

# Genetic Engineering in Agriculture: How will we be fed?

## Gathering

### HYMN

(See hymn suggestions on p. 119)

### PRAYER

Blessed are you, Lord God of all creation. You have called us out of darkness into light. Open our eyes to your presence; open our ears to your call; open our hearts to your love. Creator and preserver of all, may we work for you. Lover of all, may we love with you. Giver of all, may we give like you, in Christ's name. Amen.



### HEARING THE WORD

Ezekiel 34:20-31

### DISCERNING THE WORD

Silence

Discernment

What did you hear in this reading? Is there a word of God for us here?

## Introduction

### Session summary

The use of genetically engineered crops, animals, and microbes in agriculture presents promises and perils. Scientists, farmers, agribusiness representatives, activists, policy makers, and food eaters hold a variety of different, complex, and even mixed perspectives on how to promote the promising aspects and prevent the perilous ones. Activists on competing sides of the issues produce strongly worded position statements that may help to inform the dialogue, but may also serve to mislead and misinform. To promote debate and discernment, this session introduces some of the key issues that shape people's perspectives on the promises, perils, and controversies.



### Real life stories

1: In 1998, Mr. [Homan] McFarling bought 1,000 bags of genetically altered soybean seeds, and he did what he had always done. [He saved part of the harvest and replanted the seeds.] But the seeds, called Roundup Ready, are patented.

When Monsanto, which holds the patent, learned what Mr. McFarling had sown, it sued him in federal court in St. Louis for patent infringement and was awarded \$780,000. The company calls the planting of saved seed piracy, and it says it has won millions of dollars from farmers in lawsuits and settlements in such cases. [...] Mr. McFarling, 61, [said] he will be forced into bankruptcy and early retirement. "It doesn't look right for them to have a patent on something that you can grow yourself," he said. Janice Armstrong, a Monsanto spokeswoman, said the company invested hundreds of millions of dollars to develop the seed. "We need to protect our intellectual property so that we can continue to develop the next wave of products," she said. <sup>1</sup> [Note: Farmers do sign a contract stating that they will not save the resulting crop for seed.]

2: On the island of Hawaii, on what had been acres of withering, disease-infested plants, farmers this summer are walking among rows of lush green trees, harvesting the world's first crop of genetically engineered papayas. Designed with a gene that allows them to withstand the papaya ringspot virus—an incurable disease that ruins fruit and



God's concern for God's people is always for our vocation to be fruitful and multiply in safety.

When have you experienced our country receiving "showers of blessing" after a difficult national time? Eze. 34:26)

*Genetic engineering* refers to the use of recombinant DNA to modify the genetic structure of plants, animals, and microbes. Techniques include: altering the genetic code to turn on a latent genetic trait or turn off an active one, inserting genetic fragments from one species into recipient organisms, and the cloning of adult cells from mammals. The altered DNA thus becomes part of the recipients' genomes, leading those organisms to express new characteristics and to pass along the altered DNA to offspring. *Agricultural biotechnology, transgenics, and genetic modification* are other terms commonly used to refer to this process.

can sicken trees to the point of killing them—these genetically modified plants are already being credited with saving an industry that was on its way out. [...] “This industry was dying,” said Emerson Llantero, manager of the Papaya Administrative Committee, a research and marketing group supported by papaya farms, most of which are small, family operations of 10 to 20 acres. The new papaya, he said, is a second chance for growers.<sup>2</sup>

3: A new study shows that genes from genetically engineered grass can spread much farther than previously known, a finding that raises questions about the straying of other plants altered through biotechnology and that could hurt the efforts of two companies to win approval for the first bioengineered grass. [...] Monsanto and Scotts have developed a strain of creeping bentgrass for use on golf courses that is resistant to the widely used herbicide Roundup. The altered plants would allow groundskeepers to spray the herbicide on their greens and fairways to kill weeds while leaving the grass unscathed. But the companies’ plans have been opposed by some environmental groups as well as by the federal Forest Service and the Bureau of Land Management. Critics worry that the grass could spread to areas where it is not wanted or transfer its herbicide resistance to weedy relatives, creating superweeds that would be immune to the most widely used weed killer. The Forest Service said earlier this year that the grass “has the potential to adversely impact all 175 national forests and grasslands.”<sup>3</sup>

