Biotechnology Policy: Global Economic and Legal Issues*

—by Neil E. Harl**

The production of foodstuffs on this planet has never in the history of the human family been subjected to change that has been as dramatic and far-reaching as the change wrought by genetic modification of crops. Consumers, lulled into complacency by centuries of incremental and almost imperceptible change in the production of commodities, are now confronted by fundamental changes in the crops entering the food chain directly or the processing of crops into consumable products. Most of the changes are difficult, if not impossible, for consumers to evaluate. The problem has been compounded, in some countries, by lack of confidence in the regulatory processes.

Moreover, consumers, confronted by articulated concerns over food safety and environmental complications, typically have no reason to favor genetically modified foods. Foods that have been genetically modified typically carry no price advantage and, thus far, do not offer a taste, appearance or other desirable feature to offset any concerns about food safety or the environment. Therefore, any significant concerns are translated into a tendency to discount the perceived value of genetically modified foods. If labeling of genetically modified foods on a mandatory basis were to become widespread, consumers would be in a better position to register their preferences, as noted below.

I. Adoption of Genetically-Modified Crops

The genetic modification of crops, principally corn, soybeans, cotton and canola, has proceeded with striking success as a new technology during the past five years. Grower adoptions of crops resistant to potent herbicides (the "Round-Up Ready" crops) and crops resistant to the European Corn Borer (the so-called Bt crops) have been very rapid. Herbicide-tolerant soybeans were introduced in 1996 and were used on 17 percent of the soybean acreage in 1997, rising to 81 percent in 2003.[1] Biotech cotton expanded from 10 percent of the acreage in 1997 to 73 percent in 2003. Bt corn grew from 8 percent of U.S. farm acreage in 1997 to 40 percent in 2003.

Moreover, the genetic modification of plants to produce pharmaceuticals (so-called "biopharming") such as proteins designed as a vaccine for hepatitis B, are well within the realm of reality over the next few years and some are in production currently. One industry observer believes that in 10 years as much as 10 percent of the acreage devoted to corn in the United States could well be used to produce pharmaceuticals. Some firms are betting that genetically modified plants could be used to produce substances that would reduce the cost of making chemicals used in plastics, detergents and construction materials.

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** Charles F. Curtiss Distinguished Professor in Agriculture and Professor of Economics, Iowa State University, Ames, Iowa; Member of the Iowa Bar.

[1] USDA, National Agricultural Statistics Service. See, Fernandez-Cornejo, Jorge and William D. McBride, *Adoption of Bio-engineered Crops*, Agr. Econ. Rep. No. 810, U.S. Department of Agriculture, May, 2002.

The phenomenon of genetic modification is not limited to crops. Professor Patrick Bateson, of the Royal Society, the UK's unofficial academy of sciences, and chair of the society's working group on genetically modified animals, recently highlighted a list of benefits that could become reality. Those benefits included cures for intractable diseases, relief from suffering for millions of patients, genetically modified hogs free of intestinal disease and genetically modified cattle immune to foot and mouth disease.

II. Resistance to Genetic Modification

Consumer resistance

Unlike other technologies, which were adopted in agriculture and in processing with relatively little consumer resistance, genetic modification of foods has encountered a stiff headwind in several countries, particularly in Europe and in Asia, and has led to consumer support for food labeling. Indeed, even in the United States polls have indicated that substantial numbers of consumers favor food product labeling to reveal use of genetically modified ingredients. In April of 2001, the Pew Charitable Trust released the results of a poll conducted by the Trust which indicated that 75 percent of respondents in the United States indicated that they wanted to know if their food contained genetically modified ingredients. About 58 percent reportedly stated that they were opposed to the use of such ingredients in food. Other polls have indicated similar findings. Concerns in several other countries in Asia, Europe and the Southern Hemisphere have led to labeling or plans for labeling with as many as 48 countries embracing labeling or likely to embrace labeling.

Quite clearly, the trend has been toward more consumer resistance, not less.

Traditionally, consumers have been the major beneficiaries of technology in agriculture. Consumers may ultimately benefit from agricultural biotechnology if the technology leads to increased output and lower prices or to better nutritional qualities to the extent those developments would not have occurred otherwise and *to the extent the benefits are passed through to consumers*. Thus far, consumers in the U.S. have been largely unimpressed and many abroad, particularly in Europe and parts of Asia, have been somewhat antagonistic to genetically modified foods.

The reasons behind consumer resistance are not difficult to fathom. If consumers do not see a benefit to them, either in the form of lower priced food or in the form of food with superior qualities, any concern about food safety leads to consumer discounting of the value of foods with genetically modified ingredients and a preference for foods that have not been genetically modified as noted above.

