Monsanto & Genetic Engineering: Risks for Investors

Report prepared by Innovest Strategic Value Advisors

For Greenpeace

Uncovering Hidden Value Potential for Strategic Investors

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1. EXECUTIVE SUMMARY

Innovest Strategic Value Advisors, a financial services firm based in New York, London, Paris and Toronto, analyzed investor risks related to Monsanto's genetic engineering (GE) strategy. Partly owned by State Street Global Advisors and the Dutch pension fund ABP, Innovest is a leader in analyzing the financial impacts of environmental and social issues. Investors use Innovest's best-in-class ratings, ranging from AAA to CCC, to minimize risk and maximize return potential. In nearly every industry sector, companies with above average environmental scores, taken as a group, outperformed below average firms by 300 to 3000 basis points per year in the stock market.

Monsanto received a CCC EcoValue'21™ rating from Innovest, the lowest environmental rating. This implies the firm has above average risk exposure and less sophisticated management than peers. As a result, it will likely underperform in the stock market over the mid to long-term.

Monsanto is the global leader in developing and marketing GE seeds (in 2002, 91% of GE hectares world-wide were planted with Monsanto seeds). The company also makes the world's largest selling herbicide, Roundup/Glyphosate. Its strategy includes selling GE seeds intended to be used with Roundup (71% of GE seeds planted worldwide in 2002 were designed to be herbicide resistant) and developing new seeds which produce food and pharmaceutical products.

Monsanto claims its GE products will provide economic benefits to farmers, feed hungry people around the world and improve environmental conditions. However, it appears actual benefits may be substantially less than claimed. For example, a recent study by the US Department of Agriculture questioned the economic benefits of GE soya and corn, the two largest GE crops. Also, most developing countries have strongly opposed GE crops due to concerns about environmental contamination, reduced genetic diversity and foreign firms holding patents on traditional crops.

Environmentally, Monsanto warns investors in its 10K about substantial losses that could result from unintended contamination of food crops by its GE seeds. Given the tendency of pollen and seeds to spread in nature, contamination is inevitable. As a result, the company is lobbying for regulations that allow some GE contamination of non-GE food products.

Contamination of food crops by GE seeds designed to produce pharmaceutical products (GE pharma crops) poses an even greater risk to investors. While some consumers might accept limited contamination from GE food crops, probably none would accept food contaminated with pharmaceutical properties. Yet, as with GE food crops, contamination by GE pharma crops will occur if they are cultivated. Indicating the inevitability of such contamination, GE corn designed to produce pig vaccine recently contaminated food crops in Nebraska and Iowa. Contamination of food products by Monsanto's GE pharma crops could bankrupt the firm and cause substantial investor losses.

Monsanto faces significant market and financial risks. As a result, the company's stock is probably overvalued despite recent price declines. The risks facing Monsanto investors include:

MARKET REJECTION

The inevitability of environmental contamination and concerns about human health impacts have caused GE crops and food products containing GE ingredients to be one of the most widely rejected product groups ever. Many GE products have been removed from the market or developed but not commercialized due to market rejection. Examples include GE tomatoes, flax seed, rice and sugar beets. Monsanto withdrew its GE potatoes from the US market in 2001 after companies including McDonald's, Burger King, McCain's and Pringles refused to buy them.

At present, GE products provide no nutritional benefits to consumers. However, they do pose various environmental and human health risks. As a result, many consumers refuse to buy GE products once labeling makes them aware that GE ingredients are being used. Foreign markets, especially those with labeling requirements, have seen strong market rejection. In the US, where labeling is not required, outright rejection has been minimal so far.

Foreign Market Rejection

Over 35 countries have enacted or announced laws that restrict GE imports and/or require labeling of foods containing GE ingredients. Europe was one of the first regions to restrict GE imports and require labeling. More recently, major food importers such as China, Japan and Korea have enacted GE restriction/labeling requirements. GE concerns have caused US corn exports to Europe to fall from $305 million in 1996 to $2 million in 2001. Exports to Korea have fallen from $300 million to $85 million.

The Cartagena Protocol on Biosafety will probably enter into force in 2004. This will impose substantially greater documentation and risk assessment costs on GE exporters. The Protocol will also likely hold GE seed manufacturers liable for contamination and other problems caused by GE seed use. (In the wake of StarLink, it may be difficult or impossible to get insurance for GE-related losses. NFU mutual, the largest UK farm insurer, refuses to insure such losses.) These restrictions will make it more difficult for GE products to compete with non-GE varieties in the 103 countries that are signatories to the Protocol. To avoid losing market share, food exporters will likely demand non-GE crops from US farmers.

In Europe, moratoria on some GE crops may be lifted, but probably not in the near future. Opposition to GE food remains high. Most European food manufacturers and retailers have implemented policies to ensure that no GE ingredients are used in their food products. Companies pursuing such policies include Nestlé, Unilever, Heinz, ASDA (Wal-Mart), Carrefour, Tesco and many others. Beyond Europe, there has been strong opposition to GE crops in Asia, Africa and other developing regions.

Domestic Market Rejection

GE supporters claim that the widespread use of GE ingredients in US food products indicates acceptance by US consumers. In reality, the vast majority of US consumers do not realize they are eating GE foods since GE firms have aggressively and successfully lobbied to suppress labeling requirements. Since 1997, over twenty US polls have shown strong support for labeling. Examples include ABC News – 93% of Americans want GE food labeled, Rutgers University – 90%, Harris Poll – 86%, USA Today – 79%, MSNBC – 81%, Gallup Poll – 68%, Grocery Manufacturers of America – 92%, Time Magazine – 81%, and Novartis – 93%. A 2001 poll by Oxygen/Market-Pulse not only found that 85% of Americans want GE food labeled, but also that only 37% of women would feed GE food to their children.

Several of these polls also found that a significant percentage of Americans would not eat GE foods if they was labeled as such (the Time poll found 58% would not eat them). If labeling requirements were imposed in the US, it appears highly likely that a significant number of consumers, perhaps as high as 30% or more, would stop eating GE foods and demand non-GE alternatives. As in Europe, many food manufacturers would probably choose to carry only non-GE foods, rather than going to the expense of pushing two separate lines through the same distribution channels.

ENVIRONMENTAL AND HUMAN HEALTH RISKS

Inevitable Environmental Contamination

GE contamination is inevitable because it is impossible to completely prevent GE pollen and seeds from being carried by wind and other vectors to non-GE fields and natural areas. The inevitability of GE contamination is evidenced by StarLink and other GE contamination cases. In 2000, Aventis' StarLink corn, a GE product not approved for human consumption, was found in many different food products. Following recalls of over 300 corn products, Aventis spun off its CropScience division.

In another contamination case, GE corn designed by ProdiGene to produce pig vaccine recently contaminated corn and soya food crops in Iowa and Nebraska. Regulatory leniency limited ProdiGene contamination costs to $3 million and allowed the firm to stay in business. However, further contamination could occur and costs to the firm could rise since GE material from pig vaccine corn may still be in nature. In another case, GE corn contamination has been found in Mexico, where GE corn growing is not allowed. Investigations are being conducted to determine the source of the contamination. Significant costs could be imposed on the polluters.

The StarLink, ProdiGene and Mexican cases reflect the essential problem of GE crops – release into nature is inevitable and once released, GE materials cannot be recalled. So far, the StarLink disaster has cost Aventis nearly $1 billion. Yet, StarLink contamination is still occurring and could occur indefinitely. As a result, it is impossible to predict the ultimate cost to Aventis. Contamination costs could put

Monsanto and other firms into bankruptcy, leaving society to deal with GE contamination problems.

Monsanto uses the term 'adventitious presence' to describe unintended GE contamination. This term is misleading to lay persons since it implies 'advantageous or beneficial presence'. As the shareholders of Aventis would readily agree, the presence of StarLink corn in food products was anything but advantageous. To enhance clarity, this paper refers to adventitious presence as contamination.

In its 10K, Monsanto notes that it is addressing the problem of contamination by, "*…continuing globally to seek regulations that recognize and accept (contamination) and provide for approval and acceptance of trace amounts of (GE contamination).*" The company is seeking to convince governments, farmers, food manufacturers and consumers that they should accept GE contamination (perhaps ranging from 0.5% to 5%) of many organic and conventional non-GE food products. The contamination percentage would likely increase over time as GE crops grow and spread.

Also in the 10K, Monsanto states that, "*concerns have been expressed about the potential for (GE contamination) in food, resulting from the development and production of pharmaceutical proteins in food-crop plants. Monsanto's Protein Technologies business is one of several businesses engaged in this research.*"

Monsanto did not say GE contamination was inevitable when GE seeds for food crops were introduced. Apparently acknowledging the inevitability of contamination by GE food crops, the company is now seeking regulations that would allow it. As Monsanto develops GE pharma crops, it is not saying contamination is inevitable. But it is. Even if these crops were grown indoors, an unlikely scenario, some contamination would eventually occur. While some consumers may accept limited contamination of food products with GE food traits, probably none would accept contamination of food with pharmaceutical traits. Since contamination is inevitable, companies developing GE pharma crops are likely to face large contamination costs.

Human Health Risks

Creating GE products involves randomly inserting genetic material into an organism's DNA. It is virtually impossible to predict what interactions this will cause among the billions of components of DNA, especially over multiple generations. There are many scientific critics of the process, including the US National Academy of Science. Those concerned about GE safety point out that most research showing the safety of GE foods was conducted or funded by GE firms. Since these firms have a large financial stake in seeing GE crops commercialized, there is a risk that safety testing done by them is biased.

Other safety concerns include the fact that safety testing is usually not done over the long-term or over multiple generations. As a result, long-term impacts on human health may not be discovered until people are made ill by GE foods. Many scientists are concerned that the GE process can have unintended consequences such as creating new toxins and proteins which could cause allergic reactions and other human health problems.

An example of unintended consequences includes antibiotic resistant marker genes which are used in the production of many GE seeds. Some medical authorities have found that these genes may pass on antibiotic resistance to bacteria in the gut, thus making the bacteria resistant to clinically important antibiotics. As a result, the EU is phasing them out in 2008. The United Nations CODEX Alimentarius Committee has also recommended that they be phased out. In the US however, there appears to be no plan to phase them out.

Ethical Concerns

Numerous ethical concerns, including safety, scientific hubris and disclosure, largely explain the widespread opposition to GE foods. A nearly infinite number of interactions could occur between GE materials released into the environment and other life forms. From a statistical perspective, it is a virtual certainty that, in at least a few cases, there will be large negative impacts, such as damage to beneficial species. It is effectively impossible to test for the nearly infinite number of interactions that might occur in nature or in the human body. The effective impossibility of adequately testing the safety of GE food and pharma crops converts this to an ethical issue for many consumers. They say, if these crops cannot be safely tested, they should not be used.

Those concerned about GE believe that the creations of nature are infinitely more sophisticated than those of humanity. They argue that humanity knows virtually nothing about genetics compared to all there is to know. It is hubris on the part of the scientific community, they believe, to think that humanity can create new life forms and release them into the environment with impunity. Inserting genes into DNA in a way that could not occur in nature creates life forms that are not subject to genetic screens built up over millions of years. Once released into nature, these unnatural life forms cannot be recalled if there is a problem. Huge amounts of GE material have already been released into nature from past crops. This material cannot be recalled. There is no way to tell what impact it will have over the long-term. The idea that business continues to put the Earth's genetic wealth at risk primarily for commercial purposes arouses the most passionate opposition in many consumers.

As shown by the polls above, most consumers, whether opponents or supporters of GE foods, believe GE content should be disclosed through labeling. Given uncertainty about the environmental and human health impacts of GE foods, the vast majority of consumers believe they have the right to know if foods have GE content. In effect, not disclosing takes away their right to chose whether or not to eat GE foods. It is unethical, they believe, to take away their right to chose what food they will eat or feed their children.

STRATEGIC RISK

Monsanto's GE-focused strategy poses large risks to investors. With a 2002 loss of $1.7 billion on sales of $4.7 billion, several factors will place ongoing downward pressure on earnings. These include increasing competition for Roundup following patent expiration, growing resistance among weeds Roundup is meant to

control, difficulty in opening new markets due to concerns about GE safety, and questions about the economics of using GE products. A 2002 study by the US Department of Agriculture found that GE soya provided no net benefit to farmers in several cases. It also found that benefits from GE corn may have been due to seed companies setting low prices to gain market share.

Other threats to future earnings include new product and reputation risks. Several Monsanto products intended for human consumption have failed. The company is now facing resistance from many US and Canadian farmers to GE wheat which it plans to launch in 2004-2005. A report by Iowa University found that over 50 percent of the US export wheat market could be lost if GE wheat is introduced. Monsanto continues to face reputation problems around the world due to factors including the impression that GE foods are US products being forced on the rest of the world by the US Government and World Trade Organization, protests in developing countries against Monsanto, and the company's numerous lawsuits against farmers.

However, the largest risks facing investors are US market rejection and contamination. There is strong public support for labeling of GE foods in the US (by far the largest market for GE foods). If this occurs, it is highly likely that a significant percentage of the market for GE food would disappear. To avoid losing market share, food manufacturers would have to develop separate GE-free product lines or simply make all products GE-free.

Regarding contamination, as materials from Monsanto's GE food and pharma crops escape into the environment, which is inevitable, there is significant risk that human food crops could be contaminated. In its 10K, Monsanto states *"Some growers of organic and conventional nonbiotechnology crops have claimed that (GE contamination) will cause them commercial harm."* And *"…could lead to more stringent regulation, which may include: requirements for labeling and traceability; financial protection such as surety bonds, liability or insurance; and/or restrictions or moratoria on testing, planting or use of biotechnology traits."*

The 10K also states GE contamination *"can negatively affect our business or results of operations."* And *"…can result in the withdrawal of seed lots from sale, or in governmental regulatory compliance actions such as crop destruction or products recalls."* In summary, GE contamination could cause StarLink-scale losses for Monsanto.

ANOTHER BLACK EYE FOR THE FINANCIAL COMMUNITY?

It is understandable that the US Government has essentially taken the industry position on GE safety and labeling, but much less clear why many in the financial community appear to have done so. US Government support for GE crops appears to stem from the fact that the crops are mostly US-developed and that GE companies have made substantial financial contributions to US politicians and political parties. This is not said as a criticism of politicians but rather of the campaign finance system which allows politicians to accept money from the firms they are supposed to regulate.

Money flowing from GE companies to politicians as well as the frequency with which GE company employees take jobs with US regulatory agencies (and vice versa) creates large bias potential and reduces the ability of investors to rely on safety claims made by the US Government. It also helps to clarify why the US Government has not taken a precautionary approach to GE and continues to suppress GE labeling in the face of overwhelming public support for it.