4: *Cracking the Code of Life*, Segment 15: Genetic Modification

## About genetic engineering in agriculture

Genetic engineering (GE) was introduced in the early 1970s, when Stanford University scientists Stanley Cohen and Herbert Boyer developed methods for cloning DNA fragments and for transferring DNA fragments from one chromosome to another. One of the first organisms altered with this new technology was a bacterium genetically engineered to consume crude oil. In 1980, the Supreme Court ruled, in *Diamond v. Chakrabarty*, that the inventor of this organism could be granted a utility patent, the first time that such a patent was extended beyond inanimate objects to a living organism. (A discussion on patenting and genetics may be found in Session B7: Patenting genes.) Since then, GE has been used to alter mice to facilitate cancer research, to insert human genetic material into pigs in the hopes of harvesting pig organs for human transplants, and to alter food crops to increase nutrient levels and to produce medicines. There are many other examples of plants, animals, and single cell organisms genetically engineered for medical research, hazardous waste cleanup, and pharmaceutical uses. However, we will focus on the application of GE in agriculture in this session.

Genetic engineering was launched in animal agriculture in the 1980s when scientists used the technique to produce hormones (rBGH), which were injected into cattle to increase milk production. In the mid 1990s, the first GE crop, a tomato variety engineered to delay ripening, became commercially available. Since then, corn, soybeans, cotton, canola, alfalfa, potatoes, sweet corn, papaya, squash, and other crops have been genetically engineered and widely adopted in the U.S. and other parts of the world. At least 23 countries have adopted GE crops, including twelve developing countries. Many other nations, including European and developing nations, prohibit or restrict the use, or require labeling, of GE animals and crops.

Since debuting in the United States in 1996, GE crop acreage has expanded around the globe by 12% per year. As of 2007, the total estimated land in GE crops in the world was 282.4 million acres (about 50% of the land in GE crops is in the U. S.).<sup>4</sup> So far, the vast majority of GE crops are those modified to be herbicide-tolerant, that is, engineered to survive the application of heavy doses of glyphosate herbicides. This enables farmers to kill weeds without killing their crops. Since glyphosate is considered a more environmentally benign herbicide than some of the herbicides it replaced, such as Atrazine, there are environmental benefits. Herbicide-tolerant soybeans, corn, canola, cotton, and alfalfa account for approximately 63% of all GE crop acreage.

Another widely adopted set of GE crops includes those engineered to produce their own pesticide. Pesticide-producing corn and cotton account for 26% of the world’s GE crop acreage. Since the crops produce their own pesticides, farmers are able to reduce

the amount of chemical pesticides they apply to these crops. Additionally, the herbicide tolerance and pesticide production traits can be combined in the same plants, often called “stacking traits.” These stacked traits are becoming more common, accounting for about 19% of GE crop acreage in 2007. In the future, multiple traits may be stacked in a crop.

### Promises and perils

Despite the popularity of GE crops, they are not without controversy. *(For more detail, refer to chart at end of session)* Scientists, activists, policy makers, and farmers in industrialized and developing countries have sharp disagreements over the promises and perils of GE crops.<sup>5</sup> Proponents claim biotech developments herald the next agricultural revolution that promises: (a) to increase yield to alleviate hunger and global turmoil resulting from massive population growth; (b) to address production challenges through the development of new crop traits, including drought resistance crops and plants resistant to pests and fungi; (c) to incorporate higher nutritional values into staple crops; and (d) to reduce environmental damage due to the overuse of chemical inputs.

Those skeptical of GE crops argue that there is insufficient attention given to the perils: (a) that GE crops and animals present risks to human and animal health; (b) that GE crops present risks to the environment by creating tolerance to targeted pests and weeds, and thereby creating super weeds and super pests as well as gene flow to other crops and wild relatives; (c) that the world already produces enough food to alleviate hunger, which results from inequitable distribution, without requiring alternative agricultural production; (d) that agro-ecological production strategies coupled with fairer agricultural production and international trade policies are needed to alleviate world hunger; and (e) that GE agricultural production and distribution have socio-economic consequences that will result in corporate consolidation of the food system, the decline of small farming livelihoods, and the reduction of public participation in the decisions that affect their lives.

