

# Biotech's Plans to Sustain Agriculture

Popular movements may call for more organic methods, but the agricultural industry sees biotechnology as a crucial part of farming's future

## KEY CONCEPTS

- By 2050 or so, agriculture will need to produce about 50 percent more food than it currently does because of the expanding population. Traditional crops and farming methods could not sustain that much productivity.
- Representatives from the agricultural industry defend genetically modified crops as one of several tools that should be used to help farmers in developing countries become more productive.

—The Editors

If environmental and economic sustainability is ultimately a matter of balancing the human race's consumption and productivity, then the agricultural industry leans heavily on both sides of that scale. Its drain on the earth's resources is enormous: it claims 70 percent of all freshwater taken by our species and more than 40 percent of the planet's solid surface (nearly all the arable land), with attendant casualties in biodiversity. Yet modern agriculture is also the only reason we can produce enough food to nourish our population of 6.8 billion—a number slated to reach more than nine billion by midcentury. Keeping up with that steeply rising demand thus defines the challenge of sustainability not only for agriculture but for humanity.

Agriculture depends on many technologies, but biotechnology might be the most influential among them. To find out how the industry perceives its prospects for raising both global crop productivity and sustainability, contributing editor John Rennie spoke with representatives of four leading agricultural biotechnology companies. What follows here is an abridged version of their edited conversation.

—The Editors

## THE PARTICIPANTS



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COURTESY OF DUPONT (Borel); COURTESY OF SYNGENTA (Fischer); COURTESY OF MONSANTO (Fischhoff); COURTESY OF DOW AGROSCIENCES (Galindez)



**SCIENTIFIC AMERICAN:** How much of industry's effort to make farming and agricultural biotechnology sustainable represents a response to a demand in the marketplace for sustainability today, as opposed to a sense that there will be a future market opportunity or imperative for it?

**BOREL:** Sustainability is something that's core to DuPont and has been for a couple of hundred years. And biotechnology is one of the tools that we employ to help us move forward. As I think about agriculture, biotechnology is helping us help farmers produce more on the same or fewer acres of ground in more sustainable ways. I think about biotechnology as a set of tools, and they are helping us live out the mission of the company.

**FISCHHOFF:** It's been one of the goals of agricultural biotechnology all along to produce more with less, to reduce pesticide inputs, to deal with issues such as insufficient water or drought tolerance. Increasing population, increasing food demand and issues such as climate change have only redoubled our focus on those things.

**GALINDEZ:** You have to also take into account that as an industry we need to forecast the market environment, the regulatory environment, the environmental standards 10 or 15 years down the road, because every product we discover today takes that long to launch to the market. You always know that those standards continue to increase, and they have done so for the past 50 years. So I think as an industry, it has always been there in the fabric of the way we work.

**FISCHER:** With the challenges that we have going forward—with a growing world population and changes in diet—we know that in 25 or 30 years we are going to have to produce 50 percent more food than we are producing today. So we will have to grow more from less. It is our view at Syngenta that biotechnology is one of the tools to achieve that goal. To manage this challenge, growers will need to have access to the best available technology.

**SA:** Major conservation and sustainability worries involve freshwater and topsoil. What are some of the best technological options for tack-



**NEW STRAINS of crops with desirable traits are under development using a variety of transgenic and breeding technologies. Public controversies over the plants' environmental and economic effects persist, however.**

ling these problems? Perhaps we can talk about nontechnological options, too.

**FISCHHOFF:** For agriculture, the world is divided into those crops that currently get sufficient freshwater from sources such as rainfall and those for which farmers need to resort to harvesting water, say, through irrigation or from other sources. But I think even in cases where crops are primarily rain fed, you could argue that nearly every crop at some point during its growing season has less than optimal water. The ways of addressing that big challenge, both at Monsanto and industrywide, are really mainstays of what we do in agriculture these days.

One is through breeding—by adapting crops as best we can and using the natural diversity in the crop germplasm to increase the levels of drought tolerance, which is the capability to better use the water that is available. And over and above that, there is enhancing that capability using genetic engineering techniques—to bring new genes into crops and give them greater tolerance to drought-like conditions. I think both those techniques are showing excellent promise. This has been a long-standing problem in agriculture and for agricultural biotechnology, and I think we're finally seeing the day when we can look forward to crops that have a much better water-utilization efficiency.

