Genetically engineered crops benefit many farmers, but the technology needs proper management to remain effective

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Many U.S. farmers who grow genetically engineered (GE) crops are realizing substantial economic and environmental benefits -- such as lower production costs, fewer pest problems, reduced use of pesticides, and better yields -- compared with conventional crops, says a new report from the National Research Council. However, GE crops resistant to the herbicide glyphosate -- a main component in Roundup and other commercial weed killers -- could develop more weed problems as weeds evolve their own resistance to glyphosate. GE crops could lose their effectiveness unless farmers also use other proven weed and insect management practices.

The report provides the first comprehensive assessment of how GE crops are affecting all U.S. farmers, including those who grow conventional or organic crops. The new report follows several previous Research Council reports that examined the potential human health and environmental effects of GE crops.

"Many American farmers are enjoying higher profits due to the widespread use of certain genetically engineered crops and are reducing environmental impacts on and off the farm," said David Ervin, professor of environmental management and economics, Portland State University, Portland, Ore., and chair of the committee that wrote the report. "However, these benefits are not universal for all farmers. And as more GE traits are developed and incorporated into a larger variety of crops,

it's increasingly essential that we gain a better understanding of how genetic engineering technology will affect U.S. agriculture and the environment now and in the future. Such gaps in our knowledge are preventing a full assessment of the environmental, economic, and other impacts of GE crops on farm sustainability."

First introduced in 1996, genetically engineered crops now constitute more than 80 percent of soybeans, corn, and cotton grown in the United States. GE soybeans, corn, and cotton are designed to be resistant to the herbicide glyphosate, which has fewer adverse environmental effects compared with most other herbicides used to control weeds. In addition to glyphosate resistance, GE corn and cotton plants also are designed to produce *Bacillus thuringiensis* (*Bt*), a bacterium that is deadly when ingested by susceptible insect pests.

Farmers need to adopt better management practices to ensure that beneficial environmental effects of GE crops continue, the report says. In particular, farmers who grow GE herbicide-resistant crops should not rely exclusively on glyphosate and need to incorporate a range of weed management practices, including using other herbicide mixes. To date, at least nine species of weeds in the United States have evolved resistance to glyphosate since GE crops were introduced, largely because of repeated exposure. Federal and state government agencies, technology developers, universities, and other stakeholders should collaborate to document weed resistance problems and develop cost-effective ways to control weeds in current GE crops and new types of GE herbicide-resistant plants now under development.

Environmental benefits

Improvements in water quality could prove to be the largest single benefit of GE crops, the report says. Insecticide use has declined since GE crops were introduced, and farmers who grow GE crops use fewer

insecticides and herbicides that linger in soil and waterways. In addition, farmers who grow herbicide-resistant crops till less often to control weeds and are more likely to practice conservation tillage, which improves soil quality and water filtration and reduces erosion.

However, no infrastructure exists to track and analyze the effects that GE crops may have on water quality. The U.S. Geological Survey, along with other federal and state environmental agencies, should be provided with financial resources to document effects of GE crops on U.S. watersheds.

The report notes that although two types of insects have developed resistance to Bt, there have been few economic or agronomic consequences from resistance. Practices to prevent insects from developing resistance should continue, such as an EPA-mandated strategy that requires farmers to plant a certain amount of conventional plants alongside Bt plants in "refuge" areas.

Economic and social effects

In many cases, farmers who have adopted the use of GE crops have either lower production costs or higher yields, or sometimes both, due to more cost-effective weed and insect control and fewer losses from insect damage, the report says. Although these farmers have gained such economic benefits, more research is needed on the extent to which these advantages will change as pests adapt to GE crops, other countries adopt genetic engineering technology, and more GE traits are incorporated into existing and new crops.

The higher costs associated with GE seeds are not always offset financially by lower production costs or higher yields, the report notes. For example, farmers in areas with fewer weed and pest problems may not have as much improvement in terms of reducing crop losses. Even

so, studies show that farmers value the greater flexibility in pesticide spraying that GE crops provide and the increased safety for workers from less exposure to harmful pesticides.

The economic effects of GE crops on farmers who grow organic and conventional crops also need further study, the report says. For instance, organic farmers are profiting by marketing their crops as free of GE traits, but their crops' value could be jeopardized if genes from GE crops flow to non-GE varieties through cross-pollination or seed mingling.

Farmers have not been adversely affected by the proprietary terms involved in patent-protected GE seeds, the report says. However, some farmers have expressed concern that consolidation of the U.S. seed market will make it harder to purchase conventional seeds or those that have only specific GE traits. With the exception of the issue of seed industry consolidation, the effects of GE crops on other social factors of farming -- such as labor dynamics, farm structure, or community viability -- have largely been overlooked, the report says. More research is needed on the range of effects GE crops have on all farmers, including those who don't grow GE crops or farmers with less access to credit. Studies also should examine impacts on industries that rely on GE products, such as the livestock industry.

Research institutions should receive government support to develop GE traits that could deliver valuable public benefits but provide little market incentive for the private sector to develop. Examples include plants that decrease the likelihood of off-farm water pollution or plants that are resilient to changing climate conditions. Intellectual property that has been patented in developing major crops should be made available for these purposes whenever possible.

Provided by National Academy of Sciences

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