Journal of Agricultural and Applied Economics, 29,1(July 1997):117–122

Competitive Strategies of Biotechnology Firms: Implications for U.S. Agriculture

Brett D. Begemann

ABSTRACT

The agricultural biotechnology industry has evolved from a focus on outstanding science to a more mature phase where firms focus on near-term products and building businesses. Understanding complex relationships and distribution channels and a global perspective are crucial to commercialization. Yet, leading-edge technology and early identification of key traits will be critical to developing superior products that ensure competitiveness in the marketplace. Monsanto is organizing around a life sciences model where seed, crop chemicals, pharmaceuticals, and food ingredient businesses will exploit mutual synergies driven by basic science and discovery.

Key Words: biotechnology, Monsanto, strategies.

This paper offers a discussion of some of the things that we at Monsanto see taking place in agricultural biotechnology. First, it will cover how we have conceptualized the recent history of agricultural biotechnology, and how we see it evolving into the future. Then some of the actions that Monsanto has taken over the past 18 months will be reviewed, as well as the underlying strategies.

State of Science

Looking at the state of the science, basic biotechnology development was relatively unfocused up to 1995. There was a lot of basic research, but not many biotechnology products were being brought to the marketplace. The year 1995 marked the broad market introduction of first-generation technology which is expected to continue to the year 2005, the horizon that we will examine (table 1). A significant product flow has begun, such as with the Bacillus thuringiensis (Bt) and herbicide-resistant crops. Crop products with genetically modified quality traits are following closely.

The products of today use mostly single gene traits, where one particular gene is manipulated within a single crop to get some expected result. There is minimal interaction among different genes. Beyond 2005, we anticipate complex applications using new tools and a greater understanding of plant physiology. This will involve using multiple genes to effect a different characteristic within a plant. Consider, for example, the genetic manipulation to create a stronger cotton fiber that is more dyeable for reduced dyeing costs. These are processes that require multiple gene manipulations and will probably occur beyond the 2005 window. Monsanto believes that this is feasible.

Key Success Factors

Before 1995, outstanding science and the ability to finance long-term efforts were critical to

The author is business director for cotton products, and a member of the strategy board for development and biotechnology, the Monsanto Company, St. Louis, Missouri.

Table 1. Agricultural Biotechnology: Retrospect and Prospect

	Inception (pre-1995)	Commercialization (1995–2005)	Growth (post-2005)
State of Science	Basic technology development	Implementation of first-generation technology (e.g., single gene/trait)	Complex applications requiring a full understanding of plant physiology and new tools
Firm Success Factors	Outstanding science and ability to finance long-term efforts	Focus on commercialization of near-term products to build business	Early identification and focus on key market opportunities and skills
Industry Structure	Many small companies and some large companies	Unsuccessful companies exit; successful companies commercialize first products	Emergence of few large, fully integrated companies

success for biotechnology companies. Leading-edge science was essential. Excellent personnel and adequate financial resources to invest heavily in the business were critical for either a large self-funded company or a small start-up relying on venture capital. In the commercialization phase, the focus has shifted to near-term products and building businesses. We expect that commercialization will present significant challenges for biotechnology companies, as agriculture is a very complex industry. Developing and nurturing relationships with upstream and downstream firms will be key to successful product introduction.

In the growth phase beyond 2005, early identification and focus on key opportunities and skills will be required to bring discoveries to the market effectively. There will be some very critical traits in any crop. Those traits will have to be identified early and put into the crop to ensure competitiveness in the marketplace. Timeliness will be essential, as product cycles will continue to shrink.

In the past, when an agricultural chemical company, as Monsanto, developed a herbicide, there normally were many years to work with that product and develop it because the product life cycle was 10 to 15 years long. Then product cycles were narrowed down to about seven to 10 years due to the ability of synthetic chemistry to move products faster, and to move them around patents. Biotechnology will further quicken this pace.

Industry Structure

Changes in industry structure parallel changes in technology and commercialization opportunities. Before 1995, there were a large number of small companies and some large companies doing basic research in biotechnology. Since 1995, and on to 2005, products will be coming into the marketplace, and unsuccessful or marginally successful companies will be exiting biotechnology. Successful companies are commercializing the first wave of products. It is possible that during this initial commercialization period, companies could be successful and sustain themselves on a single product. Ten or 15 years ago, we saw much of the same type of evolution in the computer industry, which is often compared with the biotechnology industry.

Beyond 2005, we believe that the biotechnology industry will look similar to other more mature industries in agriculture. We expect to see the emergence of a few large, fully integrated companies. Manipulation of a particular trait at the agricultural production level can have an impact all the way down the food chain to the consumer. To realize value from this impact, the identity of the crop must be preserved. Identity preservation will be critical throughout the whole process and will drive change more rapidly than what we have seen in the past.