Environmental concerns

Interest groups focusing on what they perceive as environmental concerns have identified several potential risks linked to genetically modified plants and animals. Concerns have been voiced over the spread of traits from genetically modified crops into other plant species, the emergence of resistance in plants to control measures, the production of superviruses, the inadvertent suppression of immune systems in animals which could have decidedly negative

effects on animal populations and the inadvertent suppression of immune or reproductive functions in animals. More fundamentally, some argue that the subtle and delicate relationship between the genetic material of living things and the ecosystems in which they inhabit could be upset with dramatic changes from genetic modification.

A National Academy of Sciences panel in February, 2002, stated that the U.S. Government had allowed food manufacturers to market genetically modified crops without fully probing their potential environmental impact.

Production of biopharmaceuticals and other chemical materials

Public attention has recently been drawn to the production of biopharmaceuticals in the United States. USDA has stated that biopharmaceutical crops were grown on 34 sites in the United States in 2002.

In Iowa, for example, corn was produced in 2001 and 2002 with traits that would benefit those suffering from cystic fibrosis. The corn was produced under permit from the U.S. Department of Agriculture. The corn was reportedly produced for Meristem Therapeutics, a French company.

To minimize pollen drift, the biopharmaceutical corn was planted 30 days after conventional plantings to avoid cross pollination with regular corn.

Critics worry about pollen drift from volunteer corn despite the precautions; from pollen drift to conventional corn a substantial distance away if conditions (temperature, humidity, wind direction, wind speed and lack of barriers) are favorable for drift to occur; from spread of the genetically modified corn by rodents, birds and insects; and about mechanical contamination in farm equipment and storage facilities.

The Animal and Plant Health Inspection Service, an agency of the U.S. Department of Agriculture, released to the public in May of 2002 rules governing the production of biopharmaceuticals. The agency had been setting restrictions for field tests on a case-by-case basis. The rules generally prevented pharmaceutical corn from being planted within a half-mile of any other corn to prevent cross-pollination. The agency permitted, in 2002, an exception to the half-mile limit if the biopharmaceutical corn was surrounded by buffer crops. The agency says that it would "discourage" the use of buffer crops beginning in 2003. The rules also required the biopharmaceutical corn to be planted at least three weeks before or three weeks after other corn in the area to further guard against cross-pollination. Regular corn grown for seed had to be kept at least a mile away from the biopharmaceutical plots. Even those 2002 rules indicate that a clear need exists for careful and systematic checking to insure that pollen drift from biopharmaceutical crops is not occurring.

In mid-September, 2002, the *Sunday Times of London* reported that genetically modified germ plasm was found in beehives two miles from the site where genetically modified oil-seed rape was being grown under government supervision.

In November of 2002, two instances of problems with the production of biopharmaceuticals involving Prodigene, Inc. surfaced in Iowa and Nebraska. On November 12,

the Food and Drug Administration reported that it had impounded 500,000 bushels of food-grade soybeans exposed to volunteer drug-producing corn growing in the same field in Nebraska. The following day, the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture revealed an incident in September in Iowa which required the destruction of 155 acres of contaminated corn. The violations of federal regulations led to a $250,000 fine against the company plus an estimated cost of more than $2 million to dispose of the 500,000 bushels of soybeans contaminated in Nebraska from volunteer corn from a 2001 biopharmaceutical plot. The Biotechnology Industry Organization urged a moratorium of further biopharmaceutical production in major corn-producing regions but that recommendation was withdrawn under political pressure with the matter now left to federal regulation to prevent gene flow from biopharmaceutical crops.

New regulations were issued by APHIS in early March, 2003, calling for more frequent inspections of plots producing biopharmaceuticals, a one-mile separation distance for biopharmaceutical corn from fields producing corn for conventional food and feed uses (one-half mile if tassels are bagged), a restriction on land used for the production of biopharmaceuticals from being planted with a food or feed crop the following year, a requirement that farmers must maintain separate planters and harvesting equipment used for biopharmaceutical crops and dedicated storage facilities for those items of equipment and a requirement that tillage equipment must be cleaned. Biopharmaceutical corn must be planted not less than 28 days before or 28 days after any conventional corn up to one mile away.

In April of 2003, a report commissioned by the Pew Initiative on Food and Biotechnology and prepared by Resources for the Future[2] was released. The report concludes, with respect to adequacy of regulatory oversight, that—

> "We want the system of postmarket regulatory oversight to foster compliance with conditions of use or other restrictions imposed during the premarket review process; detect noncompliance and unforeseen health and environmental problems; take appropriate enforcement action to correct and penalize noncompliance; and manage follow-up investigations, market disruptions, and other consequences of noncompliance and unforeseen problems.
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> "Our research costs doubt on the preparedness of the current postmarket oversight program to achieve these traditional objectives. For the products it has deregulated, APHIS lacks a regulatory handle to require systematic data collection by sponsors to detect unforeseen plant pests or environmental problems. EPA and its regulatory parners in the states have no program to provide direct oversight and enforcement of environmentally important PIP use restrictions, and EPA is still working out with the biotech industry how to ensure the effectiveness of the compliance programs that PIP registrants are required to establish through their private contractual relationships with growers. FDA has no affirmative compliance and enforcement program for biotech crops or foods and lacks some of the basic analytical tools to test whether the biotech products already on the market are in compliance with applicable regulatory requirements."[3]

