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

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ABSTRACT

DuPont Quality Grains is focused on improving grain quality for end users, rather than on farm production traits. A major DuPont program is high oil corn. Feed corn has a huge market, and, because it requires no intermediate processing, any enhanced value is measurable by end users. Standard commodity markets do not function for capturing the value of enhanced grains, and so DuPont works with end users, elevators, farmers, and seed companies to create market channels. As biotechnology commercializes more value-enhancing traits targeted to specific agricultural customers, vertical value chains will become shorter and more coordinated while standard commodity markets will diminish.

Key Words: biotechnology, DuPont, marketing strategies.

The tools of biotechnology have for some time been widely used in science seed research and plant breeding. Now commercial products based on this research are coming to market. The cost of developing these products and their competitive impact in the market will have meaningful effects on agribusiness. Industry participants see major consequences coming in several areas, including: insect-resistant crops, herbicide-tolerant crops, virus-resistant crops, crops with improved composition (specialty oils and starches), modified crops to produce high-value specialty chemicals, and novel hybridization systems.

The number of genetically engineered crops on the market is exploding. In a recent study of agricultural biotechnology for Decision Resources, Inc., the Bowditch Group predicted that a substantial proportion of all seed products will be genetically engineered by the year 2005. In addition, hundreds of millions of dollars worth of transgenic produce will be grown, and hundreds of millions of dollars worth of high-value chemicals may be produced in recombinant plants.

North America will be the first major market addressed by these recombinant crops for two reasons. First, it is a large market, which can justify the research investment needed to develop such products. Second, the North American regulatory environment and public opinion are more accepting of genetically engineered crops than in the European Union (EU).

In addition to the difficulty of developing regulations for the whole EU (with its separate regulatory systems in each member state), there has been considerable public pressure to go slowly in implementing agricultural biotechnology. For example, bovine somatotropin (bst), approved for use and already a $100 million product in the U.S., cannot be commercially used in Europe before 1999. This is due largely to feared social and economic impacts on farm support systems. In addition, recent decisions by the European Parliament and the European Patent Office appear to affect the

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speed of patenting recombinant plants in Europe for some time.

New Technologies

In this section, the major technology areas of interest are identified and discussed.

Insect-Resistant Crops

Several genes conferring insect resistance are being genetically engineered into crop plants. The gene for the Bacillus thuringiensis (Bt) protein endotoxin is now being commercialized.

Patent rights for key plant biotechnologies are in a state of flux. That is apparently true for the Bt technology. Several companies have conflicting potential patent rights to the use of Bt genes in plants.

Herbicide-Tolerant Crops

Many more herbicide-tolerant hybrids and varieties will be offered over the next few years. In addition to the IMI corn, STS soybeans, and Roundup Ready soybeans now on the market, genetically engineered herbicide-tolerant canola and cotton are also available. Some of these products will offer farmers considerable savings in weed control. Herbicide-tolerant sugar beets and vegetables are currently in the works.

Virus-Resistant Crops

Many virus-resistant vegetable varieties are under development. Some, including Asgrow's squash and Monsanto's potato, are on the market now or will be soon. Many others, from a number of vegetable seed companies, are in field trials. Further down the road, there are technologies which may provide resistance to fungal diseases and nematodes.

Modified End-Use Characteristics

Perhaps the most profound impact on the structure of agriculture and agribusiness will come from using biotechnology to modify crops for improved or tailored end-use characteristics. This is where DuPont Quality Grains puts its focus, and these efforts will be discussed in more detail later.

Specialty Chemicals

Recombinant plant systems can produce very large volumes of high-value specialty chemicals, such as proteins, at costs competitive with or significantly below those current fermentation or cell culture production methods. The types of chemicals being targeted in such systems include proteins, oleochemicals, carbohydrates, biopolymers, alkaloids, and others. Similar systems using transgenic animals are under development, but we think plant systems have several advantages.