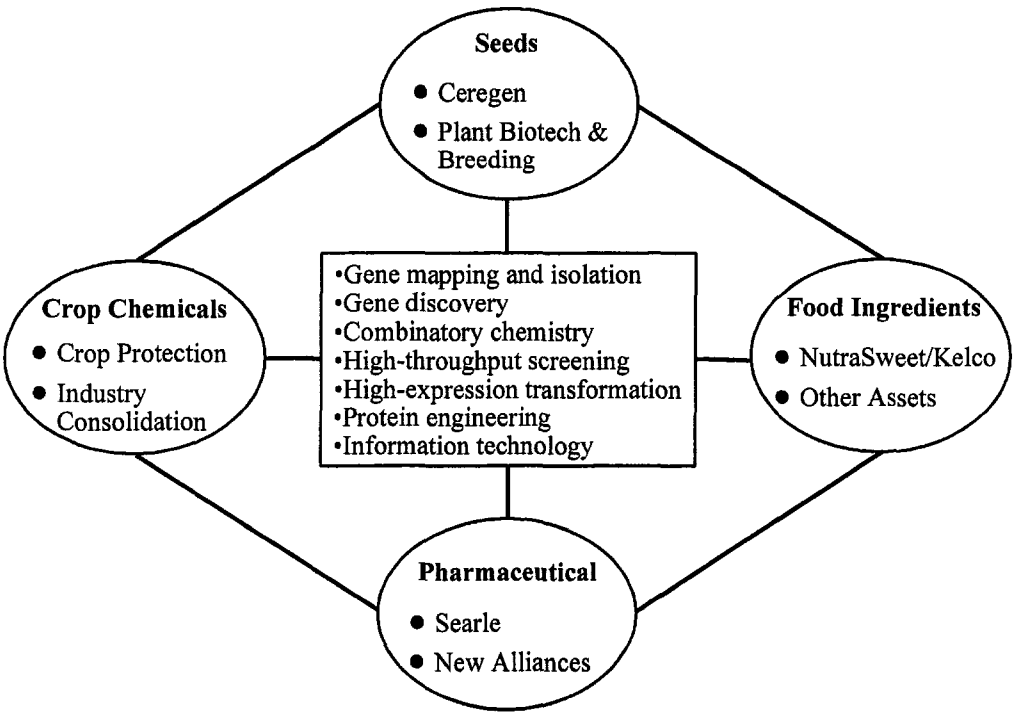

Figure 1. Monsanto's global life science platform

Challenges and Opportunities

Monsanto has demonstrated a very strong commitment to biotechnology that started in the early 1980s, and the fruits of that vision are starting to be realized. We believe that we have developed a strong skill base in our scientific research area, and that we are a leader in the near-term commercialization of our portfolio. We have introduced six biotechnology products into the marketplace over the last 18 months. We have created valuable downstream positions both in the food industry as well as in the pharmaceuticals business. There are many unique opportunities within the various companies and strategic business units of Monsanto, and so they are being merged into what will be termed a "life sciences company" (figure 1). These skill bases, technological assets, and organizations will allow Monsanto to effectively deal with challenges and act on opportunities in the future.

We believe that there are tremendous opportunities in Europe and Asia to grow our business. We also believe that biotechnology is one way of helping us do that. Consider some of these emerging economies around the world and the advantages they have. They are starting from a point further back, but have the advantage of observing what technology can do and what technology is already available. They can leapfrog to new technologies around the world where this expertise is already advanced. So leapfrogging could put some developing countries in advance of some developed countries.

Globalization of markets will require that regulatory issues be resolved. The early ban of Roundup Ready® soybeans in Europe made a lot of headlines and is a good case in point. Global registration was necessary to ensure that a U.S. grower could produce such soybeans for export. As new biotechnology products are introduced, they will tend to be global from the very first day of market introduction. Global markets will create exciting opportunities for biotechnology companies, but they will also present them with challenges of learning to do business in diverse parts of the world.

Issues regarding the distribution of biotechnology products will be increasingly important in the future as biotechnology companies attempt to capture part of the value from their innovation. There already are significant changes in the way that inputs are delivered to a grower. Farmer-saved seed remains an issue for cotton and soybeans, and to some extent wheat. Companies like Monsanto cannot continue to invest aggressively in crops for which growers save the seed and do not pay for the technologies on an annual basis. Equally challenging will be the convergence of different marketing channels. In midwest corn and soybean seed markets, there is a farmer-dealer network. In the cotton geography of the south, there is no farmer-dealer network, but instead a large established chemical industry distribution channel. These elements are coming together and, with products coming into the marketplace, biotechnology and other agricultural companies are striving to manage these dynamics.

In the case of Bollgard cotton in our introductory year (1996), we shifted approximately $75 million worth of insecticide sales that previously were delivered in the can to the seed. That is a huge impact on the channels supplying these products in the marketplace. In the south, the channels were the same for agricultural chemicals and seed, and so the impact was much less than what we have experienced in the past in the midwest. Distribution will present biotechnology companies with a variety of challenges and opportunities. We believe it is not a question of which channel actually survives, but rather one of determining how to manage distribution channels over the near term and to assess how they may look in the future.