With Enron and other financial disasters, the financial community apparently bought into company stories without looking much below the surface. Since Monsanto's stock price has fallen by more than 50 percent over the past two years, it cannot be said that this is completely true in this case. However, in light of the issues and risks noted above, the firm may still be overvalued. Monsanto could be another disaster waiting to happen for investors. If the firm does not take steps to mitigate its substantial market risks, for example by diversifying its GE-focused strategy, further investor losses seem likely. Given available knowledge about company risks, financial analysts and asset managers may be hard pressed to explain their current positions on Monsanto.

This report provides an overview of the GE crop market. It then provides a detailed description of Monsanto's GE-focused strategy and the large risks it poses to consumers, the environment, food manufacturers and investors.

2. MONSANTO STOCK PRICE PROJECTIONS

Wall Street has not been overly optimistic with respect to Monsanto's share price and Innovest's analysis of the company's financial future is generally in keeping with that view. While the company is relatively free of debt and has a reasonably sound balance sheet, earnings have been a problem over the past year and will likely continue to be as new and old issues plaguing the balance sheet continue to be a problem. As Sergey Vasnetsov of Lehman Brothers stated earlier last year, "Its not an issue that the company is financially in trouble. It's strategically in trouble."[1] While profit losses last year lead to a change in leadership at the company, they did not lead to a change in strategy. What Monsanto is facing is a lack of possibilities for growth, coupled with increasing risk for the types of financial disasters relating to contamination issues that hit smaller competitors like Aventis CropScience and ProdiGene, nearly bankrupting the latter.

Monsanto's main product Round-up is under increasing pressure from competition and the company predicts that its market share will likely go down.[2] In addition, the major droughts resulted in lower Roundup use last year. These droughts are forecasted[3] to remain in many parts of the Midwest during 2003, implying that the company will continue to have headaches with sales of Roundup. At the same time resistance to Roundup is reported to be developing in many of the weeds it is meant to control. Meanwhile, the company has rearranged its strategy for commercializing its genetically engineered crops. With efforts to open up world-wide markets stalled, Monsanto is looking to expand its presence further in the U.S. market, and states that it will sell 75% of its new corn varieties to existing customers. While this may provide new profit avenues, it does not appear to be the cash cow that Roundup has been, nor will it match previous levels of product adoption in the early nineties.

Consumer rejection of genetically engineered foods has been considerable and shows no apparent abatement. This market rejection has been moving up the food industry supply chain from consumers to retailers to producers to farmers. If the level of resistance to GE wheat is any example, Monsanto will have its work cut out for it in the effort to commercialize any new genetically engineered crops. The difference between now and the late nineties when many of its existing crop varieties were approved is that there are increasingly large financial interests arrayed against the further commercialization of GE crops. The fact that lawsuits against the company are increasing, as well as its own lawsuits against farmers in an effort to protect its patent rights on GE crops, does not bode well for the relationship between the company and its main constituents.

Investors should be very concerned about the medium to long-term prospects for the company's genetically engineered crops business. At the same time the company should be more forthright with investors about the increasing risks of products in its GE pipeline. Monsanto's GE soya and GE corn are largely sold to feed livestock. The company's new products such as GE wheat will yield GE bread and GE pasta. Judging from past market failures of GE foods such as the Bt potato, GE wheat is likely to be a costly failure. Innovest's analysis shows that going forward the company will continue to suffer from a drop in Roundup sales due to

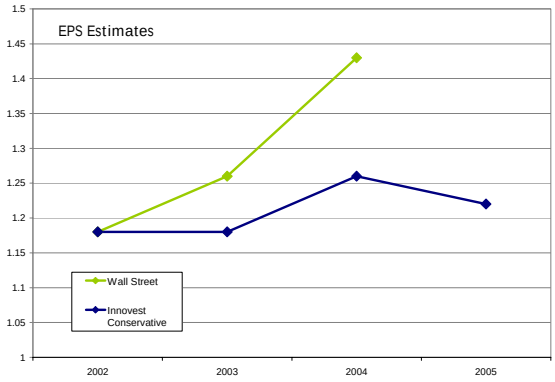
adverse weather and increased competition. It appears that new GE crop varieties will not fill in the gap between now and 2005 that the reduction of Roundup sales revenue will produce. In addition, a much greater proportion of the company's profits will rely on the riskier strategy of commercializing genetically engineered crops. The charts below outline different financial scenarios for Monsanto. The first shows that Wall Street consensus view. The second shows more conservative sales projections based on reductions in Roundup sales as well as lower sales estimates for new GE crops. It also uses a more conservative P/E ratio.

Wall Street Consensus

	Y2003 E	Y2004 E	Y2005 E
Sales (Millions)	**$4,900**	**$5,000**	**N/A**
Net Income (Millions)	**$325**	**$369**	**N/A**
EPS	$1.26	$1.43	N/A
Implied P/E Multiple	15.08	15.08	N/A
Share Price	$19.00	**(1)** $21.56	N/A
Implied Net Profit Margin	6.6%	7.4%	N/A

(1) Street consensus does not provide share price projection for 2004. We have used the implied P/E ratio from 2003 to derive this price

Figure 1. Wall Street Earnings Estimate for Monsanto



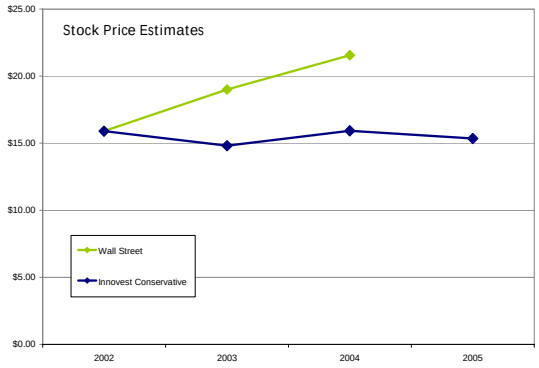


Figure 2. Stock Price & Earnings Per Share Estimates

Innovest - Conservative Case

	Y2003 E	Y2004 E	Y2005 E
Sales (Millions) (1)	**$4,570**	**$4,420**	**$4,260**
Net Income (Millions) (2)	**$303**	**$326**	**$314**
EPS	$1.18	$1.26	$1.22
P/E Multiple (3)	12.60	12.60	12.60
Share Price	$14.81	$15.93	$15.35
Implied Net Profit Margin	6.6%	7.4%	7.4%

1) Based on Monsanto's Low case est. for Roundup and other product sales.
2) Based on the net profit margin implied in the Street consensus.
3) P/E multiple used in Lehman Brothers analysis 10/30/02, which Innovest believes is more likely due to low growth prospects.

Figure 3. Innovest Earnings Estimate (Low Conservative Case)

Figure 4) shows the effect of a liability of $1 billion on the market value and share price of Monsanto. The GE/pharma company Aventis incurred costs of nearly $1 billion when it withdrew StarLink genetically engineered corn from the marketplace. StarLink was approved only as animal feed but was found in boxes of taco shells and in other products for human consumption in US supermarkets and then found throughout the US corn supply chain. The corn was restricted to use as an animal feed due to the presence of a specific protein, Cry9C, which exhibited many of the known characteristics of an allergen. After a few years of growing, StarLink had spread into processed foods and bulk corn exports. Given Monsanto's product mix and the inevitability of GE contamination, losses in the billion dollar range relating to GE contamination are quite possible.

Potential Liability	$1,000
Market. Cap.	$4,261
Liability as % of Market Cap	23.5%
Shares Outstanding (Millions)	261
Liability per share	$3.83

Figure 4. Potential Financial Fallout from Contamination - the "Starlink" Scenario

3. GE CROP DEVELOPMENT & ADOPTION

Genetically modified organism (GMO) means an organism in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination.

Genetically engineered crops have been in development for roughly two decades. While the number of acres of GE crops has grown significantly since the mid-nineties, when they were first introduced commercially, the majority of acres of GE crops reside in only one country – the United States. While major acreage of GE crops exists in Canada (soya, corn, and canola) and Argentina (soya), the U.S. has been both the corporate home of GE leaders like Monsanto & Pioneer Hi-Bred (Du Pont) and the industry's political home with the most aggressive trade policies and lobbying efforts on behalf of the industry. The estimated global area of transgenic crops for 2002 is 58.7 million hectares or 145 million acres. During the seven-year period from 1996 to 2002, the global area of transgenic crops increased by 35 fold, from 1.7 million hectares in 1996 to over 56 million hectares in 2002.[4]

Market Size of GM Crops	% of Total Transgenic Crop Plantings	% of Total Crop Plantings	Transgenic Crop Plantings (Millions of hectares)	Total Acreage by Crop (Millions of hectares)
Soya (Herbicide Resistant)	62.0%	51.0%	36.5	72
Corn (Bt Pesticide Traits)	13.0%	6.2%	7.7	140
Corn (Herbicide Resistant)	4.0%	2.1%	2.5	
Corn (Stacked Traits for Both)	4.0%	0.7%	2.2	
Canola (Herbicide Resistant)	5.0%	12.0%	3.0	25
Cotton (Bt Pesticide Traits)	4.0%	7.0%	2.4	34
Cotton (Stacked Traits for Both)	4.0%	6.5%	2.2	

Figure 5. Global Commercialized Transgenic Crop Plantings 2002[5]

The United States and Argentina account for 90% of commercially grown GE crops in the world. The next largest growers are Canada and China, with 9%. Two countries account for most of the remaining 1% of GMO acreage, South Africa (0.23m ha combined GE corn, soya and cotton) and Australia (0.2m ha cotton). Two crops (soya and maize/corn) account for 83% of the GMO acreage. Together with cotton and rapeseed/canola, they account for over 96% of the GMO acreage. Just three companies account for virtually all the GMOs currently commercially grown: Monsanto, Syngenta (formerly Novartis) and Aventis CropScience (recently acquired by Bayer). Monsanto dominates the market of commercial GMOs. In 2002, Monsanto products alone accounted for 91% of the total area sown with GMOs.[6]

Market Size of GM Crops by Transgenic Traits	% of Total Transgenic Plantings by Trait	Acreage of Plantings (Millions of Hectares)
Herbicide Resistance	71%	42.0
Insect Resistance	17%	10.1
Stacked Genes for Both	8%	4.4
Total Area		56.5

Figure 6. Transgenic Crops by Traits[7]

While estimates for growth of the GE crop market have come down since the halcyon days of the mid-nineties, the market is expected to grow somewhat, and pressure by the industry will remain unabated, despite consumer rejection in most markets. For Monsanto and other GE companies the push is still on to open up new countries to commercially grow GE crops although Monsanto's stated goals for achieving profits in 2003 do not include the opening of new markets. That is a significant change over past years when optimism for opening new markets was higher. Currently, Monsanto is looking to expand its business by selling more to its current customers. It does this by engineering multiple traits into a single crop, such as herbicide resistance and Bt toxin production, for which it can therefore receive a greater share of the farmers' operating expenditure. Since 1996, according to the company, Monsanto has increased its share of farmers input expenditures from 7% to 19% by 2002, in part by utilizing this method.[8]

Has Growth Stalled?

According to recent Congressional testimony[9] by Leon Corzine, Chairman of the Biotechnology working Group of the National Corn Growers Association, the quantity of U.S. corn exports has declined from 52.3 million tons to 47.3 million tons with a drop in value from $8.5 billion to $4.9 billion. He stated that *"(…)in some markets the influence [of trade problems with biotechnology] has been dramatic, and we anticipate that the next few years may bring increasing pressures on U.S. corn exports as more countries introduce biotechnology labeling and approval systems and more to implement the Cartagena Protocol of Biosafety*." Corzine also noted that in Asia, the number one market for U.S. corn, the Korean market had dropped from $300 million per year to $85 million in 2002 and contamination of supplies by StarLink corn, a GE variety not approved for human consumption, caused "(…)a sharp drop in the Japanese market." The EU corn market of $300 million (as of the mid-1990's) has evaporated, and exports of corn oil to the Middle East have declined by $80 million since the introduction of genetically engineered crops.[10]

Overall, the expansion in existing markets for GE crops appears to be reaching its limits, as consumers continue to resist GE crop technologies and governments and scientists continue to question the safety and risks of these crops.

At present GE soya represents 80% of U.S. and 90% of Argentinean soya crops so there is not much room in either market for further expansion. Current GE corn varieties in the U.S. may expand somewhat based on their perceived value in relation to insect infestations which vary in range, scope, and species. Not all GE varieties are suitable for all regions and expansion of the market will therefore be

limited based on those criteria. Argentina despite being pro-GE generally has for many years still banned any GE corn that is not already approved in the EU. They do this in order to protect their current corn export market to Europe. In Canada GE soya sits at around 30-35% where it has been for a couple of years. It should be noted that there is a substantial part of the Canadian soya trade that is specifically non-GE food grade beans which attract a premium. So GE soya in Canada is not expected to expand. 70% of canola in Canada is GE, and the rest is already effectively GE contaminated. This has led to growth in legal suits against Monsanto relating to the contamination but the potential for increased sales is low. GE cotton is already widely grown in the countries where it is authorized.

Significant markets have also developed and are continuing to develop for certified non-GE crops, and organically grown crops which exclude genetic engineering. This creates a very dangerous situation for the GE industry because it adds a new and powerful opponent with economic interest in preventing GE crop commercialization. Within these economic interest groups are:

- Many companies in the mainstream food industry and many countries have spent the last 2-4 years implementing non-GE policies to the extent of arranging new contracts with new or existing suppliers, implementing Identity Preservation (IP) systems for their ingredients, labeling their products as non-GE. They did this in response to their customer demands and many of them are already using the non-GE status as a positive marketing tool.
- The organic food industry. Organic production methods and standards exclude the use of GE seeds or ingredients and this market is very much threatened by potential and already realized contamination of organic produce by unwanted GE traits.
- The farmers who are already supplying these often premium markets and the food processors and shippers who have established non-GE and/or organic processing and distribution channels. These farmers, processors and shippers have good reason to seek to avoid GE contamination and to sue for loss of profit if and when GE contamination causes them to lose contracts.

The development of these economic interests, opposed to further GMO commercialization, may prevent new markets in Europe, South America and Asia from materializing. The industry's history of market failures represent a consistent pattern of market rejection that is still working its way up the industry supply chain from consumers to producers to farmers. The next section of the report outlines Monsanto's current strategy and highlights how market rejection and increased risk exposure may hurt the company financially.