Legislation has been proposed in a few states (e.g., H.B. 3387 in Texas) which would help prevent the food supply from being contaminated by the production of plant-made pharmaceuticals or industrial chemicals. As a representative of the Frito-Lay Company testified

[2] Taylor, Michael R. and Jody S. Tick, "Post-Market Oversight of Biotech Foods: Is the System Prepared?" Pew Initiative on Food and Biotechnology and Resources for the Future, April 2003.
[3] *Id.* at 85.

on April 10, 2003, the "only acceptable outcome for this issue is a guaranteed zero percent contamination of the food supply and currently the only way to achieve this is through using non-food and non-feed crops."[4]

In 2003, two state legislatures (Maine and Massachusetts) proposed moratoria on the planting of GMO crops. The bill in Massachusetts would have placed a five-year moratorium on the growing of "pharmaceutical crops." The Maine proposal would have imposed a three-year moratorium on the planting or cultivating of genetically engineered plants.

A report of the National Research Council (the research arm of the National Academy of Sciences) issued on January 20, 2004, cautioned against genetically engineered food crops being used to make industrial or pharmaceutical products because of the difficulty in controlling the plants which had been genetically modified. The report states that a plant or animal used for food would be a "poor choice" for industrial or pharmaceutical uses unless the organism is raised "under stringent conditions of confinement."

Quite clearly, if consumers lack confidence in the rules and in the oversight process, further momentum will build for food labeling and the stage will be set for even faster growth of certified organic commodities.

III. Consequences of Resistance

The concerns voiced by consumers and environmentalists predictably have led to quite different societal responses.

Environmental response

The articulated concerns over environmental or ecosystem threats have led principally to calls for more effective regulatory oversight. The Environmental Protection Agency, with lead responsibility for environmental matters, has ramped up its regulatory agenda to include studies of potential threats to the environment. A study by the National Academy of Sciences of animal cloning was recently published. The Food and Drug Administration will use the results of the NAS study to decide whether cloned animals will require regulatory approval before sale of meat and milk from cloned animals. In the meantime, biotechnology companies involved in cloning have been asked to keep cloned livestock out of the food chain until the agency completes its review, although there is some question whether that is occurring. Among the questions being pondered by FDA is whether cloned animals should be treated as genetically engineered animals, which are regulated, or like animals bred through in vitro fertilization which are normally not regulated. One scientific concern is whether mass animal cloning could lead to breeds that are more susceptible to disease.

Food safety concerns

Concerns about food safety have led to calls for more effective regulatory oversight and for labeling in order for consumers to know what they are consuming. While some doubt the

[4] Testimony of Dr. Robert Drotman, Frito-Lay Company, before the Texas House Agriculture and Livestock Committee, April 10, 2003.

value of labeling, it is likely that the move toward more labeling of foods containing genetically modified ingredients will continue with widespread, if not universal, labeling within three years.

One complication of labeling is that estimates indicate that up to 70 percent or more of all processed foods contain genetically modified ingredients. Regulatory agencies have determined that genetically modified foods are as safe as conventional foods but some consumers still want to know which foods contain genetically modified ingredients. Unfortunately, much of the testing has been conducted by or funded by the commercializing companies. Independent third party verification would help industry achieve a higher level of public confidence.

As an indication of concern even in the United States, which has embraced genetic modification of foodstuffs more enthusiastically than any other country, in the State of Oregon a measure requiring the labeling of food and food additives appeared on the November general election ballots. That measure was defeated but supporters are preparing for another initiative in 2004.

In Australia, the label law, implemented in December of 2001, requires packaged food containing measurable genetically modified ingredients, to carry an identifying label. Critics of that and similar measures argue that the law may run counter to World Trade Organization rules.

In the EU, the Agriculture Council (comprised of European Union agricultural ministers) agreed in 2002 by a majority decision that food containing more than 0.9 percent genetically modified material would have to be labeled as containing genetically modified organisms. The agreement also introduces for the first time requirements for the labeling of animal feed containing genetically modified ingredients. The agreement now goes to the European Parliament.

One highly important feature of the debate is that the consumer is king (or queen). In the types of open, transparent, market-oriented economic systems which now dominate the world, the consumer, through the exercise of consumer choice, provides a continuing plebiscite over every feature of the food supply. The consumer may be right or wrong, informed or misguided, flippant or serious-minded. Nonetheless, it is consumer choice that drives the entire food system. If significant numbers of consumers register their preferences on a food feature or trait, and that preference is negative (or positive), the results are quickly transmitted through the food chain to the producer. For that reason, it is the consumer that sits in judgment over agricultural biotechnology along with the regulators. It is important to note that consumer choice can trump the regulatory process in that a product deemed safe and environmentally benign may, nonetheless, be rejected by consumers. At the same time, regulators can only trump consumer choice by limiting or banning products before entering the food chain.