It is crucial to prepare and have the best technologies available in the marketplace. In the introductory year for Bollgard cotton, a new technology with a cotton variety that was unproven, it captured 12.5% of the target market for cotton. This demonstrates the impact that superior traits can have on the marketplace in the very first year. By comparison, Delta Pine 20, which has been and still is one of the largest selling varieties of cotton seed, captured only 0.5% of the market in its introductory year. So new traits will have large impacts on competitiveness. Companies must couple these quality traits with the very best germplasm or else their value can be lost. For example, Bt-cotton allows the grower to reduce insect control costs, but if the variety does not yield well, then the insect control value can be lost.

Monsanto's Recent Competitive Actions

Having addressed key challenges and opportunities, let us now consider some of the actions that Monsanto has taken in the last 18 months in the context of our strategies (tables 2 and 3). We have moved to secure our intellectual property position. The Calgene and DeKalb investments gave Monsanto stronger patent positions. Agracetus extended our activities into fiber technology with cotton, as well as into soybeans. We acquired Biopol, a European operation making biodegradable plastics from plant oils. Calgene, with its research and development in oils, is very important to us.

We have invested heavily in second-generation technology. Synteni and Incyte are two computer software companies that have done substantial work in gene mapping. Most of it applies to human gene mapping, but they are very active in plant gene mapping as well. We have agreements whereby they will map genes for us in various crops. Our alliance with Ecogen gives us access to a tremendous library of 10,000 Bt strains for insect control products. We are also working with many universities.

We have made substantial investments in different seed companies. Agripro is a wheat seed company that we acquired to strengthen our wheat seed business. Investment in Coop de Pau, a European cooperative, enhanced our access to wheat germplasm. We believe that we need to couple our technology with superior germplasm to develop the very best hybrids. Asgrow has a tremendous lineup of proprietary soybean germplasm, as well as an effective distribution system. Calgene has plant oil modification technology. DeKalb has proprietary corn germplasm. Our investment

Table 2. Monsanto's Strategic Actions

Investment Transactions*	Assets Gained
Agripro	Strengthened U.S. wheat seed position
Agracetus	Transformation capacity; bioreactor technology; cotton fiber modification; Bt (cotton, soy) FTO
Asgrow	Proprietary soybean germplasm and distribution
Calgene	Plant oil modification; produce and cotton seed
Coop de Pau	Increased stake in French wheat seed
DeKalb	Proprietary corn germplasm and distribution
Delta and Pine Land	Proprietary cotton germplasm and distribution
Ecogen	Bt gene library and gene screens
ELM	Preferred technology provider relationship
Gene Acquisition Program	Multiple enabling technologies
Holdens	Proprietary corn germplasm and distribution
Incyte	Corn gene sequencing
Japan Tobacco	Joint research in rice
Synteni	Gene expression technology (microarrays)
Terrazawa	Brazilian soy access
Zeneca	Biopol, genes and associated technologies

* Other transactions in process.

Table 3. Monsanto's Significant Relationships

Activity	Significant Relationships
Secure patent positions	Calgene Agracetus DeKalb
Enter new areas	Agracetus Biopol Calgene
Invest in 2nd-generation technology	Synteni Ecogen Incyte Gene Acquisition Program (> 50 deals)
Enter seed businesses	DeKalb Terrazawa Coop de Pau Delta and Pine Land Agripro CSD/CSIRO Japan Tobacco ForBio Stoneville Holdens Asgrow

in Delta and Pine Land is less than 5% of equity, but we see Delta and Pine Land as our long-term partner in cotton. Holdens allows us access to proprietary corn germplasm and gives us the opportunity to broaden our distribution base with all the companies with which Holdens does business. Conversely, these companies now have access to the biotech-

nology traits available from Monsanto. An area in which Monsanto has just started investing during the last 12 months is rice. Japan Tobacco is a leader in the rice business, and we are working with that company to develop hybrid rice as well as traits such as Roundup Ready® grain rice. We acquired 100% of Terrazawa, a soybean company in Brazil. We signed a long-term agreement with Asgrow's former owner, ELM, to be its preferred proprietor of technology in the fruit and vegetable business. These investments and agreements by Monsanto all occurred in the last 18 months in an industry environment that is evolving rapidly, and our competitors are equally aggressive and taking their own action.

Monsanto's Direction

Monsanto is a life sciences company. We look to the future and believe that genomics will revolutionize agriculture. We believe that molecular breeding will quicken the traditional breeding process by marking genes of interest. Today we do not think as much about herbicide or insect control traits, but instead more about yield enhancement. We still have a long way to go, but we believe that the relationships we have formed with many companies will keep us in the leading position of identifying the key genes.

There are synergies to be exploited in advanced genomics, either in human genomes or plant genomes. With increased linkages between food and health, we see the industry coming together, becoming increasingly integrated. Three years ago, the seed and agricultural chemical industries were viewed as two separate industries. Now, in a very short time, the seed industry and the chemical industry are merging because of herbicide-resistant and insect-resistant traits in seed. On another front there are designer crops where specific traits are altered to add food or nutritional value. This gets into the business of food, or nutriceuticals (which are enhanced foods with measurable health effects), and dovetails with pharmaceuticals.

The convergence of these various components creates a life sciences model—and this is where Monsanto is headed. This is the vision that is driving much of the action at Monsanto.