New Hybridization Systems

Several novel means of producing hybrid crops rely on genetic engineering. Plant Genetic Systems of Ghent, Belgium, has developed proprietary hybridization technology called "Seedlink." It has established a subsidiary in Saskatchewan to commercialize hybrid canola. This breaks the hybridization barrier.

Dupont Biotech Efforts—High Oil Corn

At DuPont, our emphasis has been on using technology to improve grain composition. DuPont first became interested in value-enhanced grain, specifically high oil corn, in 1986 when the Biotechnology Business Division was formed within DuPont Ag Products. We had made a commitment to biotechnology as a science and selected corn and soybeans as target crops. We are currently focused on value-adding traits in: (*a*) high oil corn (HOC), and (*b*) soybeans with high oleic content, high lysine, and high sucrose.

Rather than target "input traits" such as herbicide resistance and insect/disease resistance, we chose instead to focus on improvements to grain quality for end users, including the animal feed industry. We believed a business based on a concept we call "crops as factories" could be formed. By using plant ge-

netics to modify grain composition (similar to the way chemical and mechanical processing has been used in the past), higher value grains could be produced in farmers' fields. HOC seemed to be a logical target for accomplishing this objective and a base for future improvements from biotechnology.

Understanding the Value Chain

To determine how DuPont could add value to the corn industry, we needed to better understand the "value chain," which we define as the system or process required to convert technology into a value-added product. At the beginning is trait development that includes technology available to seed companies to develop new seed products. Next, grain farmers convert the seed to grain, while elevators serve as a collection and storage point for the grain. Grain and transportation companies move the grain to processors who convert it into value-added food, feed, or industrial products. For corn used in animal feeds, this is generally the feed miller who may also be the consumer of the feed.

We believe that this value chain is already quite efficient for commodity corn and that our best chance to contribute would be at the ends of the chain. In addition to developing technology, we spend a great deal of time at the other end of the value chain identifying and understanding customer need for improved products. This helps in quantifying the value of the product, builds market demand, and ensures that our research and development programs are focused on newer products that meet these customers' needs.

We decided to utilize alliances with others involved in the area between the two ends of the value chain. We found leaders in each segment that shared our vision and were willing to help with the development of these new opportunities. For example, there are several seed companies accessing our technology and marketing seed that will produce OPTIMUM® HOC. They benefit by offering their farmers new products that improve their profitability and expand their own seed market share. For the farmer, the primary benefit is the opportunity to add value "on-farm" and earn more net dollars per acre by producing grain at a premium over commodity corn. The elevators participate by bringing value-added crops to their farmer customers. Their grain margins may also improve. The end users are the primary beneficiaries since they capture the cost savings, improved efficiency in production, plus other handling and product quality benefits.

The key to working with this value chain is adding enough value for the end user for distribution among the value chain participants. This is why it's important to ensure products from research are directed at real and significant customer needs.

The U.S. Feed Industry

Because most corn and soybeans are used for animal feeds, we tried to learn as much as possible about the U.S. feed industry. It was an easy decision based on the sheer volume and importance of corn as a crop. Over 60% of the corn produced within the U.S. is utilized for animal feeds. When one considers that most of the corn exported is also fed to animals, it is probable that over 80% of corn produced is used as animal feed.

Within the animal feed segment, corn is a major ingredient for virtually every species. To gain an understanding of why corn is used so heavily, and how we might think of improving it further, we conducted focus groups with swine and dairy producers, supplemented by individual calls and consulting sessions with poultry integrators. We learned that even though corn is an ideal ingredient and seldom replaced in U.S. diets by other grains, customers could still identify several improvements to make it even better.

For example, although corn contributes over 75% of the energy and 40% of the protein in a typical swine finisher ration, more expensive and concentrated ingredients such as fat, high protein concentrates, and synthetic amino acids are often added to optimize performance. Through advancements in animal genetics, the need for more concentrated or "nutrient dense" feeds has increased. Modern

animals have the ability to produce more gain with less feed, but the feed must be concentrated enough to deliver the necessary nutrients. This has created a need for packing more nutrients into each mouthful of feed. Since fat contains 2.25 times more energy than starch, and synthetic amino acids are available in their concentrated forms, higher energy and amino acid balanced rations are now common. If corn could be improved in both areas, it would become an even better ingredient.

