization of public opinion on GE crops, and please remember that researchers are not immune to such polarization. Once you or I conclude that GE crops are good or bad we look for more evidence to support our previous conclusion. I hope that people looking for our report to support a pro or

con position on GE crops will initially be very disappointed in our report, but that they will read further to understand why we didn't come to simple conclusions.

The Abstract: Having spent the better part of two years working on this report, what do you feel are the most important challenges ahead in regard to GE crops?

Gould: In the preface to our report, I quoted Dan Glickman, a former US Secretary of Agriculture who gave a speech on genetic engineering, and I will quote him again for you. He said that "with all that technology has to offer, it is nothing if it's not accepted. This boils down to a matter of trust. Trust in the science behind the process, but particularly trust in the regulatory process that ensures thorough review— including complete and open public involvement."

We can't gain the trust of members of the public in specific applications of GE simply based on technical or political authority, and emotionally appealing arguments about feeding the world will only go so far. Real trust is going to depend on developing some products with clear societal benefits. I actually think it is helpful to have some people not trust your actions and thereby hold you accountable.

The Abstract: What are the key research areas that you think research should focus on to address these challenges?

Gould: There is an obvious need for public investment in GE of "orphan crops" – those crops where there is little attraction for the private sector on its own. Public/private ventures could be useful if properly

structured.

As I mentioned earlier, there are new, high-throughput technologies that can help identify intended and unintended changes in a crop's characteristics that could result in risks. Although some of these technologies are well developed, others will require more research to be of greatest utility in assessing the future GE crops.

There are claims that we will need GE to feed the world in the future. There is uncertainty about this claim. The committee concluded that the most efficient way to improve and stabilize crop yields will involve a combined approach that includes GE researchers and conventional breeders working together. Of course feeding the world involves a lot more than just higher and more stable crop yields.

The Abstract: What role could NC State play in addressing these questions? Is the university already working on projects that address these challenges?

Gould: NC State is very active in GE crop research. This research spans from actual development of GE plants, to agronomic research on how best to use GE crops. NC State is also taking a lead in understanding the interface between GE and society. We need all of these kinds of research.

I think that the new Plant Science Initiative can do a lot to make NC State a leader and model for conducting advanced, trusted research in the GE crop development for both industrial farms and for resource-poor agricultural environments.

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