4. THE RISKS OF MONSANTO'S GE STRATEGY

In the process of developing genetically engineered crops Monsanto appears to have come up against two major problems – lack of market acceptance by consumers and risk exposure stemming from possible genetic contamination of food crops. These comprise the main risks to Monsanto shareholders. There are many possible ways in which market rejection could manifest itself and many of these forces are reinforcing. This dynamic can be seen in several incidences where market rejection in one segment of the economy lead to rejection in another. For example, general consumer rejection of GE foods led food producers to abandon genetically engineered potatoes. Similarly, farmers in North America have begun to question the commercialization of GE wheat due to the potential loss of lucrative markets not just in Europe but globally. Many food producers in Europe have stated that they will not accept GE wheat.

In its development of genetically engineered crops Monsanto's business has three main constituents – farmers, producers, and consumers, only one of which provides it directly with income. The company's strategy has focused on only one of these constituents for its business: farmers. By linking seeds with pesticides through genetic engineering the company can gain a greater share of farmers' operating budgets. This strategy has forced the company to focus on seeds and chemicals as its products and farmers as its customers. However, when viewed in a larger context, Monsanto's products and customers are actually food and consumers, not farm inputs and farmers. This implies that the company's product development strategy discounts the importance of consumers and food producers to its overall business model. Since the attributes of genetically engineered crops do not have a direct benefit for consumers but rather are aimed at farmers, these crops can be seen to pose a potential and unknown risk and yet provide no direct benefit.

Clearly consumers should have been part of the equation because it was consumer rejection that triggered the food manufacturing and retail sectors in many countries already to keep GE ingredients out of their products. Food companies were also just responding to meet their own interests and sometimes their interests are different. When GE potatoes aren't good enough for McDonald's, it is sending some kind of message.

The record of successes and failures in GE crops is instructive in this regard. Corn & soya – the two most widely grown GE crops are mostly eaten by livestock (roughly 90%) or enter the human food chain directly mainly as minor ingredients or derivatives (e.g. soya and corn oil, soya flour, soya lecithin, corn starch). Particularly for the human food market outside of North America, there is a solid, fairly well established market for certified non-GE soya and corn. The biggest failures are items like the "Flavr Savr" tomato, "New Leaf" Potato, and Aventis' GE rice. These are crops with significant direct human consumption. Adding new crops for human consumption to its existing portfolio may be difficult as has been seen with the commercialization of GE wheat which is already receiving significant resistance. Indeed, the fact that farmers, Monsanto's main direct constituents, are organizing boycotts[11,12,13] before any seeds are in the ground implies that this will be the case.

The second issue of product development which Monsanto faces in its move to expand its portfolio of genetically engineered crops is risk exposure. A major part of the risk in Monsanto's genetic engineering program is the fact that it is dealing with the genetic structures of the four or five most important food crops for humanity. Risks, even remote ones, have compelling gravity given the obvious importance of food crops. Lack of complete knowledge is a problem for investors. For developers of GE crops it is *the* problem. Monsanto is also exposed to risks taken by competitors such as Aventis CropScience and ProdiGene. Missteps by these companies could seriously impact Monsanto's business in GE seeds.

Informed critics of GE crops have pointed out that scientists do not have enough knowledge about several critical areas of recombinant DNA crop science. In short those include the long term effects of eating GE foods, especially pesticide producing crops; how added genes relate to the rest of the plants' genome; how damage to plant DNA that can result from inserting genes affects plants; how inserted genes will express themselves in future generations; and finally, what ecological impacts GE crops will have over time.

MARKETING AND GOALS

The chart below describes the breeding and technology product development, comprising more than 80% of Monsanto's R&D investment. Capabilities in genomics, biotechnology and plant breeding are applied to develop seeds with preferred input and output traits.

	DISCOVERY	PHASE 1	PHASE 2	PHASE 3	PHASE 4
Description Key activities and milestones in each phase of product development	**Gene/trait identification** Conduct high-throughput screening of genetic database to identify valuable plant traits for conventional breeding or valuable genes that can be used to improve plants through biotechnology	**Proof of concept** For conventional breeding, breed plants from parents with desired traits; for biotechnology products, test gene configurations in plants to screen for desired performance.	**Early product development** For conventional breeding, conduct field trials of plants bred from parents with desired traits; for biotechnology products, conduct lab and field testing of genes in plants to select commercial product candidates, meet preregulatory requirements.	**Advanced development** Demonstrate performance of hybrid/variety developed through conventional breeding or efficacy of biotechnology trait in elite germplasm. Develop regulatory data as appropriate.	**Final regulatory submission** Produce bulk seed for potential sale, develop plans for commmercialisation/launch, response to regulatory process as appropriate.
Average duration	24 to 48 months	12 to 24 months	12 to 24 months	12 to 24 months	12 to 36 months
Average probability of success (based on all candidates in each phase)	5%	25%	50%	75%	90%
Input trait candidates Input traits aimed to provide value to farmers by increasing productivity and reducing costs.	Higher grain yield Environmental stress tolerance Insect Control *Roundup Ready*	Higher-yielding corn Specialised corn Higher-yielding soybeans	*YieldGard II* insect-protected corn Stacked *Roundup Ready* and insect-protected soybeans	Stacked *Yieldgard Rootworm* corn with the Roundup Ready trait *Roundup Ready* Flex cotton *Roundup Ready* Wheat *Roundup Ready* hybrid canola	*YieldGard Rootworm* insect-protected corn *Bollgard II* insect-protected cotton Conservation tillage elite corn germplasm
		Conventionally bred higher-yielding corn, soybeans and wheat (Phases 1 to 4)			
Output trait candidates Output traits aimed to provide consumer benefits and create value for manufacturers and processors	Protein enhancements Lipid enhancements Carbohydrate enhancements Bioactive compounds	Healthier oil II for food uses Improved-energy corn III for feed	Healthier oil I for food uses Improved-protein soybeans for food Improved-protein soybeans for feed (in Renessen pipeline) Improved-oil soybeans for processing (in Renessen pipeline)	High-starch corn for ethanol *Processor Preferred* elite germplasm for corn and oilseeds Improved-energy corn II for feed (in Renessen pipeline)	Improved-energy corn I for feed (in Renessen pipeline)

Figure 7. Monsanto Product Pipeline[14]

Monsanto's marketing approach has emphasized that its products will help to feed a growing population and will help farmers ensure yields. It's overall business model is to sell chemicals and seeds to farmers. It does so by linking seeds with chemical technologies through recombinant DNA techniques (genetic engineering), as with Roundup Ready seeds, or more directly through licensing agreements on genetically engineered seeds such as its Bt corn and herbicide-resistant soybeans for which it earns technology fees from farmers.

The company has stated in its recent annual report that it intends to increase the percentage of revenues earned from genetic engineering technology fees relative to its regular seed and chemicals businesses.[15] This will increase the company's risk exposure to potential problems associated with genetically engineered crops.

Monsanto has been one of the earliest adopters of GE crop development. Its first product was the FlavrSavr tomato, a product it acquired when it bought the original developer, Calgene. Since then it has developed GE soya, GE corn in several varieties, GE canola, GE cotton, a GE potato and GE wheat. A number of other products are in the R&D pipeline. According to the company it is in the process of developing several new genetic traits through recombinant DNA techniques (genetic engineering). These include cold, heat and drought tolerance, disease resistance, and nitrogen efficiency, as well as an "improved energy" corn for pig feed and "improved-oil" soybeans for processing efficiency (see Figure 7 above).

The company also has a number of "stacked gene" crops in its product development pipeline that include its Bt toxin and Roundup Ready traits. This year the company has submitted for final regulatory submission (the final phase of its four phase product development process) a new variety of Bt corn, second generation of Bt cotton, and a feed corn which has improved energy characteristics. It should be noted that the strategy of developing products which have no direct perceived benefits to consumers is evident here and will therefore be likely to amplify the trend of consumer rejection of GE crops. In addition, the focus on crop traits which are not meant for human consumption, and yet could result in contamination of the human food chain appears an especially risky endeavor in light of the StarLink corn problem.

Affects of Roundup Competition

In its 2002 annual report Monsanto addresses what many financial observers consider the company's most pressing issue – the loss of its patent on its *Roundup* glyphosate herbicide. The company states in it 2002 Annual Report: "*Roundup remains the world`s No. 1 selling herbicide. Global sales of Roundup and other glyphosate-based herbicides exceed those of the next six leading chemistries combined…[However] Adverse weather and continuing competitive pressure on our flagship products, Roundup herbicide, reduced U.S. revenues of branded Roundup by 26 percent.*[16]" The company made efforts to quantify the issue for stakeholders and according to Monsanto's Office of Investor Relations, the company expects that competition with its Roundup herbicide from generic brand Glyphosate manufacturers will increase in the near term. Company representatives estimate that its market share will likely drop from 77% currently, to the low 60's by around 2005. Also, as a result of competition, company officials provided estimates to Wall Street

analysts projecting that the price it receives for *Roundup* will likely drop from $23 per gallon in 2002 to around $14-$16 per gallon by 2005.[17]

This appears to be the major impetus behind the company's efforts to increase its genetically engineered seeds business, as evidenced by the following statement in the 2002 annual report: *"In late 2002, shareowners saw evidence of a fundamental shift: Monsanto's transformation from a company based on a strong chemistry portfolio and especially on Roundup herbicide, to a company based on seeds and biotechnology traits businesses."*[18]

The affects of competition for Roundup have been considerable with an estimated $1.69 billion in lost revenues, and a 14% drop in overall revenues from 2001. In some cases, Monsanto has been driven out of the glyphosate market altogether, as was the case in Australia, where competition from cheap Chinese imports caused the company to close its manufacturing plant there.[19] Based on Monsanto's estimates, losses in the glyphosate business could be anywhere in the $400 to $500 million range by 2005 representing roughly between $1.50 and $1.90 per share at current levels of market capitalization. The question remains for investors as to how serious the financial impacts of generic glyphosate competition will be and whether Monsanto can replace the lost revenues with new business elsewhere.

Genetically Engineered Wheat

"We will not only avoid buying GM wheat, but we will probably be forced to completely avoid importing from those countries/regions where it is known that GM wheat is grown." - Antonio Costato, President and CEO of Grandi Molini Italiani. (GMI has six mills in Italy and turns over some 1.4 million tonnes of grain annually.)[20]

"These bills [banning GE wheat] *are surfacing in North Dakota because of a genuine, sincere concern for the market. Our major wheat customers say they won't accept any wheat that has genetically enhanced characteristics, and we're listening to our customers."* - Terry Wanzek, chairman of North Dakota's Senate Agriculture Committee

"First of all, we are consulting our customers, located in over 70 countries around the world. The bottom line is that most of them don't want GM wheat right now. Over 80 per cent of markets for Canada Western Red Spring wheat, including customers in Japan, the United Kingdom and Italy, are resistant to GM wheat in one way or another. This opposition could mean blocked shipments and traditional customers looking elsewhere if RRW is commercially grown in Canada." - Ken Ritter, Chair, Canadian Wheat Board[21]

The significance of the controversy surrounding genetically engineered wheat (Roundup Ready) is of particular importance due to the breadth of opposition to its commercialization. The mainstream farming community, non-governmental organizations, industrial wheat sellers, processors and users have all asserted their opposition to the commercial introduction of GE wheat. While some of these parties have traditionally supported the use of GE crops, few support the introduction of Monsanto's Roundup Ready wheat.

Arguments being made against genetically engineered wheat include:

- Opposition to GE wheat from major wheat markets.
- Impossibility of segregating GE from non-GE wheat after commercial approval.
- Significant agronomic problems associated with Roundup Ready wheat, and commensurate increases in costs for farmers.
- Threats to organic farming.
- Unresolved liability issues arising from farmers who face genetic contamination or market loss.
- Environmental and possible human health risks from GE wheat.

GE Rejecting and Non-Rejecting Countries

Country	Status	Note
Algeria	Reject	Government prohibition against the import of GE crops.
Bangladesh	Not reject	Likely not to reject.
Brazil	Reject	Customers currently requesting non-GE certification.
Canada	Reject	Customers currently requesting non-GE certification.
Chile	Not reject	No comment received.
China	Reject	Pre-approval required for import.
CIS & Baltics	Not reject	No comment received.
Colombia	Reject	Customers currently requesting non-GE certification.
Cuba	Not reject	Likely not to reject.
Ecuador	Reject	Customers currently requesting non-GE certification, partial ban on imports.
Eqypt	Reject	Customers currently requesting non-GE certification.
EU	Reject	EU moratorium against the approval of new GE crops, customers currently
Indonesia	Reject	Customers currently requesting non-GE certification.
Iran	Not reject	No comment received.
Iraq	Reject	Customers currently requesting non-GE certification.
Japan	Reject	Customers currently requesting non-GE certification.
Libya	Not reject	No comment received.
Malaysia	Reject	Customers currently requesting non-GE certification.
Mexico	Reject	Customers currently requesting non-GE certification.
Morocco	Not reject	No comment received.
Peru	Not reject	No comment received.
Philippines	Reject	Customers currently requesting non-GE certification.
Poland	Not reject	No comment received.
South Africa	Reject	GE-free statement required for phytosanitary permits.
South Korea	Not reject	No comment received, although labeling required.
Sri Lanka	Reject	Government prohibition against the import of GE crops.
Sudan	Not reject	No comment received.
Thailand	Reject	Customers currently requesting non-GE certification.
Tunisia	Not reject	No comment received.
Turkey	Not reject	Likely not to reject.
US	Reject	Customers currently requesting non-GE certification.
Venezuela	Not reject	No comment received.
Vietnam	Not reject	Likely not to reject.

Figure 8. Canadian Wheat Board – Assessment of Market Acceptance for GE Wheat (2002)[22]

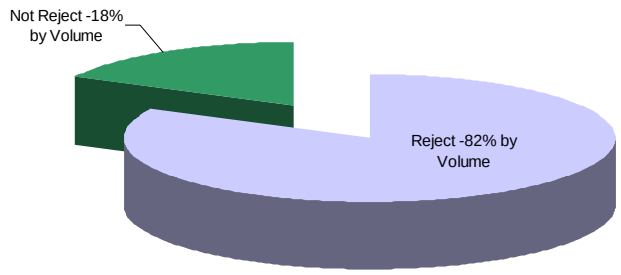


Figure 9. Wheat Export Market Rejection by Volume (based on Figure 8 above)

Monsanto has now pushed back the proposed introduction of its GE wheat from 2003 until 2004-2005, and has publicly stated that they will only do so if they can first gain pre-acceptance from buyers as well as environmental and health clearance from regulatory authorities. Given that approximately 50 percent of the wheat crop in the United States (approximate value in 2001 $3.5 billion) and 70 percent of the wheat crop in Canada (approximate value $3 billion annually) is exported, North American farmers and the wheat industry could face significant income loss after the commercial approval of GM wheat.

