

BIOTECHNOLOGY OFFERS U.S. FARMERS PROMISES AND PROBLEMS

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Transgenic crops promise to drastically change how farmers produce and market their feedgrains and oilseeds. These changes will produce challenges for United States (U.S.) farmers and the entire agricultural industry. How these obstacles are resolved will impact the future use of biotechnology on U.S. farms.

Key words: agriculture; biotechnology; farmers; genetically modified crops (GMC); input traits; output traits, transgenic.

Biototechnology promises to add another chapter to the revolutionary changes that have shaped U.S. agriculture over the past 100 years. Just like the switch from horses to horsepower and mechanical weed control to chemical control, genetic engineering will forever change how farmers produce crops. But unlike previous breakthroughs, biotechnology may rewrite the book on production agriculture--and the entire industry.

What determines whether or not a farmer adopts a new technology? Basically, it comes down to two simple questions. First, does it work? And second, will it make money? From a farmer's perspective, technology is successful only if it is profitable.

To find out, farmers generally try a promising new technology on a limited basis first. If they see a clear advantage and are comfortable using it, they expand acreage until it becomes a standard production scheme on their farms. This adoption process usually occurs over several years, through steady and sustained growth.

But acceptance of biotechnology down on the farm is occurring at an unprecedented growth rate. In 1995, there were no commercial plantings of genetically modified crops (GMCs) in the U.S. Today, it is estimated that 33% of the corn crop, 44% of the soybean acres, and 55% of cotton fields are planted to transgenic hybrids and varieties that have built-in resistance to selected insects and herbicides. Industry watchers expect the bio-engineered expansion to continue as new products come on the market.

The First Wave Of Biotechnology

Input traits represent the first wave of biotechnology. They provide a new level of protection against pests and are a powerful weapon in weed control arsenals. Early commercial products include

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Bacillus thuringiensis (Bt) corn. These genetically-altered hybrids contain a naturally-occurring soil bacterium, Bt, that kills European corn borers. *Bacillus thuringiensis* cotton protects the crop against tobacco budworm and bollworm. Farmers can expect to see genetically engineered corn hybrids that resist rootworms in the next two to three years.

To fight weeds, farmers have several genetically-engineered options to choose from. Roundup Ready (glyphosate-tolerant) soybeans and corn, and LibertyLink (glufosinate ammonium) corn are some examples. These crops are immune to the broad spectrum, but non-selective herbicides, such as Roundup, Touchdown and Liberty. When applied, the herbicide kills the weeds without harming the crop. In the case of cotton, farmers can turn to BXN (Bromoxynil) or Roundup Ready herbicide-tolerant varieties. More herbicide-resistant crops are on the way.

The rapid adoption of biotechnology can be attributed to several factors. These are as follows:

- Cost savings. Herbicide- and insect-resistant crops generally lower pesticide use and require fewer trips across the field. Fewer trips means lower energy costs.
- Convenience. Most new technology is easy to use. Farmers are also well familiar with a herbicide like Roundup and know what to expect in weed control performance. In addition, broad spectrum control requires less time to scout and manage crops.
- Environmentally friendly. Less pesticides reduce the odds of potential runoff. And many of the GMOs encourage the use of conservation tillage practices, enhancing efforts to save soil and to protect water quality.

Companies plan to add more value to bioengineered crops by stacking multiple traits. Several products are already available for corn and cotton that provide herbicide- and insect-tolerance. In addition, scientists are searching to unlock the genetic codes that will protect crops against environmental stresses (droughts, floods, and temperatures) and to enhance a crop's ability to utilize nutrients and water resources.

That is good news for farmers. Biotechnology will offer them additional tools to protect--and increase--yield potential. But while the benefits of these biotechnology crops are readily apparent, farmers are still sorting out how they fit into their overall operation. Questions they continue to ponder include the following:

- Do GMCs pay? High-tech seed carries premium prices. Some companies attach a technology fee of \$5 to \$15 per acre to purchase the seed. That is in addition to the higher prices this seed generally carries versus conventional choices. Farmers must factor in these added costs when making purchasing decisions.

Insect pressure is difficult to predict and may not warrant the use of an insect-tolerant variety every year. If it is planted under low insect conditions, the genetically altered seed becomes expensive insurance against the threat of insect damage. Also, variable growing conditions between fields and regions make it nearly impossible to formulate projected economic returns on a consistent basis.