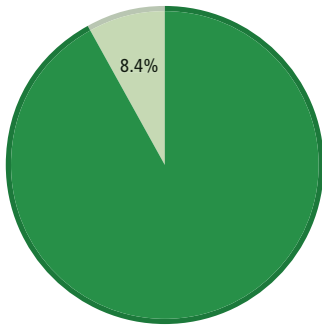
**BOREL:** Drought tolerance and nitrogen-use efficiency are very exciting. They're not going to be ready next year, but they're not very far away, either. If you think about the broader issues that

you mentioned, often times the solution is a suite of technologies or maybe even something beyond technology involving management practices. For instance, farmers have moved toward significant reductions in tillage, which has helped reduce soil erosion and reduced farming's environmental impact—this has been partly enabled by advances in crop genetics, partly by better crop-protection chemistries, partly by better equipment, and so on. So the whole system is moving forward, and most times you find farmers are as interested or even more interested in environmental sustainability than the folks who don't live on the farm.

**FISCHER:** In the case of Syngenta, we have programs that identify genetic variation and physiological changes in plants that help them to survive drought and other stress conditions, and we try to incorporate those genes identified through breeding technology. We expect to launch our first water-optimized products after 2011. We also are developing other alternatives. Take the product that we are introducing next year here in the U.S. called Invinsa. It protects crop yields during extended periods of high temperature and mild to moderate drought and other crop stresses.

**FISCHHOFF:** The general public may not realize that in some cases the benefits of modern agriculture technology come from the dissemination and adoption of conservation tillage and reduced tillage methods. And those in turn have been largely helped—not solely but largely—by the use of herbicide-tolerant crops, like those with our Roundup Ready trait and others, which help farmers use low-tillage methods much more effectively. It's not the only reason why herbicide-tolerance technology is a good thing and helps farmers and helps sustainability, but it's one of those side benefits that I think doesn't get mentioned often enough.

**GALINDEZ:** I think all the companies here today are going to have significant investments addressing drought and flood or excessive water or reductions in nitrogen fertilizer use. But there are other angles. For example, we are benefiting from biotechnology today in the area of healthy oils. If you look just at the program Dow Agro-Sciences has with omega-9 fatty acids, then you know we have removed, in the past three years, half a billion pounds of trans fats and saturated fats from the North American diet. Think about



PERCENT OF GLOBAL ARABLE LAND

GM Non-GM

**GENETICALLY MODIFIED crops make up a small but rising share of farm productivity, as reflected in the amount of arable land bearing them.**

**SOYBEANS (below, green) planted with no-till technologies grow amid the stubble in a wheat field. Such no-till approaches can conserve precious topsoil.**



the secondary impact of those health indications in the whole environment; that's another aspect that people are not normally aware of, of what modern agriculture is bringing to the table.

**SA:** Are there nonbiological aids to sustainability that you in the biotech industry are counting on to emerge? For example, I've heard hopeful discussion about improvements in irrigation technologies and ways of using information technology to deliver water more prudently to crops. To what extent are you in biotech depending on complementary technologies in other industries and their timelines for development?

**FISCHHOFF:** All those technologies really go hand in hand. We've made a commitment at Monsanto to work toward doubling the yields in the major crops that we work on—in corn, soybean and cotton, in particular—by 2030. And we see that result as having to come from three different types of effort. One is clearly biotechnology in the sense of new gene insertion and new traits. The second is biotechnology in the support of breeding—basically, DNA-marker-assisted breeding to enhance and improve the rate of yield increase available to plant breeders. And then the third is this whole area of agronomic practices, which includes precision agriculture based on remote sensing and global positioning. That is, planting the right seed in the right place depending on the field conditions or having the precise applica-

tion of pesticides, nitrogen fertilizer or other inputs. It takes advantage of new equipment for irrigation and new planting technology, for example, that would allow putting more plants per acre while still getting high yields. I don't think any one of those pieces alone will allow us to achieve these goals. I think we really need all three working together.

**SA:** Transgenic technologies are the ones most synonymous for the public with the development of many of the traits you mentioned.

**FISCHER:** At Syngenta, we believe that the combination of different technologies is actually what is going to allow us to increase food production by 50 percent over the next 25 years, which is what we need to do to feed the growing world population. So it's not only biotechnology; it's not only seed genetics; it's also crop-protection chemicals and the technologies associated with their use. Of course, we know that genetically modified foods and pesticide products are the most extensively tested and regulated in the entire food sector, so that should give us confidence that when these products come to the market they are tested and they are safe if they are used according to the labels.

**FISCHHOFF:** There is still a lot of debate, at least in some sectors. I think all my colleagues would agree that, by and large, the data show that there are well-defined, well-characterized benefits: from the reduction of pesticide use in some crops to increased yield and increased value to the growers. We've seen the very rapid adoption of the technologies by growers in those countries where they have been available. Certainly we have seen this in the U.S. with corn, soybean and cotton and with canola in Canada.

I think there are about double the acres of insect-resistant cotton planted in India as in the U.S., even though GM [genetically modified] cotton got a relatively late start there as compared with the U.S. I think in every country where growers have basically been able to "vote" in terms of what they would like, they have seen the benefits, and there has been this great adoption. That speaks volumes.