In reality, however, the consumer is not always the moving force behind rejection or acceptance of foodstuffs. Processors look after the “king” and devote a great deal of time and resources to anticipating consumer response. No processor wants to be on the wrong side of consumer preference. For that reason, the more dramatic developments in the last three years over genetically modified foods have come from processors which ostensibly were anticipating consumer reaction. The Frito-Lay decision on genetically modified raw material for its chips; the decision by Novartis (through its babyfood subsidiary, Gerbers) not to use genetically

modified commodities in processing; the move by various brewers in Japan and in Mexico to reject genetically modified ingredients; the announcement by McDonalds to use non-genetically modified materials in its potatoes; and the announcement that Calbee Food Co. had recalled its popular Jagariko line of snacks in Japan because of the discovery that the snacks were made from genetically modified potatoes; all were taken well in advance of the emergence of consumer pressure directed at the firms. As Carole Burke, editor of Japan's Food Industry Bulletin has stated, "all leading food-processing companies in Japan are very conscious of consumers' fears of GM foods. Market leaders in all segments of the food industry are demanding GM-free commodities, and the menus of major restaurant chains note their foods are GM-free."

IV. Impact on Trade

Predictably, resistance to genetic modification of foodstuffs has produced clear and unmistakable impacts on trade patterns. U.S. corn and soybean exports to the EU, and corn exports to Japan have been adversely affected by the inability to assure suppliers of non-genetically modified commodities.

The European Union has had a tough labeling law for some time, requiring food containing more than one percent of a genetically modified ingredient to include a label that warns consumers. The current proposal, to reduce the percentage to 0.9 percent, and to extend labeling to animal feed, is discussed above. The EU stance is backed by strong consumer sentiment. A study by the National Consumer Council in Great Britain indicated that 80 percent of consumers believed that meat from animals fed genetically modified feed should be clearly labeled as genetically modified.

A 2003 Iowa State University study by Dr. Robert Wisner concluded that there was a "high risk" that the United States wheat industry would lose 30 percent to 50 percent of its business with foreign markets for spring wheat if genetically modified wheat is released for planting.

Monsanto announced in August, 2002, that it could take until at least 2005 to gain regulatory approval in Europe for its genetically modified products. On April 26, 2002, the Governor of North Dakota signed into law a moratorium on the introduction of genetically modified wheat in the state until August 1, 2003.[5] That action was a response to concerns voiced on a number of fronts including concerns about possible impacts on trade.

Although there is evidence that Brazil's exports are not completely free from genetic modification, Brazil has officially positioned itself as a reliable source of supply for non-genetically modified corn and soybeans. The country achieved that reputation principally by banning the import of all genetically modified seeds and commodities. Brazil's status as a reliable source of non-genetically modified crops was a key factor in South Korea's recent decision to import Brazilian, rather than U.S., corn. In Asia, Thailand has been particularly well

[5] H.B. 1338, North Dakota General Assembly, 2002.

positioned to serve the non-genetically modified market. More than three years ago, the Government of Thailand banned the import and cultivation of commercial seeds which had been genetically modified. While there have been experimental field trials of genetically modified cotton in Thailand and the government-funded National Centre for Genetic Engineering and Biotechnology has conducted research into genetically modified tomatoes, cucumbers and papaya, there has been concern that the field trials might not continue.

The May 28, 2001, edition of *Feedstuffs* reported that Australia's Industrial Suppliers Office had "identified the non-genetically modified (non-GM) status of Australia as a possible advantage over other soybean producers, such as the U.S., which has more than half its soybean crop sown to GM varieties." A May 21, 2001, news report stated that a delegation from India, sponsored by the Soybean Processor's Association of India, met trade officials in Italy, Spain, France, Germany, the Netherlands and Britain to attempt to persuade buyers that their soybean meal is non-genetically modified, unlike that of other export competitors. The report indicated that India was already exporting 2.5 to 3 million metric tons per year of non-genetically modified soybean products to Asia.

To the extent the market for non-genetically modified commodities is met without discount or premium, the situation does not pose a serious economic threat to exporters of genetically modified crops. However, a continued trend toward greater demand for non-genetically modified food ingredients could lead to serious problems for those countries dominated by the production of genetically modified commodities.

V. The Future of Agricultural Biotechnology

The controversy over genetic modification of crops is expected to be resolved on the basis of three economic relationships—(1) the demand for GMO and non-GMO crops; (2) the supply of GMO and non-GMO crops; and (3) the costs for maintaining a two-track or multiple-track production, marketing and handling system and who bears those costs.