- Do GMCs yield? There are no yield guarantees regardless of the kind of seed you plant. However, when the first herbicide-resistant soybeans were released, for example, many farmers reported that they did not yield as well as the elite non-GMC varieties. Some thought the new technology produced a yield drag. But in truth, it was because many of the early GMCs were not

placed in a company's elite seed. As old germplasm is replaced with the newest and the best, concerns over yield differences -- real or perceived -- will decrease.

When first released, transgenic cotton also experienced growing pains in certain growing regions. The yield-hampering problems were amplified by environmental stresses and other factors. In both instances, farmers learned valuable lessons: GMCs are not a cure-all. And some may require a higher level of management than conventional crops.

- Will GMCs last? The overuse of any technology fuels fears that weeds or insects may eventually develop resistance to the science. That's one reason farmers are required to plant a certain percentage of their acres to a refuge (non-GMC hybrid) when using Bt corn. For herbicide-tolerant crops, rotating herbicides and mode of actions will help reduce the odds of resistant weeds.
- Who will buy GMCs? The European Union and some Asian countries view biotechnology, and food derived from the gene-altered crops, with hostility and suspicion. This viewpoint threatens potential grain sales for U.S. farmers. If there is not a market for a crop, farmers are not going to plant it. The fallout from Europe's concerns was amplified earlier this year when some U.S. processors announced that they would not buy corn from hybrids not approved by the European Union.

The Second Wave Of Biotechnology

The second wave of biotechnology is output traits. Unlike input traits that are designed to protect and enhance yield, output traits promise to enhance the value of the crops from the farmer to the consumer. A myriad of specialized grains with unique uses is, and soon will be, on the market. For growing tailored traits, farmers can earn premiums on each bushel. These premiums range from as little as 20 cents per bushel to several dollars per bushel depending on market demand and specifications. Dr. Charles Hurburgh, a specialist in grain quality at Iowa State University, predicts that 40% of the corn and soybeans grown in the U.S. will eventually contain a value-added trait for a specific end use.

Early efforts in valued-added crops have focused on enhancing the value of animal feed since livestock are the dominant users of feedgrains. This has led to the development of high-oil corn and hybrids with increased levels of amino acids and starch, to name a few. Other traits include low phytate corn, also known as high available phosphorus corn, that increases the digestibility of the phytate nutrient by swine and poultry. As a result, less phosphorus is excreted in the manure, making it more environmentally friendly.

For soybeans, many of the tailored traits are being developed to produce healthier oils and soy foods. The most common specialty soybeans are high oleic, high sucrose, low saturate, low linolenic and low null (produces a less beany taste).

Work is also progressing to turn plants into factories, using bio-engineered crops for renewable energy sources and industrial uses. Genetic engineering may also help tailor plants into nutraceuticals -- the blending of a regular food product with a health-enhancing attribute, like calcium-enriched orange juice.

Finally, some see biotechnology as a way to use plants to produce vaccines and other important medicines. Or the crop could be manipulated to contain a drug allowing it to be distributed and administered orally.

Like their input trait cousins, specialty crops that contain bioengineered output traits also face potential challenges that will impact the rate of adoption by farmers. These challenges are as follows:

- Do not fool Mother Nature. A living plant can throw any number of roadblocks at science, no matter how good the technology. What may make sense in the laboratory may not make sense to the plant. When you ask a plant to do something different from its normal physiology, you do not know how it will react. So the promise of something big could turn instead into an empty promise.
- Share the wealth. Everyone who participates in a value-added system must be adequately compensated. Farmers worry premiums may disappear if everyone jumps in. There is also concern they will not share in the higher margins that generally go to players outside the farm gate.
- Build solid relationships. To be a viable player in the value-added chain, farmers must develop relationships along the entire chain. Specialty grains could eventually change the entire scope of production agriculture, moving it towards contract production, similar to what is found in the poultry and hog industry. Interdependence will replace independence. Some farmers may choose not to participate.
- Keep it separate. Specialty grains must be segregated from commodity crops. The question is who will develop and pay for the immense infrastructure required for value-added grains? Costs could be so prohibitive that the returns may not justify a farmer's participation.
- Politics. Our trading partners overseas are much more skeptical of genetically modified crops than we are in the U.S. These hurdles will be difficult, but not impossible, to overcome. Acceptance will be slow. Regardless, consumers everywhere must believe there is value in the final product no matter what the level of technology.

Like most revolutions, no one really knows how it will end. But one thing is certain, biotechnology offers exciting promises and prospects for the American farmer. And it will forever change U.S. agriculture.