### Conditions underlying the controversy

The intensity of the debates is understandable since GE in agriculture affects the pillars of life: the food supply and the environment. As “bread and butter” matters they affect everyone, even though they most immediately affect farm communities and developing nations. The complexities then are not simply about the introduction of a new technology, but involve concerns about human health, international trade, the environment, global corporations, government regulation, the economic wellbeing of farmers and farm communities, and the world food supply. The task is further complicated when distinct groups are unable to agree on what criteria should be used when evaluating promises and perils or even what constitutes a promise or peril.

Technological changes are simultaneously social changes, and not everyone affected by the changes will deem them desirable. Some changes may be more dramatic than others, and the promises and perils of the changes may not always be distributed fairly. Some may benefit from a change at the expense of others. What one person or group calls a promise, another person or group might call a peril. As with the introduction of any new technology, (consider the computer or cell phone) the reach and magnitude of these social changes is impossible to fully understand, although a brief look at recent changes in agriculture may enable predictions of social impacts.

GE in agriculture emerged at the end of a century of dramatic changes in agriculture due to industrialization. Mechanization, chemicals, higher yielding crops, and the concentration and consolidation of agricultural and food production, processing, and distribution have benefitted some and harmed others. The increased productivity of agricultural commodities has been credited with reduced food costs, but it also introduced the problem of surplus production. In a market-based system of production and distribution, a surplus of production leads to a drop in prices for the producers. Thus, as farmer productivity increased, farm numbers dropped along with commodity prices. (There were nearly 7 million farmers in the 1940s, but just over 2 million at the start of the twenty-first century.) Although there are still over 2 million farms, a much smaller number of large

farms account for most of the commodity production. Less than 10% of farms account for over 75% of the value of production. Most of the remaining 90% of farms rely on off-farm income.<sup>6</sup> Livestock and dairy production are mostly concentrated in confined production facilities.<sup>7</sup> These dramatic changes in the agriculture and food system have led social scientists to ask if farming as a family livelihood strategy is becoming obsolete.<sup>8</sup>

## Hunger

Perhaps one of the most contentious claims regarding GE in agriculture is that it is needed to solve world hunger problems. Skeptics of this claim often acknowledge that GE in agriculture might be able to address specific agricultural production problems, such as drought and pest resistance. However, they emphasize that the same problem of oversupply that led to the decline in farm numbers in the U.S. is now a global problem. Subsidized commodities, like corn, rice, and wheat produced in Europe and the U.S., are shipped to developing countries around the world. This may lead to reduced food costs for some, but it also undermines markets for local agricultural production, even in remote areas of the world. By undermining agricultural markets in developing countries, these global commodity chains can undermine farm livelihoods. Undermining farmer viability can in turn create more poverty and hunger.

Although there are cases of localized food shortages, there is no shortage of food in the world. Modern famines tend to be driven more by poverty than lack of available food to consume. For example, the *Times of London* reported in 2006 that Kenya was exporting food during a time of famine.<sup>9</sup> And the *New York Times* reported in 2002, that there were 350 million hungry people in India, even as wheat crops rotted in the field and as crops from past years sat untouched in granaries.<sup>10</sup> Such occurrences have been common since the first modern famine, the Irish potato famine of the 1840s, when a fungus nearly eliminated this primary food source for tenant farmers in Ireland. As Busch notes, “Ironically, during the entire period of the famine, Ireland continued to export grain, meat, and other expensive foodstuffs—in quantities that would have been more than able to alleviate the famine.”<sup>11</sup> The problem was not a shortage of food, but a shortage of political will to modify an economic system in which the productive land was owned by a few who exploited poor tenant farmers to produce commodities for export.