Demand for GMO and non-GMO crops

The demand for GMO and non-GMO crops promises to be highly important to the future of agricultural biotechnology. That factor is squarely in the hands of consumers, worldwide, and in the hands of processors which continually endeavor to anticipate consumer demand.

Arguably, the labeling of foodstuffs as to the GMO status of ingredients will make more precise the demands of consumers. As noted earlier, consumers will ultimately get what they want. On May 3, 2002, the U.S. Food and Drug Administration closed a comment period to ascertain if the public wants genetically food labeled as such.

Some see in the estimated 20 percent per year growth in the organic food market in recent years (estimated to total close to a $10 billion market in a March, 2001, report by Solomon Smith Barney) evidence that, absent labeling, consumers will seek organically grown foods. Regulations under the National Organic Standard Program, authorized in the 1990 farm bill, were recently finalized, reviewed by Congress and became law on April 21, 2002. The regulations, which became effective October 21, 2002, increased the minimum percentage of

organic ingredients in products labeled "Made With Organic Ingredients" and imposed limits on genetically modified foodstuffs in certified organic foods.

On April 5, 2001, the *Wall Street Journal* published a study of genetically modified foods. Twenty food products labeled as "non-GMO" or "GMO-free" were tested by a prominent food laboratory on behalf of the *Journal*. Of the 20, 16 contained evidence of genetic material used to modify plants. As the *Journal* article stated, "the problem, regulators say, is that some genetically modified crops—which have been designed to resist disease, pests and chemicals—can cross-pollinate freely with regular crops, passing along their altered traits to the next generation."

Supply of GMO and non-GMO crops

The supply of GMO crops and non-GMO crops, the second critical economic variable in the future of agricultural biotechnology, is squarely in the hands of producers, worldwide, as producers make decisions about seed selection each year.

Notwithstanding the rapid adoption of corn resistant to the European Corn Borer and crops resistant to potent herbicides, the evidence is clear that, in the long-run, producers rarely benefit from new technologies and often suffer economically from their adoption.

As has been known for several decades, only early adopters benefit economically from output increasing technology—such as fertilizers, chemicals and better seed, such as Bt corn. That's the type of corn that creates a substance toxic to the European Corn Borer so the technology increases yields.

Why do farmers not benefit from output increasing technology? With inelastic demand for most agricultural products, increases in output in the aggregate reward producers with a disproportionate drop in price and in profitability. That's been known and documented for decades. Farmers have been on a treadmill. They have to adopt technology to be competitive but they are rewarded by lower prices and profits if they do.

Even cost decreasing technologies, such as Roundup Ready Soybeans, are ultimately output increasing as such technology enables crops to be grown in areas where production would be uneconomic were costs higher. Thus, cost decreasing technology, also, ultimately leads to an increase in output which means a disproportionate drop in price and in profitability for the producer.

In recent years, the pace of adoption of new technology has been so swift both here and abroad as to leave little benefit for producers, even for early adopters.

The stream of output increasing and cost-decreasing technology has been a major reason why producers, particularly crop farmers, have been under economic pressure much of the time over the past 70 years.

The cost of maintaining segregated crop supplies

A major problem faced by the U.S. and other producers of genetically modified crops on a widespread basis is the feasibility and cost of a two track or multi-track marketing and handling system. For crops that are particularly susceptible to gene flow (such as corn because of pollen drift), the tolerance level (amount of GMO germ plasm in non-GMO crops) is critically important. Contamination can occur from several sources—(1) contamination of GMO germ plasm in non-GMO seed coming from the seed companies; (2) pollen drift in the field; (3) physical contamination in planter boxes, combines, augers, elevators, wagons and bins on the farm; and (4) physical contamination at the elevator or other handler of the commodity after it leaves the farm. Research indicates that the cost of segregation rises exponentially as the tolerance level is reduced.

The experience with StarLink™ corn in 2000 illustrates how widely unacceptable supplies of crops can become diffused throughout the food system. In that case, StarLink™ was approved for feed use but not for food use by the Environmental Protection Agency. As the terms of the registration stated, "none of the seeds, plants or plant materials in the StarLink™ plot, or within 660 feet of the field, may be used for food uses or may enter international commerce." EPA was concerned that the CRY9C protein in StarLink™ possessed qualities that could cause allergic reactions in humans (although the Centers for Disease Control and Prevention, in mid-June 2001, announced that it was unable to conclude that reported illnesses were the result of the StarLink™ corn). After traces of the protein were found in various food products, starting with taco shells, an effort was made to locate and dispose of supplies of the StarLink™ corn from the 2000 (and earlier) crops.

Unfortunately, not all producers acquiring StarLink™ seed were advised of the limitation on use and disposition of the crop. The 11 licensees of the seed from Aventis Crop Science were the actual sellers of the StarLink™ seed and apparently, in some instances, did not advise producers of the limited registration and the possible consequences if other corn was contaminated with the StarLink™ germ plasm. Therefore, contamination occurred inadvertently at planting and harvest, pollen drift produced gene flow into non-StarLink™ fields and the StarLink™ crop was commingled with other corn in on-farm storage and at elevators. While the number of acres planted to StarLink™ totaled only 340,908, the number of bushels containing the StarLink™ protein was several times the production from those acres actually planted with StarLink™ seed.