In terms of the total market represented by the list above, Figure 9 above illustrates the size of the estimated market rejection in thousands of tons. As a result, the Canadian Wheat Board is asking that before GE wheat can be approved, a cost benefit analysis of the impact of commercialization should be done.[23] This marks a change from previous commercialization processes that Monsanto has faced. Now instead of merely meeting safety requirements, the company may have to show that no economic harm will be done to farmers in the process of commercialization. Under the current market situation which puts large markets such as the EU off-limits, this development could create additional barriers to Monsanto's product development process.

Catastrophic Failure Risks

"Adventitious Presence" [Contamination]

As noted above, this report refers to the misleading term "adventitious presence" as "contamination" to enhance clarity.

"(…) the detection of unintended trace amounts (adventitious presence) of biotechnology traits in pre-commercial seed, seed varieties or the grain and products produced can negatively affect our business or results of operations. (…)In addition, concerns have been expressed about the potential for adventitious presence of proteins in food, resulting from the development and production of pharmaceutical proteins in food crop plants. Monsanto's Protein Technologies business is one of several businesses engaged in this research." – From the Monsanto 2002 Annual Report pgs.36-7

Monsanto has admitted in its latest annual report that research and development of GE crops will result in the spreading of GE traits to non-GE crops.[24] This is a major admission for the industry and implies that the risk of contamination and negative impacts is very high going forward. The report acknowledges concerns about research and development of both traditional biotechnology as well as pharmaceutical proteins appearing in food crops. This implies that the company is aware of the possibility that both approved GE traits as well as unapproved traits still in the development process could end up in the human food supply-chain. The level of environmental and human-health risk, and therefore financial risk, cannot be understated.

Contamination can occur for example through the following paths: cross pollination, so-called "volunteers" – seeds from previous crops that are herbicide resistant, and mix of grain in silos. Even one gene with unapproved characteristics escaping into the general population of food crops could impugn the entire industry, and could result in major business losses for the company as was seen with the StarLink contamination episode. Given that Monsanto has multiple GE crops in the development pipeline that are discussed as being animal feed crops, it will be interesting to see how those are dealt with at the regulatory approval stage. New controversies and negative financial impacts for investors are highly likely. While Monsanto, as a large company with a varied and broad agricultural inputs business, will likely make short term earnings targets, the issue of inevitable contamination implies that a serious contamination problem is a matter of when, not if. Investors, take note.

The problem of contamination is going to become an increasingly difficult problem for Monsanto going forward. The company has stated that competitive pressure on its flagship product, Roundup, will increase and profits derived from its sale will drop along with market share. The company will be under increasing pressure to bring new products to market in order to fill the gap in terms of profits. A juxtaposition of the company's pipeline for products, which include pharmaceutical and animal feed crops not intended for human-food consumption, with increased pressure to commercialize its GE crops, implies that the company will be at increasing risk for contamination problems.

Contamination of Mexican Crop Cradle

In Mexico, genetic contamination of one of the major staple crops of the world has occurred. In September 2001, Mexican government officials first reported contamination of local varieties of corn with genetically engineered sequences in communities in the states of Oaxaca and Puebla, despite a federal moratorium on the planting of GE corn. Further investigations confirmed these findings.[25]

The most likely source of the contamination is unsegregated U.S. corn, huge quantities of which are imported into Mexico each year. According to the U.S. Department of Agriculture (USDA) more than five million tonnes of corn with a value of 585 million USD were exported to Mexico in 2002.[26] In 2002, 34% of the corn grown in the US was genetically engineered.[27]

Upon request of affected communities, the Commission for Environmental Cooperation (CEC), established as an environmental body under the NAFTA, is

currently investigating the full magnitude of the genetic contamination and its social and environmental consequences.[28]

Mexico is one of the so-called centers of origin and diversity of corn. Teosintes, the closest wild relatives of cultivated corn, and thousands of landraces of corn are found growing in Mexico. Corn is the most important crop in Mexico in terms of land area devoted to it. Contamination from GE varieties is feared to have broad impacts on biological diversity. Corn is open-pollinated and it is known that gene flow occurs easily among such plants. Their is a potential for GE crops to interbreed with wild relatives varieties and the offspring to be viable. The novel gene could give them an advantage over wild relatives, resulting in a loss of genetic diversity. Diversity in food crops is important for the global food supply and food security.

It is instructive for investors to examine the past record of contamination cases involving genetically engineered crops to quantify the real material risks facing Monsanto not only from GE food crops but also from second generation products which have been genetically engineered to contain pharmaceutical and industrial proteins. Going forward, the company will be relying much more heavily on profits from its GE seeds business. This will place greater pressure on the company to commercialize products in its pipeline and therefore push the company to greater levels of risk exposure.

StarLink

"…year-to-date, US exports of corn, wheat, and soy products were down 65 million bushels. And that was compared with projections by USDA that call for exports to be up by 330 million bushels. So that shows you the order of magnitude of what's happened. And I don't think it's that we've been uncompetitive price wise with other people around the world. I just think South Americans in particular have been able to take advantage of the situation and take some of the business formerly supplied by US farmers and merchandisers on the basis of having GMO free material. That's happened in Europe. That's happened in Korea. It's happened in Japan." – Larry Cunningham, Senior Vice-President of Corporate Affairs of ADM, commenting on the effects of the Star Link contamination in an April 23, 2001 quarterly analysts' conference call.

In the fall of 2001, independent analysis of grocery store food products uncovered wide-spread contamination by a GE corn variety known as "StarLink." The corn contained an insecticidal protein from the *Bacillus thuringensis* bacterium which had not been approved for human consumption due to potential allergic reactions. While less than 1% of the U.S. corn crop was planted with StarLink corn, upwards of 10% of U.S. corn were contaminated. The recall cost companies along the food chain hundreds of millions of US Dollars as they attempted to find, retrieve and replace products that used the corn.[29] StarLink corn also turned up in Japan - the top foreign buyer of U.S. corn – where the GE corn has no approval for use as food or feed. In 2001, Japanese imports of U.S. corn fell by about 1.3 million metric tons due to the StarLink issue.[30] To date this event has cost StarLink's developer, Aventis, an estimated $1 billion. Recently, in February of 2003, Aventis and the StarLink

distributor agreed to pay $110 million to farmers who say they were financially hurt by the incident.[31]

ProdiGene and "Pharma-crops"

"It is possible that crops transformed to produce pharmaceutical or other industrial compounds might mate with plantations grown for human consumption, with the unanticipated result of novel chemicals in the human food supply." - Committee on Environmental Impacts Associated with Commercialization of Transgenic Plants of the National Academy of Sciences

In the wake of the StarLink fiasco, a second contamination case has raised serious questions about the safety procedures surrounding the development of genetically engineered crops containing industrial or pharmaceutical proteins which produce medicines or vaccines.

ProdiGene, a small Texas-based genetic engineering firm, was found to have mishandled genetically engineered pharmaceutical corn that produced pig vaccines in Iowa and Nebraska. A test plot of ProdiGene pharmaceutical corn was grown on a Nebraska field in 2001. Ordinary soybeans that were planted in the same field in 2002 got contaminated by the GE corn and mixed with 500,000 bushels of soybeans, worth roughly $2.7 million, at a commercial grain elevator. The company was fined $250,000 and had to spend up to $3 million to destroy the soybeans. The company will also have to post a $1 million bond to guarantee its financial responsibility for future problems.[32] The company's CEO acknowledged that no formal human safety testing had been done on the pig vaccine protein contained in the corn.[33]

In a similar incident, the USDA ordered ProdiGene to destroy several thousand bushels of corn in Pocahontas County, Iowa after the company failed to follow procedures designed to stop the spread of the engineered genes to other fields containing food crops.[34] The seed distributor, Stauffer Seeds (owned by ProdiGene) ran ads in farm journals telling farmers they could grow "*genetically enhanced corn containing industrial and pharmaceutical products*" with "*No change in current farming practices*."

These incidents have galvanized the food industry in opposition to the further development and commercialization of food crops genetically altered to contain industrial or pharmaceutical proteins. Politically powerful trade groups for the $500 billion food sector such as the National Food Processors Association and the National Grocery Manufacturers of America have been pressuring the genetic engineering industry to change its approach to the development of these crops by staying away from food crops and switching to non-food crops such as tobacco. These industries see pharma-crops as a financial threat and don't want to repeat the StarLink fiasco. "*If need be, we could even go to the public*" stated Rhoda Applebaum, Executive V.P. of Scientific and Regulatory Affairs at the National Food Processors Association.[35] This is significant opposition coming from an industry that has previously been supportive of genetic engineering.

The editors of the journal Nature Biotechnology and the U.S. National Academy of Sciences have both stated that cross-pollination with non-GE crop varieties was a potential problem.[36,37]

All this implies that Monsanto will face increasing pressure to limit the development of pharmaceutical crop varieties. Potential contamination of food crops by pharma-crops, even those of a competitor, could further galvanize market rejection to its products including the genetically engineered food crops upon which it will increasingly rely for profitability.

5. GE RISKS AND THE IMPLICATIONS FOR SHAREHOLDERS

MARKET RISKS

"Public Acceptance: The commercial success of agricultural and food products developed through biotechnology will depend in part on public acceptance of their development, cultivation, distribution and consumption." – From the Monsanto 2002 Annual Report

This section covers the general risks to investors resulting from development and marketing of genetically engineered crops and food products.

Consumer Rejection and U.S. Public Opinion

The depth of market rejection for GE crops is not likely to be equaled by any other consumer product. In addition to large numbers of consumer groups, a majority of the world's governments and many large players in the food industry have banned GE crops and ingredients. Below is a flowchart showing the development of market rejection for genetically engineered foods which shows no signs of abatement. For investors, this list should serve as a stark example of the uphill battle Monsanto and other GE crop producers face in getting products to market.

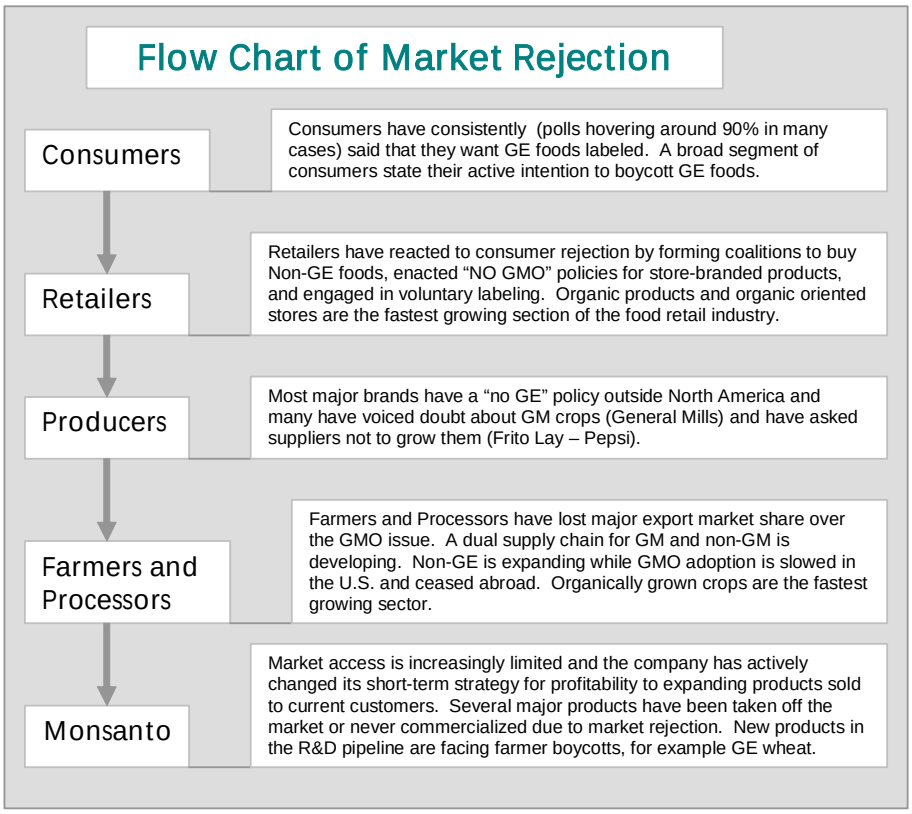
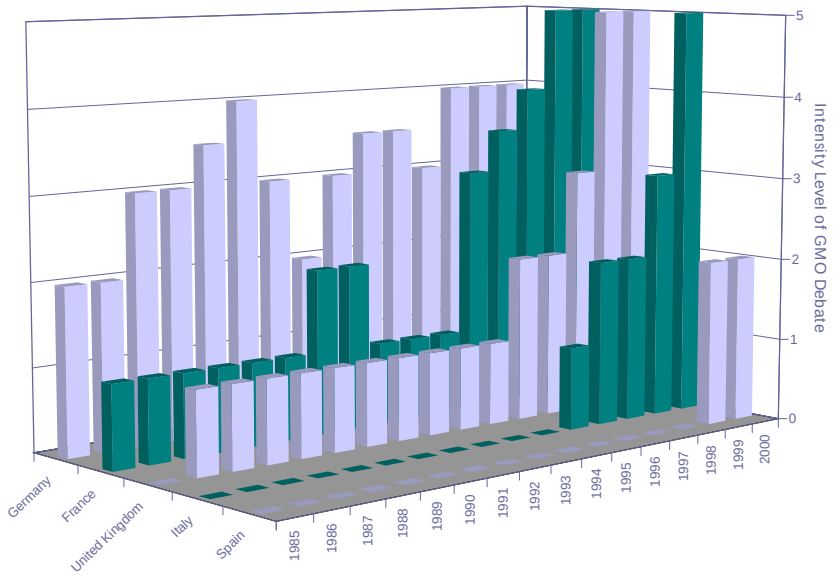


Figure 10. Flow Chart of Market Rejection of GMOs

The market risks for genetically engineered crops are greatly related to the level of consumer awareness about the issue. This has been the main driver of market rejection. A key market to examine in understanding the development of consumer awareness and opposition to GE crops is the European market. Figure 11 below illustrates the growth in awareness of the issue as reported by the Final Report of the PABE research project for Commission of European Communities.[38]



"0" indicates no debate on the issue at all, in any arena. "1 to 2" (situation B in Figure 2) indicates a debate which is mainly confined within a small number of specialized arenas: the debate involves only a few professionals who handle the problems raised according to the established rules of each specific arena. It hardly enters the media and remains unnoticed by the general public. "3 to 4" indicates a debate which involves a greater number of arenas, greater interaction between the different arenas, and a debate which overflows from specific arenas. This is reflected in greater media interest and changes in opinion polls, but the debate still involves mostly official stakeholder representatives: it is stimulated by NGOs and other forms of organized social movements. "5" (situation D in Figure 2) indicates that the fundamental characteristics of most of the arenas, including the type of actors present and the frames of reference used within each of them, have been significantly influenced by the dynamics of the public debate. Media coverage is high and the non-organized mass public becomes actively enrolled: everybody has heard about the issue and has something to say about it.