The animal feed industry is quite competitive. Nutritionists will substitute ingredients on a weekly basis for a very small difference, often for as little as $0.25/ton. For poultry, feed can represent 70% or more of the final cost of live bird production, so small savings in feed cost have a significant impact on final profitability. Customers would therefore be motivated to switch to a better ingredient for a relatively low percentage of the total added value. This would provide an economic opportunity for other participants in the value chain.

DuPont OPTIMUM® HOC Program

Since we decided that the two major traits for quality improvements to animal feeds would be higher energy and improved protein quality, high oil corn became a natural choice. Through a research and commercialization program with Holdens Foundation Seed Company, Pfister Hybrid Corn Company, and a number of other collaborating hybrid corn companies, we have been able to develop and market high oil corn under the OPTIMUM® brand. Seed products that produce grain with 50–150% more oil have been commercialized and are available within the U.S. market. The most common grain type from these seed products is designated OPTIMUM 80 because it provides an additional 80 kilocalories of gross energy per pound on a 9% moisture basis.

Determining the Value of High Oil Corn

Since the major benefit of utilizing high oil corn is feed cost savings, it is fairly easy for customers to determine the value of high oil corn in their operation. If used in an optimized diet, the value will be directly influenced by the substitution cost of other concentrated ingredients such as feed fat, soybean meal, or amino acids. For example, a typical corn/soy swine diet that uses animal fat and synthetic lysine to provide 1,562 kcal/lb. of metabolizable energy (14% protein, and 75% lysine to energy ration) will generally cost around $140/ton. If high oil corn is used to substitute for the animal fat and a portion of the soybean meal, the same diet specifications can be attained at a cost of about $130/ton assuming the same price for high oil corn as regular corn. The approximate $10/ton savings comes from the substitution of higher priced ingredients with lower priced corn to achieve the same diet. This $10/ton "opportunity value" is attributable to the high oil corn in a ton of feed, and it shows that the high oil corn is worth an extra $0.35/bushel in this ration.

Marketing OPTIMUM® High Oil Corn

Technology without a customer or market is a wasted effort. If products are developed based on customer needs, then marketing should be straightforward. However, marketing an enhanced quality grain within the commodity grain system is probably the greatest challenge we have faced.

For a product like high oil corn that has application in the entire animal feed market in both the U.S. and foreign countries, flexibility in marketing is paramount. The customer base can vary from a dairy farmer in Wisconsin who produces corn and sells milk, to a poultry integrator in the southeastern U.S. who purchases 75 car trains of corn, to an animal feed company in the Pacific Rim that buys corn in 50,000 ton ships. Each will have a different "value chain" and preferred source of supply, so the challenge is to make it as simple as possible for each customer to access high oil corn.

For the domestic market, seed companies who license technology from DuPont and market their seed products under the OPTIMUM® trademark are the first source for high oil corn.

For the "on-farm" or domestic market, grain is generally produced by the farmer/feeder. It is then fed to the farmer's livestock, and all the value can be captured by this customer. In addition to producing and identity-preserving the grain, the farmer will reformulate the ration to either improve performance or lower cost through ingredient substitution.

Corn customers who cannot produce their own grain can acquire high oil corn through contract growing systems being developed by U.S. grain companies. By working with cash grain farmers who are seeking higher value crops, several grain companies are putting together systems to grow, identity-preserve, and ship value-added grains to targeted customers. For high oil corn, the end customers can work with their preferred suppliers and develop a system that meets their needs and the requirements of the supplier.

For the domestic market, DuPont works with end users, elevators, farmers, and seed companies to create markets for high oil corn. DuPont production and sales representatives located across the midwest, plus nutritionists and other product development specialists, assist companies or individuals interested in jointly developing market opportunities. These working relationships have been critical in the early growth of the high oil corn market.