**SA:** But the standard rebuttal, as you know, is that the benefits of GM crops accrue lopsidedly to the seed producers and larger farms and not necessarily to the smaller farming interests, which may be more common in poorer regions.

BILL BARKSDALE (soybean); MELISSA THOMAS (illustration)

**"The big, big challenge in front of us in the next 40 years will be meeting the needs of the much larger population. You cannot meet that supply challenge without doing it sustainably."**  
*—Antonio Galindez, Dow AgroSciences*

What's disturbing to a lot of people is the economic side of the sustainability issue for these crops.

**FISCHHOFF:** There are, by our understanding, almost four million cotton growers in India who are raising insect-resistant cotton now, and they are growing cotton on a very, very small scale. We've seen similar adoption by small-scale growers in the Philippines. In South Africa we see it with insect-resistant cotton. Those are places where the value is clearly on the side of the grower, and I think our grower customers know that our products are priced to the value they deliver, whether the product involves a seed, or a genetically modified trait, or a new chemical or treatment. The growers get a very large share of that total value. Certainly we're all profit-making companies and we need to make money on what we produce, but I don't think it's disproportionately shared at all.

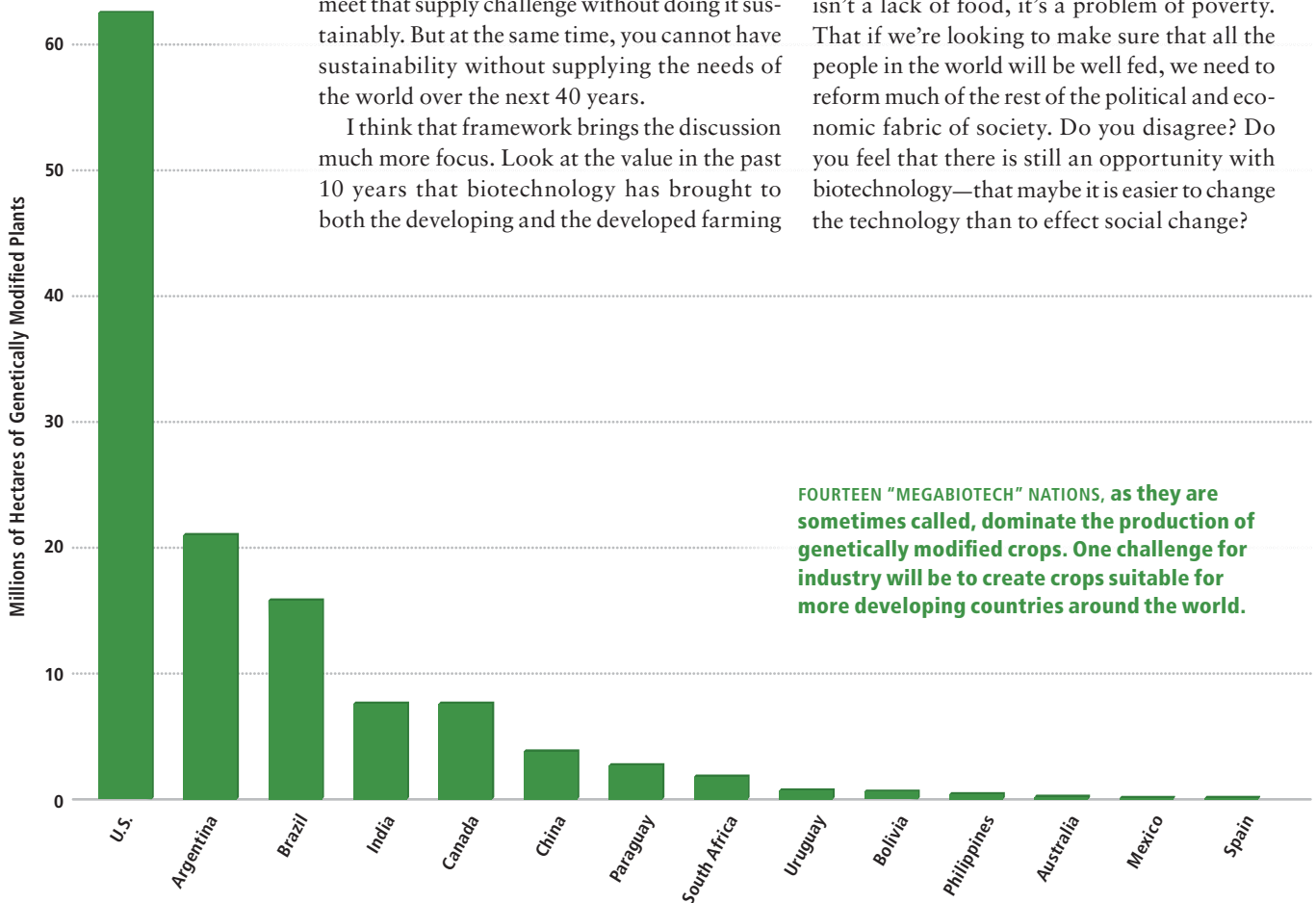
**GALINDEZ:** The big, big challenge in front of us in the next 40 years will be meeting the needs of the much larger population. You cannot meet that supply challenge without doing it sustainably. But at the same time, you cannot have sustainability without supplying the needs of the world over the next 40 years.