Figure 11. Intensity Level of GMO Debate in Five Selected European Countries
Source: PABE (2001) *Public Perceptions of Agricultural Biotechnologies in Europe*.
(The authors emphasize, that this should not be taken as a strictly quantitative assessment of the situation, and that the graph in Figure 11 should be considered together with the qualitative narratives in section 5.2. (pgs. 41-5) of the report.)

The Public Perceptions report research shown above was conducted through focus groups designed to gather in-depth understanding of public knowledge and opinion on the development and sale of genetically engineered food in five European countries. Each country had eleven focus groups designed to capture different segments of the population. Some of its findings are very revealing for investors and shed light on the complexity of public opinion and some of the motivation behind the wide-spread market rejection of genetically engineered crops. Some of it bears repeating here due the nuanced level of input researchers were able to elicit from

participants which gives a greater understanding of public opinion than mere polling. The researchers reported that lack of information was an overwhelming feeling expressed by the focus groups, although this reflected not the amount of information received but the *quality* of information received. This translated into a demand for labeling.

> Comprehensive labeling of products containing GMOs or ingredients derived from GMOs was systematically demanded, but this had not been provided by EU or national legislation (labeling of "GE-free" food products was not considered to be an adequate solution).
>
> Lack of labeling was seen as an infringement of personal choice and control, but this was not solely demanded in order to protect oneself from potential harmful consequences. Labeling was also felt to be important to allow consumers to boycott the products in order to 'send a message' to manufacturers about a whole range of concerns other than health risks associated with GMOs; and to enable post-market monitoring of unintended harmful effects, and removal from the market if such harm was identified. A frequent question raised was "How can long term chronic impacts be evaluated if the products were not even labeled?" It was also felt that labeling would demonstrate that "they [the promoters] have nothing to hide". (PABE, 2001)[39]

In the United States, the largest market by far for GE foods, researchers from 12 American universities, headed by the University of North Carolina conducted a recent polling study entitled *"The Globalization of Food: How Americans Feel About Food Sources, Who They Trust, Food Security, Genetic Modification, Food Labeling and the Environment".*[40] The researchers obtained a sample of 819 randomly selected US respondents. They adjusted mailed survey responses using 2000 U.S. Census data on age, race, sex, income, education and region in order to make findings more nationally representative. According to researchers 92% of respondents stated that they wanted labels on genetically engineered foods. Only one percent said they did not. 7% were undecided on labeling of genetically engineered food ingredients. When asked if they would eat foods grown with new biotechnological techniques 51% were undecided and there was a spit between those agreeing (26%) and disagreeing (23%).

Other results included

- 47% were not sure if they consider genetically engineered plants unsafe.
- 28% say genetic engineering makes plants unsafe.
- 25% believe they're safe.
- 43% aren't sure if genetically engineered foods from animals are unsafe. 39% see them as unsafe and 17% see them as safe.
- 17% say they are safe.
- 71% would pay more for food produced in ways that protect the environment.
- Another 60% would pay more for food produced without using chemicals.
- 81% would pay more if it were grown on farms using good environmental practices.

Previous polls of Americans found similar consistent wariness of genetically engineered foods with a consistent focus on the need for labeling.[41,42]

U.S. Polling Data History 1997-2001

Date	Poll Source	Response
Nov. 2001	**Food Policy Institute, Rutgers University**	On November 15, 2001 the Food Policy Institute at Rutgers University released the results of their latest opinion poll on genetically engineered crops. Their public opinion poll found that 90% of Americans say that foods created through GE should have special labels on them.
Sept. 2001	**Farm Foundation/Kansas State University**	In a survey of farms through out the U.S. 90% of American Farmers support labels on GE products if they are scientifically different from conventional foods and 61% support labels on GE products even if not scientifically different.
Jun. 2001	**ABC News.com**	In June 2001, ABC News.com found that 93% of people wanted GE food to be labeled. ABC reported that the results showed that Americans "almost unanimously favor mandatory labels on genetically modified foods."
Apr. 2001	**PBS/Frontline**	An April 2001 poll with over 21,000 respondents found that 65% said we should not grow GE crops.
Mar. 2001	**Pew Initiative on Food and Biotechnology**	A March 2001 poll found that 75% of Americans believe it is important to know if food is made with GE ingredients. 58% say they oppose the introduction of GE foods, while those that believe that GE foods are not safe or are unsure of the safety of GE foods total 71%.
Feb. 2001	**International Food Information Council**	A February 2001 poll found that just 37% of Americans support the Food and Drug Administration's policy on labeling GE foods, while 58% support critics of the agency who call for mandatory labeling of all GE food.
Dec. 2000	**Oxygen/Market-Pulse**	A December 2000 poll found that 85% of Americans support labeling of GE foods, with 88% supporting safety testing. Only half of women surveyed say they would eat GE food, with only 37% saying they would give GE food to their children. 47% of women say they would pay more for non-GE food.
Nov. 2000	**Reuters/Zogby**	A November 2000 poll found that over 54% of Americans say that recalls of products found with an unapproved GE corn raise questions about the safety of the food supply. 33% believe that farmers should not be allowed to grow GE crops, while under 40% believe that GE crops should be permitted.
Jun. 2000	**Harris Poll**	A June 2000 poll found that 86% of Americans think the government should require labeling of all food from GE crops.
Spring 2000	**Texas A&M**	A Spring 2000 poll showed just 39.5% of Americans approve of current government regulation of biotechnology. According to Susanna H. Priest of Texas A&M, their survey shows that "…the U.S. increasingly resembles Europe in having significant amounts of opposition [to GE food]."
Mar. 2000	**International Communications Research**	A March 2000 poll found that 86% of Americans want labels on genetically engineered foods.
Feb. 2000	**USA Today Weekend Poll**	A February 2000 poll found that 79% of Americans said it should not be legal to sell GE fruits and vegetables without special labels.
Jan. 2000	**MSNBC**	An internet poll conducted in January 2000 found that 81% of Americans think the government should require labeling of GE food, and 89% think the government should require pre-market safety testing of GE foods, as with any food additive.
Dec. 1999	**The Economist/Angus Reid Group**	A poll conducted in November-December 1999 (reported January 13, 2000) found that "Only 4% of Americans would actually be more likely to buy foods because they are genetically modified. By contrast, 57% [of Americans] would be less likely to buy them. (T)he sharpest distinction between America and Europe lies not in the percentage of people rejecting GE foods, but in public awareness."
Fall 1999	**Gallup Poll**	A Fall 1999 poll found that 68% of Americans want labels on GE food, even if labeling means higher food costs.
Sept. 1999	**BSMG Worldwide for the Grocery Manufacturers of America**	A September 1999 poll found that 92% of Americans support legal requirements that all GE foods be labeled.

Jan. 1999	**Time Magazine**	A January 1999 poll found that 81% of American consumers believe GE food should be labeled. 58% say that if GE foods were labeled they would avoid purchasing them.
1998	**National Federation of Women's Institutes**	A 1998 poll found that 93% of women surveyed say they want all GE food clearly labeled.
1997	**Novartis**	A 1997 poll conducted for the gene food maker found that 93% of Americans agree that GE foods should be labeled as such, with 73% saying they feel strongly about labeling.

Figure 12. U.S. Polling Data on Genetically Engineered Foods (1997-2001)[43]

It is important to place the discussion of consumer rejection in the large context of market rejection of genetically engineered foods. The dynamics of market rejection are reinforcing as the economic consequences flow from one sector to the next. As can be seen in the next section on rejection of GE foods by the food industry, consumers are beginning to move the food retail industry further and further away from full adoption of GE foods. As full market penetration by GMOs has failed to materialize, the section of the economy with a vested economic interest in preventing the further commercialization of GMOs has grown.

Food Industry Rejection

Driven by consumer rejection of GE foods, retailers and producers have been moving away from GE foods. Below are some of the GE food crops which have been developed but failed to be commercialized or were removed from the market due to consumer rejection.

- GE potatoes were withdrawn from the U.S. market in 2001 by Monsanto after a series of major market rejections, including by McDonald's, Burger King, McCain's and Pringles.[44]
- GE flax seed was taken off the market in 2001 under pressure from the Flax Council of Canada and the Saskatchewan Flax Development Commission because European customers, who buy 60 percent of Canada's flax, said they didn't want GE flax.[45]
- Genetically engineered rice has also faltered with Aventis backing off from commercializing its herbicide resistant GE rice largely because of warnings from millers and large value-added domestic and foreign producers that they'll reject it.[46]
- GE sugar beet has also been rejected by U.S. sugar refiners who told farmers to avoid GE sugar beet because Japan, which accounts for 80% of the sugar beet pulp market from the US, will not buy GE crops.[47]
- Subsequently to the StarLink corn scandal, Aventis CropScience (now Bayer CropScience) decided to abandon GE StarLink corn and withdrew it from the market.

These market failures for the GE industry represent a consistent pattern of market rejection that is working its way up the industry supply chain from consumers to producers to farmers.

Figure 13 below is a sample list of food companies representing in excess of $450 billion in yearly revenues that have publicly committed to remove GE ingredients from their supply chains in key countries or regions. The scale of rejection by each company varies from those who have removed only GE ingredients from food for human consumption in products sold in one or more countries, to companies who have an international or global policy to remove GE ingredients from their supply chain and also to exclude the use of GE crops as animal feed.

Aldi	Coop	Hipp	Sapporo
Alpro Soya	Corona	Kirin	Soya Hellas
Amadori	Danone	Kraft Jacobs Suchard	Spar
Asahi	Delhaize Le Lion	Marks&Spencer	Superquinn
ASDA	DUC	McCain	Tegel
Barilla	Edeka	McDonald's	Tengelmann
Ben & Jerry's	Esselunga	Migros	Tesco
Bodin	Ferrero	Nestlé	Trader Joe's
Burger King	Findus	Nutricia	Unilever
Cadbury's	Friki	ParknShop	VitaSoy
Carrefour	FujiOil	Perdigao	Waitrose
Coca Cola	Gerber	Sadia	Wiesenhof
Colruyt	Heinz	Safeway	Wimpy Fast Foods

Figure 13. List of Food Companies with No GMO Policies

These companies are among many worldwide that have responded to consumer demand for non-GE foods. The management of the companies may be generally sympathetic to the promises of GE crops but they have recognized the potential for profit losses that would result from not responding to consumer demand. The food industry is in the front line of the consumer complaints regarding GE foods and they bear much of the burden of government regulations regarding labeling, segregation and product recalls. Recent accidents with GE crops highlighted in this report help explain the waning enthusiasm for GE foods in the industry, with pharmaceutical crops being of particular concern. The recent accidents in the U.S. have pushed even the most staunch supporters of GE foods to call for much stronger safeguards. The prospect of pharmaceuticals in their cornflakes is one which rightly concerns them.

International Markets Shifting to Non-GE crops for Food and Animal Feed

Virtually the entire European food industry has already taken action to ensure that no GE ingredients are directly used in any of their food products. Such policies are being actively pursued by major retail groups and food manufacturers. A significant number of these have already extended their policy to cover animal feed. Since animal feed represents an estimated 80-90% of the market for crops such as soya and corn, rejection in the feed market can be anticipated to have a greater economic effect than rejection in the consumer food industry.

The U.S. Department of Agriculture in May 2001 stated that, *"Over the last 12 months, demand for certified biotech-free soybean meal has grown from near zero to 20-25 percent of the EU market according to officials in the compound feed*

industry."[48] Since then there have been a further series of commitments by major companies across Europe to use only non-GE feed.

Below are just two illustrative examples of company statements taken from the UK. One from a globally recognized food producer from April 2002 stating its new policy including animal feed and the other from a major poultry supplier concerning its switch to non-GE soya.

Heinz: April 2002 (Policy statement) GENETICALLY MODIFIED INGREDIENTS

- Heinz remains committed to taking every possible step to ensure that Heinz varieties remain free from ingredients derived from genetically modified crops and this includes animals fed on GM crops.
- Where there is the potential for GM material to be present, or where ingredients are derived from soya or maize, we source non-GM, identity preserved ingredients through carefully audited suppliers. In addition, independent testing is carried out.
- The use of GM crops in animal feed is a sizeable farming issue particularly with respect to commodity ingredients widely used in food manufacture. However, Heinz has continued to review this issue.
- As a result of our achievements to date and our continuing ingredient review programme, the suppliers we use for beef, lamb and poultry do not use GM animal feed. We are also continuing to review our sourcing strategies for pig meat with the aim of ensuring similar status whilst still meeting the highest technical and quality standards.
- With respect to other ingredients such as eggs and dairy produce, we continue to make progress as part of our GM review programme.

GRAMPIAN TO BEGIN PRODUCTION OF NON-GM ANIMAL FEED

Grampian Country Food Group announced today that it is to begin manufacturing all of its poultry and pig feed with non-GM soya by June 2001. This decision has been taken in the light of requests by several of our retail customers to remove GM soya from our animal feeds. Commenting on this announcement Alban Denton, Grampain's Feeds Division Managing Director said "We have been in negotiations with our supply base for some time to source the volume of non-GM soya we require for our five feed mills. With the support of our retail partners we are now in a position to offer a non-GM poultry and pig feed with the guarantee that it has been sourced from a hard ip scheme. Consumers will have the confidence that the livestock fed by Grampian will consume a non-GM diet." By making this decision Grampian Country Food Group is the first major UK animal feed manufacture to produce non-GM animal feed in all its mills in response to both our consumers and retailer requests. Where feed is sourced from third party supplies Grampian will co-operate closely with these farmers and feed compounders to assist them in sourcing non-GM soya to the same exacting standards.

- Alisdair Cox, Group Corporate Marketing Manager, Grampian Country Foods. Tel 01224 696113
Press Release from Grampian Country foods - FEBRUARY 2nd 2001

Supplementary Notes: Grampian Country Food Group produces 3.8 million chickens, 24,500 pigs a week. To support these activities the Feed Milling Division produces 20,000 tonnes of compound poultry and pig feed per week. ; Hard IP Non-GM soya : Grampian Country Food Group have procedures in place throughout the supply chain to form a rigorous quality assurance scheme, ensuring identity preservation. These detailed procedures are backed up with PCR tests, any positive results would lead to rejection from Grampian's supply chain. The whole process is independently validated by an accredited auditing company.