Similar conditions persist today. Professor Mamadou Diawara, a scientist in Mali, compares GE in agriculture to medicines when he states: “We have had antibiotics since 1928. But we still have kids dying daily here from very light infections. The challenge is not technical. It is social and political. It is finding simple solutions on the ground.”<sup>12</sup> The point is that, like medicine, food may be available; however, when more than 2 billion people in the world make less than \$2 per day, they are going to find it difficult to purchase food, even if agricultural yields continue to rise.

Hunger may be caused by political corruption and instability, war, and other factors. However, it is primarily caused by poverty. And perversely, as has already been indicated, the oversupply of agricultural commodities in the world may be causing poverty by undermining the viability of small farmers. Therefore, increasing agricultural production is no substitute for a genuine, global effort to redistribute wealth through education efforts, economic development programs, and fair international trade policies.

A committee of experts and activists from industrialized and developing countries was assembled with the title *The International Assessment of Agricultural Science and Technology for Development*, which was sponsored by the United Nations, the World Bank, and several countries. The committee concluded that, rather than rely on GE, hunger might more effectively be addressed by adopting approaches that simultaneously address social, economic, and environmental challenges including: agro-ecological production strategies to address environmental issues, developing opportunities for poor farmers and rural laborers, integrating traditional and community knowledge into formal knowledge, and creating space for more diverse voices.<sup>13</sup>

## Patents and regulation

Concurrent with the dramatic changes in agriculture over the past century, a small number of large agribusinesses have gained greater market share of the complete production and distribution process: agricultural inputs, commodity buying and processing, and transportation and distribution. And these companies have extended their production, processing, and distribution networks around the globe.

Proponents of GE in agriculture claim that patent protection granted to these companies provides an incentive to investment in the development and distribution of improved crops and animals. Since these large agribusinesses can mobilize substantial financial and intellectual resources in the pursuit of specific goals, the hope is that these companies will bring vigor to efforts to address agricultural problems.

Opponents counter that granting patent protection on agricultural crops and animals provides agribusinesses unprecedented control over the food supply, which may lead to higher prices for consumers and force farmers to purchase seeds and breeding stock, thus undermining the viability of small and medium-sized farmers. Although most parties agree that GE crop technology is a powerful new agricultural tool, the United Nations Food and Agriculture Organization (FAO) contends that important factors, such as patenting of seeds, may generate food insecurity along with any benefits.<sup>14</sup>

The disparate social and economic impacts of technologies, such as GE in agriculture, have led some to question the adequacy of government regulatory processes. As has already been discussed in Session A5, government regulatory agencies rely on three standard criteria to evaluate and approve new products and processes: (1) food safety for human consumption, (2) risks to animals and the environment, and (3) technical efficacy. However, increasingly over the last couple of decades, social scientists, citizen groups, and policy makers have recognized a fourth criterion: the social and economic effects of a product or technology.<sup>15</sup> Many Christians may consider this fourth criterion to be consistent with concerns for justice.

The fourth criterion has been advanced by people who increasingly recognized that the issues of GE in agriculture are not purely technical, but also concern the balance between the different worldviews and values that enter the scene of national regulatory and product approval processes. Assessing the perils associated with GE crops and animals, therefore, becomes a complex problem that is being heatedly debated.

## Christian responsibility for moral deliberation

The ELCA's social statements *Economic Life: Sufficient, Sustainable Livelihood for All* and *Caring for Creation: Vision, Hope, and Justice* offer important resources for evaluating the promises and perils of GE in agriculture. The principles of sufficiency, participation, and sustainability provide resources for critically engaging the conventional wisdom and prevailing political philosophies serving as obstacles to theological and moral reflection surrounding scientific research and new technologies.