EPA cancelled the registration on October 12, 2000. Aventis Crop Science moved quickly to isolate the corn containing StarLink™ and offered producers 25 cents per bushel premium over the October 2, 2000, market price for corn; agreed to compensate growers producing corn within 660 feet of StarLink™ corn with the same price premium; assured elevators that the company would pay elevators for "additional transportation, demurrage and testing costs incurred by a grain elevator because of commingled corn;" and agreed to "work with" elevators to address problems related to discounts in value of StarLink™ contaminated corn.

Even with the aggressive efforts by Aventis Crop Science, augmented by pressure from state Attorneys General in several states, but particularly in Iowa and Missouri, the StarLink™ crop promised to continue to flow through the food chain for several months. The announcement

by the Centers for Disease Control that StarLink™ was not the cause of allergic reactions may allay some of the concerns.

In late winter, 2000-2001, the U.S. Department of Agriculture asked 280 seed companies to test their seed supplies for traces of the StarLink™ protein and offered to purchase the seed supplies failing the test. Some lots were found to contain StarLink™ and USDA reportedly set aside $20 million to purchase that seed. However, about one-fourth of the seed companies did not respond. The possibility is that part of the 2001 corn crop was planted with seed containing StarLink™ germ plasm.

This highlights a shortcoming of the oversight process over foodstuffs in the United States. The federal government lacks recall authority, on a mandatory basis, over commodities or other food ingredients. This lack of authority is especially notable if—(1) the crop is visually indistinguishable (which it was) and (2) there is a perception of value on the part of the producer.

The StarLink™ controversy focused attention on civil liability in such situations.

- A commercializing company or licensee that fails adequately to warn producers of limits on the production or marketing of the resulting crop could be liable to growers who suffer damages. Licensing agreements would presumably address problems of liability in this area.

- A producer who knowingly ignores limits on registration could be liable for damages suffered by owners of neighboring fields to which pollen drifts (for those crops susceptible to pollen drift).

- A producer who delivers a crop contaminated with unacceptable germ plasm could be liable to the elevator for damages suffered. Farmers who are deemed to be "merchants" under the Uniform Commercial Code are subject to—(1) express warranties made orally or in writing about the crop; (2) implied warranties of merchantability about the crop passing without objection in the trade; and (3) implied warranties of fitness that the crop is fit for the purpose for which it is to be used, if known to the seller.

- Firms processing, manufacturing and distributing food products could complain of damages to those who sold them ingredients unsuitable for use, presumably elevators and grain handlers and shippers. Claims could include actual damages from product recalls, increased handling and manufacturing costs and damages to brand identities and reputations.

- Consumers who suffer damages could have a claim against food suppliers and manufacturers if injury can be established and if damages can be proved.

- Finally, producers may have a claim, against the commercializing company or companies, if it can be proved that the offensive germ plasm resulted in a discount for the crop generally in the country. Several class action lawsuits have been filed in the United States alleging that corn producers in general were damaged by the StarLink™ episode even though there was no contamination of their crop by the CRY9C protein. In the first of these cases, on July 11, 2002, *In re StarLink Corn Products Liability Litigation*, the federal district court for the Northern District of Illinois dismissed the claims related to labeling but did not dismiss

allegations relating to public and private nuisance, negligence and possible violation of the Tennessee Consumer Protection Act.

Pollen drift

Pollen drift is a more serious problem with some crops (such as corn)[6] than for other crops (such as soybeans). For rice, there are indications[7] that, while cultivated rice is an inbreeder, there is some chance of pollen drift. In a 1993 World Bank Technical Paper,[8] the statement was made that a separation distance of 20 meters eliminates contamination and a distance of 10 meters "makes it unlikely" that contamination would occur. The same publication states that "…the normal viability of the pollen is on the order of 5-6 minutes."[9] In the *2002 UC Davis Comprehensive Rice Research Annual Report*, the authors observed, as part of a two-year study, that "the greatest distance traveled from the donor site was 6-feet." Wild rice has characteristics more favorable to outcrossing and could pose greater problems of pollen drift.

It is generally thought that the distance pollen drifts is a function of temperature, humidity, wind direction, wind speed and the presence or absence of barriers.

Thus far, there has not been a case of pollen drift involving GMO crops which has been litigated to an appellate-level court. There are several theories that could be employed by courts to resolve conflicts over pollen drift.

Negligence. The negligence system of liability is a fault system. In a few areas, such as automobile insurance and workers' compensation, the concept of fault has been rejected, but a pure negligence system requires that fault be established.