The U.S. Food Industry: Tipping Points Towards a GE-Free Food Supply

The first mainstream US retailer, Trader Joe's, recently followed the major health food retail chains Genuardi's, Whole Foods and Wild Oats in rejecting GMOs

saying that "*we determined that, given a choice, our customers would prefer to eat foods and beverages made without the use of genetically engineered ingredients.*"[49]

It is clear that the US food industry is already aware and increasingly cautious about the potential negative financial impacts of GE foods. Most companies have experience on the issue. Through global or international operations and communications, they receive significant consumer feedback on the issue. National organizations in particular the Grocery Manufacturers Association of America (GMA), have been outspoken in their support of GE foods and of the potential benefits, however their members are seeing costs and burdens resulting from GE food. Conversely, counter-balancing financial benefits have yet to be identified for retailers and producers. In addition, it is difficult to identify benefits that the current GE crops on the market have for consumers. GE foods are neither cheaper to buy, nor fresher, nor better tasting than conventional or organic foods. The current GE crops are designed to benefit farmers but the promised second generation of GE crops, which were intended to provide consumer benefits have not materialized. Judging by Monsanto's development pipeline which includes animal feeds and perhaps pharmaceuticals and herbicide resistant wheat, it is fair to say that those benefits may be far off.

How long it will take for the US food industry to follow what is rapidly becoming the global standard of either non-GE, labeled as GE or organic remains to be seen. With consumer support for GE labeling in the 70-90% range and the food industry facing costly segregation procedures, it would be fair to guess that retailers and producers have already assigned teams to look at the logistics.

Monsanto has chosen an aggressive GE development strategy at the same time that previously pro-GE or non-aligned economic interests are lining up against further commercialization of the technology. This is a development that should give investors pause.

REGULATORY RISKS

Regulatory and institutional barriers to the commercialization of genetically engineered crops have expanded and solidified considerably since the introduction of mass produced GE crops in 1996. In many ways these barriers comprise the largest obstacle that Monsanto and other genetic engineering firms face in the commercialization process. In the past Monsanto pinned its hopes on opening up new markets as the path to increased profitability. Monsanto set out ambitious goals in 2000 and 2001 for regulatory approval as part of its business plan for its GE crops but largely failed to win those battles. As a Senior Analyst from Lehman Brothers put it: *"This is a company that has been optimistic on the verge of lying."* [50] In 2002 the company scaled back its goals for regulatory approval while seeking to work with U.S. government representatives to push for a WTO challenge to bans on GE crops.[51] The sections below outline the development of regulatory barriers world-wide that have come about due to consumer rejection and scientific caution regarding GE crops.

Regional Regulatory Situation

Figure 14 below shows the development of regulatory action which may stop GE crops from spreading into new markets.

Examples of Legislative Action Taken by Governments Worldwide to Identify & Halt GMOs

Country	Since	Legislative action
Algeria	12/2000	- Introduction of a ministerial decree to prohibit import, distribution, commercialisation, utilisation of GMOs. [52]
Argentina	1997	- The National Advisory Commission on Agricultural Biotechnology rejects a request for authorisation of GE canola due to scientific and economic concerns. [53]
Australia	12/2001	- Introduction of mandatory labelling of GE foods with a 1% threshold. [54] - The state government of Tasmania implements a moratorium on commercial releases of GE crops and animals, to be reviewed in 2008. [55]
	03/2003	- Three canola growing states have implemented or announced their intention to put a commercial moratorium in place should GE canola get approved. [56]
China	03/2002	- Measures on GMO safety evaluation, GMO import and comprehensive GE labeling take effect. [57] - GE soya, maize, oilseed rape, cotton and tomatoes must be clearly labeled, also if the GE ingredient is not detectable in the product. - The import and sale of unlabelled GE products is illegal. [58]
	2003	- The northeastern province Heilongjiang intends to introduce a non-GE policy.[59]
Croatia	09/2001	- An interim law imposes a ban on the import, placing on the market, use and production of GMOs and GE products until specific, EU-adapted regulations come into force. [60]
Czech Rep.	01/2002	- Introduction of mandatory labelling of GE foods with a 1% threshold. [61] - Legislation gets adapted to EU standards.
European Union Member States	11/1997	- Labelling is required for food products in which the DNA or new protein of GE maize or soya is detectable. [62]
	1997 and later	- Austria and Luxembourg ban the import of Syngenta (former Novartis) GE maize over health and environmental concerns. - Greece and France ban the import and marketing of Bayer (former AgrEvo) oilseed rape. - In 2000, Germany bans the growing of Syngenta Bt maize. - Austria bans the growing of Monsanto Bt maize in 1999 and of Bayer (former Aventis) herbicide tolerant maize in 2000. [63]
	06/1999	- EU environment ministers implement a factual ban on any new approvals for the commercial release of GMOs until the introduction of strict environmental standards.
	04/2000	- Additives and aromas must be labelled if new DNA is detectable in the end product. [64] - A 1% threshold is established for mandatory labelling in case GE material is present due to 'adventitious contamination'. [65]
	10/2002	- The tightened release directive 2001/18 comes into force, requiring strict environmental impact assessment of GMOs and only allowing commercial approval of GMOs for limited period of time. [66]
	11/2002	- EU agriculture ministers reach a political agreement to have all GE food and feed ingredients clearly labelled, including highly processed derivatives. The proposed labelling threshold is 0.9%. [67]
	12/2002	- EU environment ministers reach a political agreement on a comprehensive traceability system for GMOs. [68]
	06/2003	- Next round of discussion of the new regulations on GE food and feed and traceability of GMOs in the European Parliament expected.
	early 2004	- The two new regulations are expected to come into force.
	2004	- 10 new EU accession countries are expected to adapt their legislation to reflect EU policies.
India	03/2003	- The Genetic Engineering Approval Committee rejects another consignment of US maize soya blend for concerns over GMO contamination. [69] - With the exception of soya oil, no GE food has received approval for import, produce or sale.
Indonesia	2000	- Mandatory labeling of GE foods is required. [70]
Israel	11/2002	- A proposal for GE labeling gets released for public comments. [71]
Japan	2001	- Labeling is mandatory for products where DNA is detectable and where GE ingredients constitute more than 5% of the final product. [72] - There is zero tolerance for unapproved varieties. [73]
Rep. of Korea	03/2001	- Mandatory labeling of foods where GE maize, soybeans, bean sprouts, or potatoes are detectable comes into force. - Below a threshold of 3% labeling may be avoided with proper Identity Preservation procedures. [74]
New Zealand	2001	- Introduction of mandatory labelling of GE foods with a 1% threshold. [75]

Norway	1997	- The government bans the import of several GE crops and products which contain antibiotic resistance genes. [76] - No GE crops are grown commercially. [77]
	02/2003	- Tightened labelling regulations now require the labelling of all products if the GE content is more than one percent in any ingredient. [78]
Paraguay	2000	- The use of GMOs in the agricultural sector is banned due to environmental and commercial concerns. [79]
Poland	2003	- A proposal for GE labelling is under discussion. - Adoption of GE regulations reflecting EU policies is under way. [80] - The only GE crop approved in food and feed is GE soya.
Saudi Arabia	12/2001	- Strict labelling requirements for processed GE foods come into force. [81]
	2002	- Imports of foods containing GE animal products are prohibited. [82]
	from 01/2004	- Labeling of all imported and locally produced GE animal feed, planting seed, fruits and vegetables will be required. [83]
Switzerland	2000	- Mandatory labelling for food and feed products which are or contain GE matter . [84] - No GE crops are allowed for commercial growing.
Taiwan	01/2003	- Mandatory labelling of raw agricultural products containing 5% or more GMOs comes into effect [85], processed maize and soya will follow.
Thailand	10/1999	- The Thai International Economic Policy Committee prohibits the import of GE seeds for commercial cultivation. [86]
	04/2001	- Field tests of GE crops get banned. The Cabinet confirms the ban in April 2003. [87]

Figure 14. Examples of Regulatory Barriers to GMO Commercialization

Agriculture is in many ways a more “political” sector of the economy than many others, and investors should consider the political ramifications of crop production as well as the economics factors. In the case of genetically engineered foods, politics plays an even stronger role than usual because these crops cross regulatory boundaries such as environmental, trade and public health.

Labeling

Around the world, GE restrictions are increasing and labeling of GE food is becoming standard practice (see figure 13). This development reflects public demand, as surveys have shown that worldwide 70 to 90 percent of the public are in favor of clear and mandatory GE labeling. Where such labeling requirements have been legally enacted, consumer-products containing or derived from GMOs have not been placed on the market successfully.

Japan, which takes 20% of all US food exports worth $11billion a year, has had a labeling law in place since 2001. Recently Japan announced a revised GE labeling regime that adds potato products. The earlier scheme which imposed rules on an initial list of 24 product categories. In the same year, South Korea, another important market for U.S. products, implemented mandatory labeling rules for GE foods. The USDA noted recently that "*residual effects of the StarLink problem and mandatory labeling requirements have shifted Korean corn processors toward suppliers perceived not to be producers of biotech enhanced corn.*"[88]

In addition, China, the world‘s single largest importer of soy beans, has introduced labeling and safety regulations for GMOs. Under the new Chinese labeling system, GE soya, maize, oilseed rape, cotton and tomatoes must be clearly labeled, regardless of whether the GE ingredient can be detected in the final product or not. The import or sale of unlabeled GMOs is illegal.[89] China's Dalian Commodity Exchange recently introduced new contracts for non-GE soybeans to conform to the

country's rules on GMOs. Trading of non-GE soya futures in Japan's Tokyo Grain Exchange started already in June 2000.[90]

Other Asian governments, including Thailand, Philippines, Malaysia and Indonesia, are already discussing GE labeling. Australia and New Zealand have adopted a strict mandatory labeling regime for GE food which came into force in December 2001.[91]

In the European Union, two new regulations on traceability, labeling and approval procedures for GE food and animal feed are under discussion and expected to enter into force by the end of 2003 or beginning of 2004. The tightened labeling regime would include highly processed products derived from GMOs such as oil and starch as well as animal feed. Traceability of GMOs is included in the proposed regulation for the first time, obliging producers to indicate all GMOs which 'have been used' in a shipment.[92] These regulations can be expected to drive further rejection of GE ingredients.

The new EU accession countries[93] will eventually be covered by EU legislation of GE crops, including strict labeling and safety testing requirements. Also in the major GMO producing countries, USA, Canada and Argentina, there are debates about the issue, with proposals for GE labeling laws being discussed on the State and federal level. Support for labeling in the U.S. has been consistently high in many polls. (See Figure 12 above)

The Biosafety Protocol

On 29th January 2000, the Conference of the Parties to the 1992 Convention on Biological Diversity (CBD) adopted a supplementary agreement, known as the Cartagena Protocol on Biosafety.[94] The Protocol seeks to ensure the safe transfer, handling and use of LMOs - living modified organisms (i.e., genetically modified organisms) - that may have adverse effects on the conservation and sustainable use of biodiversity, also taking into account risks to human health. The Protocol is specifically concerned with cross-border movements of LMOs. Examples of organisms treated as LMOs under the Protocol include seeds, microorganisms for bioremediation, fish, and modified crops such as soya beans, canola, corn and rice. LMOs do not include processed foods derived from GMOs (e.g. vegetable oils; peanut butter; corn flakes, etc). To date the Protocol has been signed by the governments of over 100 countries and ratified by 45, and will enter into force 90 days after the 50th ratification. Only five more ratifications are needed before the Cartagena Protocol becomes legally binding. This is expected to occur by 2004.[95,96]

It should be noted that the Protocol is neither superior nor subordinate to the existing World Trade Organization (WTO) rules. This may create inconsistencies in international law, should the refusal of an import on the grounds of biosafety be seen to be a trade barrier masquerading as environmental protectionism. However, it should also be noted that the WTO's agreement on Sanitary and Phytosanitary (SPS), like the Protocol, spells out what procedures signatories must follow in restricting trade in the face of scientific uncertainty. Some requirements are in fact stricter than the Protocol.[97]

Key Features of the Protocol

A key element of the Protocol is its incorporation of the precautionary principle.[98,1]

The Protocol recognises that scientific knowledge of GMOs is incomplete and in the absence of scientific certainty about environmental harm allows governments to take necessary measures to prevent such harm. The Protocol expressly allows the government of an importing country to ban or severely restrict imports of GMOs on the basis of the precautionary principle. This applies regardless of whether the exporting country is a signatory of the Protocol or the CBD.

An advance informed agreement (AIA) procedure is established for LMOs destined for direct introduction into the environment, such as seeds and microorganisms. This is designed to ensure that governments are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory. In such cases, the exporter must provide a detailed, written description of the LMO to the importing country in advance of the first shipment.

Shipments of commodities that may contain LMOs destined for food or feed products must be identified as such in their accompanying documentation, along with relevant traits and characteristics, requirements for safe handling, storage, transport and use, and information about the importers and exporters. However, an importing country also has the right to request that an AIA procedure is applied to commodities **before** imports can take place.

A definitive documentation regime for LMO commodities and more rigorous standards for identification, handling, packaging and transport of LMOs is under discussion by the Parties to the Protocol. Notably, non-parties to the CBD and non-parties to the Protocol have little influence in decision-making under the Protocol.

Also under discussion is the system for liability and redress. This includes the attribution of liability, time limits for redress, and the extent of compensation and restitution. A liability regime may emphasize implementation of preventative and reinstatement measures, cost recovery for these measures and compulsory intervention by public authority.[99] Significantly, the majority of international legal instruments channel liability to the "operator" – the person who has the operational control of the activity at the time of the incident causing damage. The current aim is to reach an agreement on these issues within the four-year period following the signing of the Protocol, implying that these issues will be clarified by the end of 2004.

[1] There is no internationally agreed definition of the Precautionary Principle, however, Principle 15 of the 'Rio Declaration on environment and development' by the United Nations Conference on Environment and Development in 1992, explains the Precautionary Approach: *"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."*

Relevance to Monsanto

The company is clearly interested in seeing free trade of GE products without burdensome bureaucratic approval procedures and trade barriers raised through environmental protection measures. This might be hampered to some extent by the entry into force of the Protocol. The prior notification and consent regime is likely to be burdensome as Article 15 of the Protocol goes some way toward laying the onus on the exporter to undertake the risk assessments and risk management of the exported commodity, and to establish the harmless nature of the LMO in question. This documentation will be unwelcome for exporters who will be forced to segregate LMO and non-LMO commodities. This requirement will place sizable burdens on exporters and will certainly be costly. Alternatively, exporters may be required to label all exports with the words 'may contain LMO-FFPs' – a move that may result in the discounted value of these shipments.