For customers outside the U.S., DuPont and Continental Grain have teamed up both to develop and supply the market for HOC. This alliance utilizes each company's people and expertise to properly position and market the added value of high oil corn, and then develop efficient value chains to assure the customer of a consistent, dependable, and high quality supply. This alliance has successfully grown, identity-preserved, and marketed over 500,000 metric tons of OPTIMUM® high oil corn over the past four years. Production in 1996 alone was approximately 500,000 tons, and we estimate significant growth in the future.

The overall growth of HOC over the past five years has been driven by several factors, but most important are the collective efforts of many companies and individuals in the value chain. Each has found ways to derive benefit from HOC for their business and has worked hard to grow the market. We expect the growth to continue for several years as more users of corn for animal feed discover the value and benefits of OPTIMUM® HOC.

DuPont Soybean Marketing

In the area of soybeans, we are in the process of formulating our marketing plan, and all strategies are not as firm as with HOC. There are some aspects of the value chain that will be similar. However, most soybeans are crushed or processed, and this adds another challenge. Probably, we will also have to add a downstream player in the edible oils business to our marketing scheme.

Implications for Agriculture

We are in the early stages of a new industrial age—the biotech revolution. How companies market the technology will depend on the value of the trait, the markets they seek, and the degree of participation needed to capture the value. Some examples of marketing methods being used are: (*a*) royalty-bearing licensing, e.g., Mycogen to Ciba (Bt technology); (*b*) nonroyalty-bearing licensing, e.g., AgrEvo (Liberty Link), DuPont (STS); and (*c*) seed premiums/royalties/fees, e.g., DuPont HOC, Monsanto Roundup Ready.

Impacts on the Seed Industry

Even for seed companies not developing their own in-house biotechnology capabilities, the era of recombinant crops will impose new research costs. Only those who invested in agricultural biotechnology years ago, and who have spent heavily since then, will have significant proprietary positions in the building blocks of genetically engineered crops. But seed companies will have the germplasm that will provide the foundation. Licensing and partnering negotiations will be delicate. Considerable effort can be wasted pursuing blind alleys with technology that ultimately cannot be commercialized because of conflicting proprietary positions. Few seed companies are yet

adept at this type of negotiation in this rapidly changing field.

The ability of plant breeders to modify the end-use characteristics of crops will be expanded by genetic engineering. At the same time, end users of crops and plant products are becoming more demanding and sophisticated about specifying the raw materials they require. These two trends will create opportunities for partnering between research-based seed companies and processors or end users.

However, seed companies should be aware that the value of improved end-use characteristics will be small relative to the cost of the raw material in most cases. Further, that value will have to be shared with the processing or marketing partner, or provide a return investment in a processing venture. It may become increasingly necessary to invest in addressing the needs of end users as well as farmers (i.e., "who is your customer?"), but seed companies must be realistic about the returns on such investments.

The Rest of Agriculture

There are other implications affecting all of agriculture as the scenery changes to include biotechnology processes and products. The technology will cause some of this, but in many cases it will be agribusiness members struggling to capture some part of the value created that will be the cause of the change. The following are expected changes for people and organizations in the agribusiness value chain: (*a*) consolidation of seed/crop protection, (*b*) unprecedented financial opportunity/risk, (*c*) alliances and mergers (continuing), (*d*) shortening of the value chain with greater efficiency, (*e*) community-based soybean processing (specialty processing on a small scale), and (*f*) component pricing of delivered product attributes.

In sum, consolidation in agriculture will continue. As multinational companies struggle to stay in the game and "boutique" biotechnology firms struggle for survival, financial deals will be made creating opportunity and risk. Mergers and alliances among seed, agricultural chemical, and equipment companies will blossom. The value chain may shorten as integration, both vertical and horizontal, continues. Community-based soybean processing may crop up and prosper to meet differentiated and identity-preservation needs. And finally, the Chicago Board of Trade may change as alternative pricing grows.