For a person to be deemed legally negligent, certain conditions must exist. These conditions can be thought of as links in a chain. Each condition must be present before a finding of negligence can be obtained. The first condition is that of a legal duty giving rise to a standard of care. To be liable for a negligent tort, the defendant's conduct must have fallen below that of a "reasonable and prudent person" under the circumstances. A reasonable and prudent person is what a jury has in mind when they measure an individual's conduct in retrospect—after the fact, when the case is in court. The conduct of a particular tortfeasor (the one causing the tort) who is not held out as a professional is compared with the mythical standard of conduct of the reasonable and prudent person in terms of judgment, knowledge, perception, experience, skill, physical, mental and emotional characteristics as well as age and sanity. For those held out as having the knowledge, skill, experience or education of a professional, the standard of care reflects those factors. For example, the standard applicable to a professional veterinarian in diagnosing or treating animals is what a reasonable and prudent veterinarian would have done under the circumstances, not what a reasonable and prudent *person* would do.

[6] Research in 2003 at Iowa State University confirmed that corn pollen can drift more than 1600 feet.
[7] *Rice Biosafety*, World Bank Technical Paper, Biotechnology Series No. 1, 1993.
[8] *Id.*
[9] *Id.*

If a legal duty exists, it is necessary to determine whether the defendant's conduct fell short of the conduct of a "reasonable and prudent person (or professional) under the circumstances." This is called a breach, and is the second element of a negligent tort case.

Once a legal duty and breach of that duty are shown to exist, a causal connection (the third element) must be established between the defendant's act and the plaintiff's injuries (whether to person or property). In other words, the resulting harm to the plaintiff must have been a reasonably foreseeable result of the defendant's conduct a the time the conduct occurred. Reasonable foreseeability is the essence of causality (also known as proximate cause).

Finally, contributory negligence by the complaining party may limit or deny recovery.

Strict liability. Some activities are deemed to be so dangerous that a showing of negligence is not required to obtain a recovery. Under a strict liability approach, the defendant is liable for injuries caused by the defendant's actions, even if the defendant was not negligent in any way or did not intend to injure the plaintiff. In general, those situations reserved for resolution under a strict liability approach involve those activities that are highly dangerous. When these activities are engaged in, the defendant must be prepared to pay for all resulting consequences, regardless of the legal fault.

Thus, if an individual keeps wild animals on his or her premises, the individual will be strictly liable for any damages that the animals caused to other persons or their property. In many jurisdictions, the owner or possessor of hard-hoofed animals, such as cattle, horses and donkeys, may also be strictly liable for injuries caused by those animals, at least if known to have a vicious propensity.

Strict liability is imposed on persons responsible for activities or conditions on their property that are unreasonably dangerous and cause injury or damage to other persons or their property. For example, if a farmer or rancher decides to create a drainage ditch with explosives, and the resulting rock debris causes damages to a neighbor, the farmer will be strictly liable.

A strict liability approach for "non-natural" land use activities was applied in an 1868 English case. In that case, the defendants hired an independent contractor to construct a reservoir on their property. When the reservoir was filled up, water broke from it and flowed into abandoned mine shafts on the property, and then flooded adjacent mine shafts owned by the plaintiffs. The defendants themselves were not aware of the abandoned shafts, and were therefore not negligent (although the contractor probably was). After the lowest court denied liability, the case came before the Exchequer Chamber, in effect an intermediate appeals court. The court reversed, holding that there was liability because "…the person who for his own purposes brings on his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and if he does not do so, is prima face answerable for all the damage which is the natural occurrence of its escape." The case then went to the House of Lords, the final appellate tribunal. The holding of the Exchequer Chamber was affirmed, but was significantly limited. Liability existed because, the court said, the defendants put their land to a "non-natural use for the purpose of introducing [onto it] that which in its natural condition was not in or upon it", i.e., a large quantity of water. If, on the other hand, the court said, the

water had entered during a "natural use" of the land, and had then flowed off onto the plaintiff's land, there would have been no liability.

Initially, American courts frequently misconstrued the 1868 decision and purported to reject it. They focused on the Exchequer Chamber version, which would have imposed liability for escaping forces even where the land is put to a natural use. Eventually, however, the vast majority of American courts accepted at least the practical result of the case, even if not the case by name. Today, the rule has been extended to include most activities that are extremely dangerous.

Perhaps the most frequent application of the doctrine to agriculture is in situations involving the aerial application of pesticides and other chemicals to crops. Most states utilize a strict liability rule if damage occurs. A few states purport to require a showing of negligence, but, in reality, even in these jurisdictions it may be difficult for a farmer to escape liability if damage occurs. A 1977 case decided by the Washington Supreme Court, *Langan v. Valicopters, Inc.*,[10] demonstrates the application of the strict liability rule in an aerial crop dusting case.