Politics and Genetically Engineered Foods

Genetically engineered foods have been a major trade and environmental controversy since before their commercial introduction in 1996. Genetically engineered crops are increasingly seen as an "American" product since the U.S. comprises the largest market for GE crop production, hosts the largest industry players, and has had the most aggressive trade policies regarding GMOs. While the outcomes of the political dynamics surrounding international trade are uncertain and subject to interpretation, the fact that U.S. trade representatives have backed off of a WTO challenge to the E.U.'s current ban on GMOs is an indication of the serious role politics will have in this issue. Monsanto, as the industry market leader, is particularly vulnerable if a GE foods backlash is associated with any anti-American sentiment. Investors should take into account the current negative state of relations with key allies in determining the potential for success in opening up important foreign markets, especially the EU. Given the overwhelming dominance of Monsanto in the industry, it is likely that even if markets are opened to GE foods and production, boycotts of GE foods could result, with potentially negative results for the bottom line.

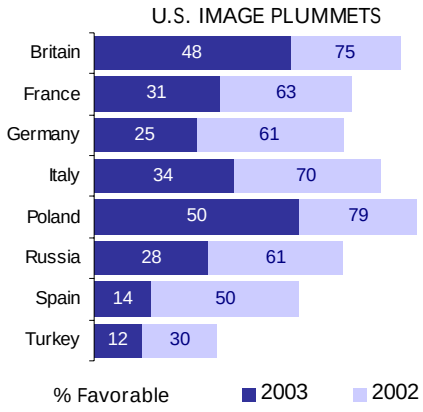


Figure 15. Drop in U.S. Approval Ratings World-wide
Source: The Pew Research Center for the People and the Press (March 18th, 2003)[100]

Figure 15 above provides an example of the change in sentiment towards the U.S. in select countries over the past year. Monsanto has been pinning its hopes on opening up markets to which genetically modified foods are currently blocked. As it states in its 2002 annual report, these goals have been overly ambitious.[101] The company is now working with allies in the U.S. government,[102] in particular the US trade office, to pressure the WTO to open up markets. However, as seen in the PABE report on European consumer attitudes (see Figure 11 above), consumer rejection of GMOs appears to be closely linked to awareness in the general populace about the issue.

Given that a WTO challenge would likely result in a certain amount of publicity, it is reasonable to wonder if success at the WTO would be a pyrrhic victory, especially where Europe is concerned.

Insuring Genetically Engineered Crops

"*Concerns about the adventitious presence [*unintended contamination by genetically engineered proteins] *of biotechnology traits could lead to more stringent regulation, which may include: requirements for labeling and traceability****; financial protection such as surety bonds, liability or insurance****; and/or restrictions or moratoria on testing, planting or use of biotechnology traits.* – From the Monsanto 2002 Annual Report, pg.37 [emphasis added]

One of the main problems with gaining new access to markets is the reassessment of GMOs by insurers in the aftermath of the StarLink fiasco. In New Zealand for instance, a study paper by the Law Commission on insuring operations utilizing or developing genetically modified crops had some sobering conclusions for farmers.

"*Given the current stage of the genetic modification industry, full insurance is unlikely to be available for all projects that might be approved by ERMA* (Environmental Risk management Authority)". Insurers are likely to be deterred by the absence of information on which sensible underwriting decisions can be made (lack of claims history, uncertainty of future claims). As the genetic modification industry develops and experience is gained, insurance may become more available, but because of the pace of the biotechnology industry, such delay may often be tantamount to a prohibition.[103]

The New Zealand Law Commission has identified several key issues of concern with respect to insuring GMO producers and developers. Those include:

- Time periods between the development of problems and the time by which claims are made. In that time, the insured company may no longer exist or the insurer may no longer exist.
- The insurance industry is unlikely to be able to cover the liability if catastrophic damage is suffered. There is also the possibility of irreversible or incompensatible loss being suffered.

These risks are highlighted by the fact that currently, the largest insurance company for the UK farming industry, NFU Mutual, has stated that it will not insure against genetic contamination or damage.

ENVIRONMENTAL AND HUMAN HEALTH RISKS

The Technology

Genetic engineering technologies involve the insertion of novel gene(s) into the DNA of a host. Whilst the sequence and primary function of the genes in the insert are both usually well-defined, current methods insert gene sequences into the host DNA at random positions. There is no external control on the position at which the insert is incorporated into the host DNA. Together with differences in the local environment of the inserted genes, this makes the expression of the inserted and surrounding natural genes unpredictable. Hence, inserted genes can cause unintended additional effects, which can be unexpected.[104]

Monsanto predominantly use "particle bombardment", also known as "biolistics" to produce GE crops. DNA is forcibly introduced into cellular tissue, where it hopes recombination occurs as the cell heals. During particle bombardment, microprojectiles (usually gold particles) are coated with DNA and then fired at cells of plant that is being genetically engineered.

Several studies have now shown that the particle bombardment technique gives rise to several artifacts including multiple copies and fragments of the genetic insert also being present in the organism's genome. In addition, the inserted DNA itself can become inverted and the regions immediately adjacent to the genetic insert (the flanking regions) can become deleted or rearranged.[105] In some cases, significant rearrangements of genomic DNA were observed[106] and scrambling of the inserted gene and genomic DNA[107] have been observed. It is not possible to predict the consequences of unidentified regions of DNA, of additional copies and fragments of the inserted gene.

Human Health Risks

There are two principal ways in which genetic engineering can affect food safety: Gene disruption or instability may lead to new toxins being produced; and/or the new protein produced by the foreign gene may cause allergies or toxicity.

Substantial equivalence:

For all regulatory authorities, assessment of GE products for food makes regulatory use of the concept of "substantial equivalence" where, after routine chemical analysis, the food is considered to be equivalent to its unmodified counterpart. Criticism of the concept of substantial equivalence has been raised in many scientific papers[108] and by respected organizations including the U.S. National Academy of Sciences[109], the Royal Society[110] the Canadian Royal Society[111] and the British Medical Association.[112] Substantial equivalence was never intended as a scientific tool, but a conceptual tool for regulators. The most significant criticism of substantial equivalence is that it has been used as an excuse not to perform adequate

testing on GE crops, whereas it should be an entry point for compositional analysis.[113] There is no standard list of what should be measured and there is no process to look for unexpected or unintended changes – one of the most important concerns over GE food safety.

Allergy and toxicity testing

There are some limitations with the systems to assess the potential allergenicity or toxicity of GE products. Genetic engineering is designed to produce new proteins not normally present in the plant and these may cause allergies. It may also result in unintended modifications to existing plant proteins, which could make them allergenic. However, it is not possible to predict whether a protein is a potential allergen with any certainty. Tests examining the protein's characteristics and comparing them with known allergens are not an entirely foolproof method of detection. This is partly due to the fact that the proteins may never have been part of humans' diet before so there may be no experience to go on or incomplete data for comparison.

When food safety testing is performed on GE crops, it is only short-term - over days or a few weeks. There is no long-term testing or testing for chronic effects of toxicity or nutritional changes. Because of this, the French food safety authority, AFSSA, concluded that current safety testing is not sufficient to ensure the safety of GE foods.[114] Their report also stated that it was important to research into the possible gradual development of allergic reactions through prolonged exposure to GE foods. Even if the allergenic potential of a GE crop is recognized by the regulatory authorities, it can still end up in human food.

Aventis' StarLink was a type of insect resistant GE corn grown in the USA from 1998, which produced the *Bt* protein, Cry9C. It was only approved for animal feed and industrial purposes, as there were concerns that the Cry9C protein could cause allergies because it shares characteristics of other allergens. However, in September 2000, StarLink was found in corn taco shells and other foods, and over 300 corn products had to be withdrawn from the market.[115] It is not known how StarLink came to be in the human food chain - it may have been inadvertently mixed with other corn at a mill, a conventional crop may have cross-pollinated with a StarLink crop.[116] With the recent ProdiGene contamination case for instance, it was revealed by company executives that no formal human health safety testing had been done prior to growing GE pharmaceutical corn in open field trials.[117] These episodes raise questions about the ability to control, segregate and regulate GE crops.

Potential Risk for Infants

The Royal Society[118] considered the possible effects of GE foods on the health of infants. The report recognized that food allergies are far more common in children than adults, stating that: "*food allergies occur in 1-2 % of adults and 6-8 % of children*". Therefore, children would be most vulnerable to any allergens that may have gone undetected in GE food. In the report, infants are classified as a "*high risk group*" for post marketing surveillance of deleterious effects of GE foods in humans. It was also recognized infants are vulnerable to harmful effects from nutritional changes in their diet. Any changes in the composition of foods made from GE crops could be important when given to infants over a long period of time, especially if it is

a food such as infant formula which infants may live off as a complete food. The report recommended that any GE ingredients in foods such as infant formulas "*should be investigated most rigorously*".

Antibiotic Resistance Marker Genes

It is often standard procedure for GE crops produced to contain antibiotic resistance marker genes which are used during the gene insertion process. There is concern that such genes may be transferred to soil or gut bacteria. This would aid the increase of antibiotic resistant bacteria, making bacterial infections difficult to treat. The EU has now passed legislation with a timetable to phase out antibiotic resistance marker genes[119] by the end of 2008 and the FAO/WHO Codex Alimentarius[120] has also recommended phasing out the use of antibiotic marker genes.

Conclusions

There are concerns about the safety of eating GE foods. The safety testing systems appear to have inadequacies. Genetic engineering can produce unintended and unexpected effects but the regulatory processes, which are based on the principle of 'substantial equivalence', are not designed to detect such effects. The systems used to detect allergenicity and toxicity rely on incomplete information. The long-term implications for human health of eating GE food, including the use of antibiotic marker resistance genes, are not known but infants are known to be especially vulnerable to allergies and changes in the nutritional composition of their diet.

Whilst a number of regulatory authorities have approved many of the GE crops currently on the market as being safe to eat, questions remain for some scientists and for many consumers. As the process of scientific understanding of gene function continues to grow and as new methodologies for testing become available, a more rigorous testing of the safety of GE crops will be possible.

In the meantime consumer opinion appears likely to continue to view GE food as having little direct benefit, limited safety testing and either unknown or potential risks.

Environmental Risks

There are numerous environmental or ecological risks associated with GE crops. Many of these may expose companies producing the GE crops to significant liabilities. Below are several examples of environmental liabilities stemming from the research, development, and commercialization of GE crops.

Gene flow to neighboring crops (Crop-to crop)

Gene flow can occur via cross-pollination of the same crop from neighboring fields. For many crops, there is little information on the extent and distance of cross-pollination. However, the number of studies is steadily increasing and these show that there is considerable potential for cross pollination from crop-to-crop.[121] Gene

flow is affected by local ecological conditions and agronomic practices e.g. field size.[122] Therefore, it is not possible to accurately predict pollen movement and separation distances may be inadequate.[123]

The contamination of neighboring crops can have severe implications for organic farming, e.g. certified organic farmers, who have initiated a class action lawsuit against GE companies seeking compensatory damages for revenues lost through contamination of organic crops with the companies' GE herbicide-tolerant canola.[124] In addition, there have been incidences of contaminated seed being rejected from the EU, or even corn fields burnt, with compensation payable to the farmers.[125]

Contamination during harvesting and storage can also be significant. One of the major issues is the control of "volunteers", i.e. unsown GE seed from a previous crop growing in a field margin/roadside or within the crop. This is particularly important for canola the seeds of which can remain dormant in the soil for several years.[126] Control of feral populations, e.g. with herbicides, could adversely affect biodiversity in hedgerows, roadside areas, railway banks which may also be a haven for wildlife. There is an issue over who will be responsible for control of volunteers. There are also implications for the type of herbicide used should "gene stacking" occur. Canola (or rapeseed) volunteers resistant to three herbicides in Canada, caused by cross-pollination of GE and conventional herbicide resistant crops[127] now requires control with the notorious herbicide, 2,4-D. The spraying of such a herbicide to control GE volunteers in non arable land (e.g. hedgerows) would have serious consequences, and possible liabilities for the producer(s) of the herbicide resistant crops.

Crop-to wild gene flow.

All crops can outcross with their wild relatives somewhere in the world.[128] For example, GE oilseed rape has been shown to hybridize with wild relatives in Europe[129], rice will outcross with wild relatives in Africa, Asia and Australia.[130] The long-term implications of this crop-to-wild gene flow are uncertain – predicting the transgression of the genetic trait through a population is not simple. However, it has been shown that the trait does not necessarily need to confer an ecological advantage to a plant in order to transgress through a population. There may be considerable impacts on biodiversity from gene flow involving traits such as. insect resistance, or drug producing genes ("pharm" crops).

GE corn has been found to hybridize with traditional land races in Mexico.[131] Mexico is a centre of diversity or centre of origin for maize, the "home" of cultivated maize. Studies of the contamination, and the implications, are still in progress, but the origin of the GE corn is thought to be imports from the US for food use. Thus, the export of grain to other countries may have environmental liabilities, even if no planting is intended.

Unintended Effects

GE plants can have effects other than they were intended. The majority of studies to date have focused on the non-target effects of insect resistant *Bt* crops.

However, such unintended effects could be applicable to a wide range of insect (and possibly virus) resistant crops.

Research has suggested that transgenic *Bt* plants could also be harmful to non-target organisms that feed on pests exposed to their toxins. The U.S. Environmental Protection Agency's (EPA) scientific advisory panel,[132] has recognized that the *Bt* toxins can persist in soils and that further studies needed to be done to determine whether this persistence would cause problems for non-target organisms and the health of the soil ecosystem.

Conclusion

In the short time since GE crops have been first grown commercially a number of the predicted problems have occurred including gene flow to neighboring fields and wild relatives creating unwanted GE contamination of non-GE farming systems and creating "volunteer" weeds which are resistant to a number of herbicides. Bt plants could also be harmful to non-target organisms that feed on pests exposed to their toxins.

RISKS BEYOND GENETIC ENGINEERING

Monsanto's history as a company goes back a number decades before its current manifestation as an agricultural products company and it still retains liability for many of its previous chemical operations. For example, the company's previously owned subsidiary, Solutia (spun off in 1997) – a large chemical concern, has a number of hazardous waste sites that it is liable for, including a large PCB contamination case in Anniston, Alabama that involves 3,600 plaintiffs, or 1 in 9 city residents.[133] Monsanto has indemnified former owner Pharmacia for any liabilities relating to Solutia. In addition, its new manifestation as a company focused on servicing the agricultural sector carries with it risk associated with dependence on that industry.