Debates about new technologies tend to be shaped by four prominent perspectives: (1) technological developments are synonymous with progress, (2) scientific and technical decisions can be made apart from consideration of social values, (3) a market-place of individuals in pursuit of private gain offers a more efficient means of determining the appropriateness of a technology than a government regulatory body, and (4) moral deliberation on the part of citizens, usually through the mechanism of government policy, is necessary to enhance the common good by ensuring a broad distribution of the promises and perils of new technologies. Sociologists note that the first three perspectives tend to prevail in the U.S. debates. The fourth is more prominent in Europe, but still not dominant.<sup>16</sup>

The lack of emphasis on the promotion of the common good is problematic from a Christian perspective. *Economic Life: Sufficient, Sustainable Livelihood for All* claims that all too often, presuppositions regarding scientific progress, markets, and government regulations inhibit Christians from engaging their vocational responsibility to deliberate and

strive to promote the common good. This would seem to indicate that the dominant institutions of modern society—science, economy, government—are morally empty without a mobilized citizenry committed to moral deliberation.

## Invitation to conversation, prayer, and action



### QUESTIONS FOR DISCUSSION

- Christians may disagree on the promises and perils of a new technology; however, a reasonable starting point for a technological debate between Christians is on the principle of neighbor love. Based on the principle of neighbor love, what conditions need to be met before a new technology can be said to contribute to the common good?
- Are all technologies synonymous with progress? What role can science, markets, government policies and regulations, and individual Christians play in ensuring that the promises and perils of new technologies are distributed fairly?
- How is it possible that what one person considers the promise of a technology another might deem a peril? Can both be right?
- When new technologies are introduced, it is likely that each will bring with it some promises and some perils. How might well-meaning people work to maximize the promises and minimize the perils?
- How does the problem of sin inform a Christian's perspective on unintended consequences from GE in agriculture and precaution?

### *Closing prayers*

#### INVITATION TO INTERCESSORY PRAYER

Pray for farmers, agribusiness representatives, and consumers.

#### PRAYING WITH THE TRADITION

Grant to me, O merciful God, that I might ardently love, prudently ponder, rightly acknowledge, and perfectly fulfill all that is pleasing to you, for the praise and glory of your name. Amen.

(Prayer of Thomas Aquinas, who lived from 1225 to 1274)

## Genetic Engineering in Agriculture

	PROMISES	PERILS
CROPS	<ul style="list-style-type: none"> <li>• Resistance/tolerance to disease, pests, herbicides</li> <li>• Increased yields</li> <li>• Improved nitrogen fixation</li> <li>• Tolerance to drought, frost, and other environmental stresses</li> <li>• Reduced need for fertilizer and pesticides/herbicides</li> <li>• Reduced labor and input costs</li> <li>• Faster than traditional plant breeding</li> <li>• Produce pharmaceuticals</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced biodiversity</li> <li>• Unforeseen consequences of mixing genes across species</li> <li>• Creation of resistant weeds and pests (super weeds and super pests)</li> <li>• Farmers unable to replant saved seed</li> </ul>
ANIMALS	<ul style="list-style-type: none"> <li>• Increased hardiness and productivity</li> <li>• Disease resistance with fewer antibiotics</li> <li>• Improved disease diagnosis and treatment</li> <li>• Better yields of meat, eggs, and milk</li> <li>• Faster than traditional animal breeding</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced genetic diversity</li> <li>• Unforeseen consequences of mixing genes across species</li> <li>• Inhumane treatment of animals</li> <li>• Creation of resistant animal diseases</li> </ul>
CONSUMERS	<ul style="list-style-type: none"> <li>• Enhanced taste and quality</li> <li>• Improved nutritional content</li> <li>• Longer shelf life for fruits and vegetables</li> </ul>	<ul style="list-style-type: none"> <li>• No labeling in many countries</li> <li>• Limited regulatory capacity in many developing countries</li> <li>• Food safety concerns (allergens)</li> <li>• Long-term effects not known</li> <li>• Mixing genes among species objectionable to some</li> <li>• Loss of food if devastated by resistant disease or pests</li> </ul>
ENVIRONMENT	<ul style="list-style-type: none"> <li>• Reduced chemical usage</li> <li>• More benign herbicides and pesticides</li> <li>• Natural waste management</li> <li>• May enable more efficient food processing techniques, thus reducing energy use</li> </ul>	<ul style="list-style-type: none"> <li>• Gene flow to wild relative through pollen drift</li> <li>• Unintended consequences</li> <li>• Farmer liability for unforeseen consequences</li> </ul>
SOCIETY	<ul style="list-style-type: none"> <li>• Higher yields increase global food supply</li> <li>• Less water pollution from less chemical usage</li> <li>• More efficient use of land resources</li> </ul>	<ul style="list-style-type: none"> <li>• Higher yields exacerbate agricultural commodity oversupply, leading to lower farm income</li> <li>• Hunger or famine created by lack of alternative varieties if GE plant or animal destroyed by pest or disease</li> <li>• Bio-piracy: industrialized nations exploiting resources of developing countries</li> <li>• Increasing dependence on scientific expertise over farmer knowledge and skills</li> <li>• Few, large companies control the world food supply</li> <li>• Profits concentrated in wealthier nations</li> </ul>