I think that framework brings the discussion much more focus. Look at the value in the past 10 years that biotechnology has brought to both the developing and the developed farming

community. The biotech is not the only element; it's not the only tool in the box. But I think there are enough facts, if we want to look for them, that tell us that it has become one of the important tools. Together with machinery, together with irrigation technology, together with IT and the globalization of information, biotechnology is bringing the solution to both supply and sustainability.

**FISCHER:** It's not only about the benefits of the technologies that we develop but also the possible trade-offs that we would have to make. If we need to produce more food, we can do so either by bringing more acres into production, which is going to have an effect on the environment, or by increasing the efficiency and productivity of the current acres. I think the answer is clear: we should work harder to achieve greater productivity on the current acres using the best technologies available. But that is going to be a discussion we need to have as well.

**SA:** I'm sure you have all often heard the comment that the real cause of hunger in the world isn't a lack of food, it's a problem of poverty. That if we're looking to make sure that all the people in the world will be well fed, we need to reform much of the rest of the political and economic fabric of society. Do you disagree? Do you feel that there is still an opportunity with biotechnology—that maybe it is easier to change the technology than to effect social change?



**FOURTEEN "MEGABIOTECH" NATIONS, as they are sometimes called, dominate the production of genetically modified crops. One challenge for industry will be to create crops suitable for more developing countries around the world.**

MELISSA THOMAS; SOURCE: FRIENDS OF THE EARTH INTERNATIONAL, 2008; BASED ON DATA FROM FAOSTAT, 2007, AND ISAAA, 2008



**CROPS MOST COMMONLY MODIFIED include cotton, soybeans, corn and canola for its oil (left to right). The traits genetically engineered into them have mostly involved greater pesticide resistance.**

**BOREL:** Well, maybe if we start with Africa as an example, where there are a lot of people suffering from poverty and malnutrition, the technology can help. There are stories of farmers who have adopted hybrid technology in corn, and it's fundamentally changed their lives—their ability not just to feed their family but also to sell the crop and to have enough money to send their kids to school. There are amazing stories of impacts on people's lives with what, to us in the U.S., is fairly basic technology.

But it's more than just the technology. It takes access to credit. It takes land tenure. It takes insurance. It takes market access and communications. So certainly a focus we all have is to bring science to the market in a way that makes a difference. But I think—certainly at DuPont—we're also working with organizations to try to improve the infrastructure development and the local capability. In our case, we work directly with farmers in virtually all the countries in which we operate. In addition to the technology, it's working to help them get the right product on the right acre, whether in the center of Iowa or in a local area in Ethiopia.

**FISCHHOFF:** We can't solve all the world's poverty and food-distribution problems, but one of the things we can do is make sure that our technologies are accessible and available to farmers at all scales and in all countries.

One example is the way in which we can work with other organizations that are better able to address those problems. Monsanto has

a partnership with some of the international agricultural institutes and with the Gates Foundation on delivering drought-tolerance technology in varieties and hybrids of corn adapted for Africa as quickly as possible after it is available to growers here in North America.

**FISCHER:** That's the same approach that we use in Syngenta. We develop our technologies and try to adapt them so that farmers all over the world can afford them. We have a policy of providing our technology, royalty-free, to benefit subsistence farmers in developing countries.

**FISCHHOFF:** We also can't ignore that we are now seemingly balanced just about equally between grain supply and grain demand every year. As the population increases, in order not to have more people be undernourished, we really need to keep this momentum for increasing yield and productivity going forward, or we'll be in an even worse situation.

**BOREL:** I think it surprises some people to realize that in 2008 more than 13 million farmers planted biotech crops. The surprise often comes when they realize that more than 12 million of those were small-scale farmers. There are still many countries where the traits and the advanced technologies aren't present yet, but there is a lot of work the industry is doing, and we as companies are doing, to get those technologies out where they can make a real difference regardless of the size of the farming operation. ■

STOCKBY/GETTY IMAGES (cotton); NEIL FLETCHER AND MATTHEW WARD/Getty Images (soy plant leaves); BURAZIN/Getty Images (corn); BOB O. A. SCHIBEN/Getty Images (oil bottle)