Roundup Dependence Makes Monsanto Vulnerable to Climate Change

As a provider of agricultural productivity products such as seeds and chemicals, Monsanto's fortunes are closely linked to those of farmers. Natural phenomena therefore play a greater direct role in the company's productivity than most companies in the chemical sector. As Monsanto stated in its 2002 Annual report: "***In 2002, much of the United States experienced its worst drought since the Dust Bowl of the 1930s. Adverse weather*** *and continuing competitive pressure on our flagship product, Roundup herbicide,* ***reduced U.S. revenues of branded Roundup by 26%.***" [emphasis added] [134] While there is not space within the scope of this report to fully cover an issue as complex as climate change, it is clear that

Monsanto is very vulnerable to climate change, as seen with recent widespread drought, which have scientists linked to climate change.[135, 2]

NOAA's seasonal drought forecast through June 2003 shows key areas of the Midwest face continued drought conditions. [136] This would imply that the revenues that Monsanto expects to receive from the second round of Roundup sales that occurs later in the growing season may be reduced. Going forward, increased weather volatility as a result of climate change may further impact Monsanto's profitability by negatively impacting farmers incomes and thereby reducing spending on inputs.

Anti-Trust Investigation

Monsanto is currently involved in an anti-trust inquiry by the U.S. Department of Justice regarding possible anti-competitive conduct in the glyphosate industry.[137] *"The Department of Justice has initiated an inquiry about possible anti-competitive conduct in the glyphosate industry,"* said Monsanto spokeswoman Lori Fisher. The company states that it is cooperating with the government in the investigation. A judgment against the company could further damage its Roundup business which is currently a central component of Monsanto's profitability.

Intellectual Property - Litigation and Contingencies:

"We are involved in numerous major lawsuits regarding contract disputes, intellectual property issues, biotechnology issues, antitrust allegations, and other matters. Adverse outcomes could subject us to substantial damages or limit our ability to sell our products." – Monsanto, 2002 Annual Report pg.37

Due to the nature of the agricultural seed industry, the ability of the company to ensure a return on the sale of its products is heavily dependent on patent rights. This has resulted in an large number of law suits for violation of those patent rights. Monsanto has been accused of taking a heavy-handed approach with farmers regarding potential patent rights infringement[138]. This issue overlaps with the issue of potential contamination as traits that end up in a farmer's field who has not signed an agreement with Monsanto may be liable for patent rights infringement. Conversely, Monsanto may be liable for contamination under the same circumstances. The company states: *"There is some uncertainty about the value of available patent protection in certain countries outside the United States, and patent protection may not be available in some countries. For example, we do not have patent protection for our Roundup Ready soybean traits in Argentina." (…) "Certain*

[2] Innovest Strategic Value Advisors has extensively covered the challenge investors face with respect to climate change. For more information on climate change, investment and fiduciary responsibility please see: **The Carbon Disclosure Project:** Carbon Finance and the Global Equity Markets (February, 2003); **Climate Change & the Financial Services Industry** - Module 1 - Threats and Opportunities & Module 2 - A Blueprint for Action (October 2002); Innovest with guidance from UNEP Finance Initiatives Project Coach, Dr. Andrew Dlugolecki; **Value at Risk: Climate Change and the Future of Governance** (April 2002) CERES Sustainable Governance Project Report prepared by Innovest Strategic Value Advisors, Inc. All reports are available free of charge on Innovest's website: www.innovestgroup.com. Click on the link to "Publications". For general information about climate change science please contact the UN Environment Program's Intergovernmental Panel on Climate Change (IPCC). www.ipcc.ch

of our germplasm and other genetic material, patents, and licenses are currently the subject of litigation, and additional future litigation is anticipated." [139]

6. ANALYSIS OF THE BENEFITS

While this report has detailed the risks of Monsanto's GE strategy, there are benefits driving adoption by many farmers. Higher yields, lower costs and pesticide usage, as well as less labor have been the main claims with which GE crops have been marketed. The economic record remains unclear and genetically engineered crops have been a mixed bag for developers and farmers. While Monsanto lost $1.7 billion last year due to droughts and growing competition for its Roundup herbicide, among other things, the financial benefits for farmers are also uncertain with studies showing both positive and negative financial results.

An analysis by the USDA looking at the adoption of genetically engineered crops in the United States found the following conclusions:[140]

- The adoption of herbicide tolerant soybeans did not have a significant impact of net farm returns in 1997 or 1998. This is consistent with other surveys done. [141,142]
- Adoption of Bt cotton had a positive impact on net returns but adoption of Bt corn had a negative impact on net returns among specialized corn farms. Positive return may be due to seed companies setting low premiums for herbicide tolerant varieties in an attempt to expand market share.
- The adoption of herbicide tolerant corn improved net returns among specialized corn farms (deriving more than 50% of the value of production from corn.)
- Broader financial analysis used in determining performance measures, such as net farm income and return on assets, did not show GE crops to have a significant impact.

These results imply that positive returns for farmers, where they were found, may only last while the company cuts prices to expand its market share. Monsanto may find its ability to lower prices is curtailed as Roundup competition increases the pressure on the company to achieve higher revenues for its GE seed business. This would indicate that in order for the company to maintain and increase profitability, it will have to raise prices on its technology fees, thereby reducing any net financial benefits to farmers and thus reducing or eliminating their incentive to buy its products. This dynamic combined with increasing market rejection may have a negative effect on the company's profitability.

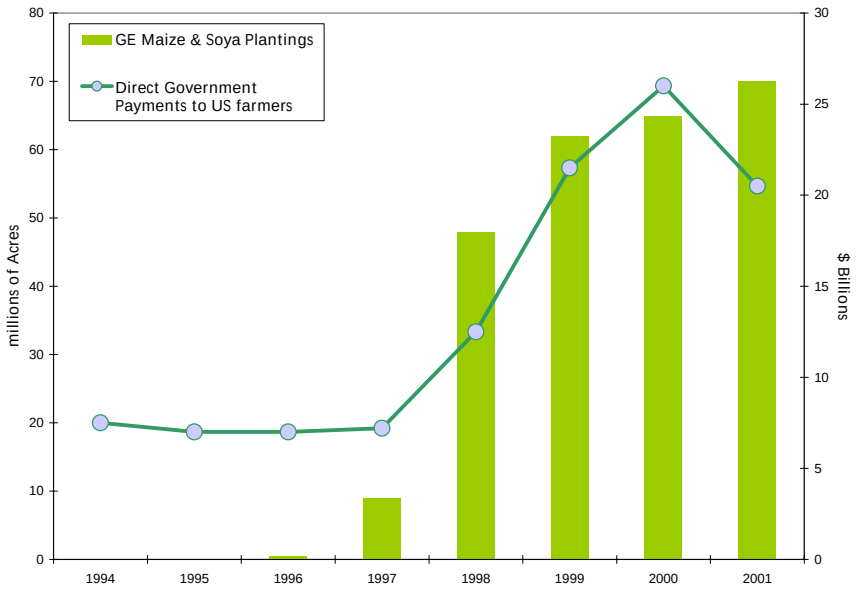


Figure 16. Direct Payments to U.S. Farmers and GE Crops Plantings [143]

"Were it not for the …income support payments… that act as a kind of limited economic damage control system…farmers would be feeling a much greater negative impact from the export sales lost as a result of GMOs." - Dan McGuire, policy chairman, American Corn Growers Association[144]

A similar report by the Soil Association, a farming group in the UK, estimated that the U.S. farm economy lost roughly $12 billion from 1999-2001 due to market rejection of GE crops.[145] Much of the loss caused by GE introduction has been covered by massive increases in U.S. government subsidies [146] (see Figure 16 above). The report also outlines reasons why many farmers are planting GE crops, that go beyond the explanations of the industry. Some of the agricultural sector dynamics that may explain increased use of genetically engineered crops despite supposed losses include:

- Lack of farmer awareness of differences between GE crops and other crops. Many high yielding hybrids are now available only in GE varieties. Therefore, farmers seeking those advantages had to accept GE traits as well.
- Lack of information provided to farmers stating that they were buying GE crops.
- Lack of awareness of market rejection and agronomic problems associated with GE crops. Government and company information sources frame GMO rejection as a "trade barrier" by competing governments rather than market rejection by consumers.
- Many farmers are "locked in" to GE crop production due to contamination problems from neighboring farms growing GE crops. Lack of access to

premium non-GE markets, such as for Canola farmers in Saskatchewan where contamination levels essentially rule out growing non-GE canola.

- Many farmers have been sued by Monsanto for alleged patent infringement, alledging that GE crops were found growing on their property. Gagging orders used by Monsanto after patent infringement cases, have hidden the problem from many farmers.

Lower Pesticide Use & Increased Yields

"Farmers are really starting to question the profit-enhancing ability of products that seem to be shutting them out of markets world-wide" Cory Ollikka, Canada's National Farmers Union current president calling for a moratorium on GE crops, December 2000.

In the U.S., Argentina and Canada, farmers have been won over by industry's promises of better yields and lower costs. Since the introduction of GE crops, a number of studies have found these promises to be false - some found that GE agriculture had no net effect on farmer profitability, some that it had a negative effect due to yield losses and increased costs. In addition, long-term effects on farm-land should also be considered.

- Increased seed costs negatively impact on farmers income. *"The case of Bt corn, thus far, suggests that farmers will be expected to finance a greater share of seed industry intellectual property, research, and development costs from their per acre earnings. The evidence also suggests that these costs are markedly higher for new corn varieties including traits introduced via genetic engineering."*[147]

- A comparitive study at the University of Nebraska found that "*yields were suppressed with GR [glyphosate resistant] soybean cultivars*". The potential for losses lies between 5-10% yield supression in GE soybeans compared to non-GE lines caused by the insertion process and cultivar genetic differential.[148]

- In Canada, the number of herbicide applications used on herbicide tolerant canola is higher than for conventional canola. Between 1997-2000, there was an average of 2.13 herbicide applications per crop with Roundup Ready and Liberty Link compared to 1.78 in conventional crops.[149] Both 2,4D and paraquat (grammoxone), highly toxic pesticides, are being recommended by government agencies to control herbicide tolerant oilseed rape volunteers in Canada.[150] Herbicide tolerant varieties were marketed as using lower levels of pesticides and Monsanto's Roundup (glyphosate) is marketed as a low-toxicity herbicide as well. The development of resistance indicates that unintended effects of GE crop technology may result in higher levels of chemical use.

- The Leopold Centre for Sustainable Agriculture examined the benefits of GE crops at the farm level, covering all aspects of crop production. The study found that for both RoundupReady soya and Bt maize the return essentially equaled those of non-GE varieties. The study notes that "*given the analyses in 1998 and again in 2000, there does not appear to be any difference in the per acre profitability between the two varieties.[...] Bt corn produced a return essentially equal to the non-Bt corn."* [151]

- Another research study found that Monsanto's herbicide resistant soya seems to have an increased lignin content which made the plants brittle in hot temperatures, potentially leading to yield losses.[152]
- Glyphosate application on Monsanto's Roundup Ready soya can inhibit soybean root growth and nitrogen fixation, especially under water deficient conditions, and can lead to yield loss.[153]
- Many U.S. farmers adopted herbicide resistant GE crops because it simplifies weed management. However, in addition to decreased yields, increased pesticide use was reported for Roundup Ready crops, based on official U.S. Department of Agriculture pesticide use data. *"Total herbicide use on RR soybeans in 1998 was 30 percent or more greater on average than on conventional varieties in six states."*[154]
- GE Bt crops pose the risk that targeted pests could develop resistance to the effects of *Bt.* There is strong scientific data to support this concern.[155] If widespread resistance were to occur, the insect resistant properties of the GE crops would become ineffective. The application of new and even more toxic chemical pesticides would therefore be required.
- There is also research that suggests that secondary pest damage from - pests that are not targeted or controlled by the Bt toxin - increases with the use of Bt crops.[156] Growers will still have to use chemicals against these pests. Further research also suggests that transgenic Bt plants could be harmful to non-target organisms such as natural enemies[157] of pest insects or earthworms.[158]
- Scientific studies have shown that Bt crops may secrete the toxin from the root into the soil[159] and that Bt toxin can persist in certain soils for a long time.[160] The US Environment Protection Agency's (EPA) Scientific Advisory Panel,[161] has recognized this risk and suggested that further studies are needed to determine whether this persistence can cause problems for non-target organisms, and health of the soil ecosystems.
- Syngenta - "Managing Glyphosate-Resistant Weeds, *An Investment in Land Value"*. "…, weed resistance to glyphosate herbicides has recently been documented in various on-farm locations throughout the United States…. Suddenly, glyphosate-resistant weeds have become more than an in-season production and profitability issue. They can also affect the long-term value of farmland and even determine who receives preference as the tenant farmer." …"While weed resistance to glyphosate is not yet a widespread problem, it is more than a laboratory or greenhouse theory. The first on-farm cases in this country were recently documented. Glyphosate-resistant marestail (horseweed) was confirmed by university weed scientists in Delaware and Tennessee, while more than fives cases of glyphosate-resistant rigid ryegrass were reported in California orchards. The high volume of glyphosate being used across the country as a result of RR technology adoption makes this a very real concern for growers, professional farm managers and the owners of farmland."[162]

7. CONCLUSIONS: WHAT IS THE FUTURE FOR MONSANTO?

The issues for Monsanto shareholders can be summed up as follows:

1: Market rejection will continue to limit profits and imperil the industry.

2: Contamination of conventional crops by GE traits is inevitable. This implies large liabilities for the company and the industry.

In summary, the risks to Monsanto's shareholders from the company's genetic engineering business are substantial. As this report illustrates, the company faces business constraints in the form of market rejection by consumers, producers, and farmers; significant legislative hurdles to commercialization; uncertainty in the face of human health and environmental impacts stemming from the company's products; and finally, significant risk exposure from potential contamination of the human food chain by unapproved genetically engineered traits. It should be stressed that even if the company is a good actor with respect to safety and control during product development, problems stemming from actions by a competitor could impact the company's profitability.

Another contamination event on the scale of the StarLink fiasco could conceivably impair Monsanto's genetically engineered seed business with the potential to substantially reduce the market. While many observers would consider this possibility remote, recent experience including the ProdiGene case detailed above, indicate that such an event is quite possible.

In light of this, it appears the company's stock may still be overvalued despite recent declines over the past few months. To help investors gage the level of risk, analysts should pose the following questions to Monsanto:

- What will the likely impact of labeling be should it occur in the U.S.?
- What is the risk that the company will incur contamination costs on the scale of the StarLink problem?
- If market rejection of the company's genetically engineered seeds should increase, what are the company's plans to diversify?
- What is the company's strategy should a WTO challenge to the EU moratorium on genetically engineered crops fail, or should the scope of acceptance be limited?
- Can the company more effectively utilize its current research and development assets to produce seed varieties that are not genetically engineered and therefore will face less market rejection and have a lower risk profile?
- Given the level of risk exposure facing the company, can Monsanto make available to shareholders, copies of the Regulatory Affairs and Scientific Outreach Units Monthly Summaries for 2002?[163]

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