## Endnotes

- 1 Excerpt from: Adam Liptak, "Saving Seeds Subjects Farmers to Suits Over Patent" *New York Times*, Nov. 2, 2003. [www.nytimes.com](http://www.nytimes.com).
- 2 Excerpt from: Carol Kaesuk Yoon. 1999. "Stalked by Deadly Virus, Papaya Lives to Breed Again." *New York Times* July 20, 1999. [www.nytimes.com](http://www.nytimes.com).
- 3 Excerpt from: Andrew Pollack "Genes From Engineered Grass Spread for Miles, Study Finds," *New York Times*, Sept. 21, 2004. [www.nytimes.com](http://www.nytimes.com).
- 4 Clive James, *Global Status of Commercialized Biotech/GM Crops*, ISAAA, Ithaca, New York, 2007. [www.isaaa.org/Resources/Publications/briefs/37/executivesummary/pdf/Brief%2037%20-%20Executive%20Summary%20-%20English.pdf](http://www.isaaa.org/Resources/Publications/briefs/37/executivesummary/pdf/Brief%2037%20-%20Executive%20Summary%20-%20English.pdf)
- 5 Erik Stokstad, 2008, "Dueling Visions for World Hunger." *Science* 319(March 14): 1474-1477.
- 6 Robert A. Hoppe, Penni Korb, Erik J. O'Donoghue, and David E. Banker. 2007. *Structure and Finances of U.S. Farms: Family Farm Report, 2007 Edition*. USDA: Washington, DC.
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- 8 Linda Labao and Katherine Meyer. 2001. "The Great Agricultural Transition: Crisis, Change and Social Consequences of Twentieth Century US Farming." *Annual Review of Sociology* 27: 103-124.
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- 10 Amy Waldman. 2002. "Poor in India Starve as Surplus Wheat Rots." *New York Times*. December 2. <http://query.nytimes.com/gst/fullpage.html?res=9D0CE0D91E38F931A35751C1A9649C8B63&scp=1&sq=350%20million%20hungry%20india%20december&st=cse>
- 11 Lawrence Busch. 2000. *The Eclipse of Morality: Science, State, and Market*. New York: Aldine De Gruyter. p. 100.
- 12 Tom Knudson, Edie Lau, and Mike Lee. "Seeds of Doubt: Mali's People Reap No Reward from Cloned Wild-Rice Gene." *Sacramento Bee*. June 6, 2004. [www.sacbee.com](http://www.sacbee.com).
- 13 Erik Stokstad, 2008, "Dueling Visions for World Hunger." *Science* 319(March 14): 1474-1477.
- 14 Food and Agriculture Organization. 2004. *The State of Food and Agriculture*. Agricultural Biotechnology: Meeting the Needs of the Poor? (Rome: FAO).
- 15 William B. Lacy. 2000. "Agricultural Biotechnology, Socioeconomic Issues, and the Fourth Criterion." (pp. 77-89) In Thomas J. Murray and Maxwell J. Mehlman *Encyclopedia of Ethical, Legal, and Policy Issues in Biotechnology*. John Wiley & Sons, Inc.
- 16 D.L. Kleinman and A.J. Kinchy. 2003. "Why Ban Bovine Growth Hormone? Science, Social Welfare, and the Divergent Biotech Policy Landscapes in Europe and the United States." *Science as Culture* 12(3), 375-414.