In that case, the Langans owned a small (2 ½ to 3 acre) farm in the Yakima Valley. The Langans were organic farmers—that is, they used no nonorganic fertilizers, insecticides or herbicides to aid them in their farming but relied on natural fertilizers and natural pest control agents. They had planned to can and sell their produce to organic food buyers.

Valicopters, Inc., was a Washington corporation which engaged in the aerial application of agricultural pesticides.

The spray company sprayed for Colorado beetle infestation on the farm adjacent to the Langan's property with a chemical pesticide known as Thiodan. A small patch of the farm was sprayed with the chemical Guthion. While applying the pesticides to Thalheimers' property, the helicopter traveled approximately 45 miles per hour while 6 to 8 feet off the ground with a 42-foot application boom extending from the sides of the helicopter. Langan testified that, during one spraying pass, the helicopter began spraying while it was over his property. However, this testimony was disputed. He further testifid that the spray settled on the entire length of their tomato, bean, garlic, cucumber and Jerusalem artichoke rows.

A laboratory test conducted after the spraying indicated the presence of 1.4 parts per million by weight of Thiodan on the Langans' crop tissue. The United States Department of Health Education and Welfare, Food and Drug Administration's tolerance for Thiodan on tomatoes and beans is 2.0 parts per million. Following the test results, the board of directors of the Northwest Organic Food Producers' Association revoked the Langans' certification as organic food growers. The Langans' entire property was decertified in conformance with the NOFPA rule which requires decertification when a portion of the land is contaminated.

As the court noted, three jurisdictions have held crop dusting to be an activity to which the principles of strict liability apply. Section 519 of the Restatement (Second) of Torts provides:

[10] 567 P.2d 218 (Wash. 1977).

(1) One who carries on an abnormally dangerous activity is subject to liability for harm to the person, land or chattels of another resulting from the activity, although he has exercised the utmost care to prevent such harm.

(2) Such strict liability is limited to the kind of harm, the risk of which makes the activity abnormally dangerous.

Section 520 lists the factors to be used when determining what constitutes an abnormally dangerous activity…

(a) Whether the activity involves a high degree of risk of some harm to the person, land or chattels of others;

(b) Whether the gravity of the harm which may result from it is likely to be great;

(c) Whether the risk cannot be eliminated by the exercise of reasonable care;

(d) Whether the activity is not a matter of common usage;

(e) Whether the activity is inappropriate to the place where it is carried on; and

(f) The value of the activity to the community.

The Washington Supreme Court pointed out that, under these circumstances, there can be an equitable balancing of social interests only if appellants are made to pay for the consequences of their acts.

The court stated, "we realize that farmers are statutorily bound to prevent the spread of insects, pests, noxious weeds and diseases…. But the fulfillment of that duty does not mean the ability of an organic farmer to produce organic crops must be destroyed without compensation." The court upheld the trial court's instructions on strict liability.

Interestingly, the *Langan* court did not consider whether it made a difference that the plaintiff, because of his specialization in the organic food business, was abnormally sensitive to the defendant's conduct. Some courts, however, have limited application of the strict liability rule and have found a defendant not liable for an abnormally dangerous activity in situations where the plaintiff was abnormally sensitive to the defendant's conduct. For instance, in a 1954 Washington case,[11] an individual was conducting blasting operations which frightened female mink owned by an adjoining landowner. Adult mink kill their young in reaction to fright. The court refused to hold the defendant strictly liable for his blasting operations and stated that what makes blasting operations unusually dangerous is "the risk that property or persons may be damaged or injured by coming into direct contact with flying debris, or by being directly affected by vibrations of the earth or concussions of the air." The court ruled that, since the plaintiff's mink ranch was more than two miles away from the blasting, and there was no unreasonable interference with any other landowners at that distance, the "exceedingly nervous disposition of mink" must be held responsible for the damage, not the blast itself. Strict liability does not protect against "harms incident to the plaintiff's extraordinary and unusual use of land." This is similar to the modern trend in manufacturer's liability cases, where recovery is limited to

[11] Foster v. Preston Mill Co., 268 P.2d 654 (Wash. 1954).

instances where the defect in the manufactured product was the proximate cause of the injury or damage.[12]

Arguably, if a farmer plants a genetically modified crop with knowledge that the crop is likely to cross-pollinate conventional crops in adjacent fields, the farmer could be held strictly liable for any resulting damages. The situation could be viewed as similar to the problem of pesticide drift present in *Langan*. The damages in a cross-pollination case could include, among other things, loss of organic certification, and costs associated with breaches of identity preserved crop contracts. Neighboring farmers could also be sued by seed companies for "theft" of genetic intellectual property that was actually present in their fields due to wind and cross-pollination.[13]

In Massachusetts, legislation was introduced in 2003 that would have imposed strict liability on companies that manufacture GMO products but no action was taken on the bill. Legislation was also introduced in North Dakota, Montana and Vermont addressing liability for GMO crop contamination.

Trespass. Presently there has not been a case of pollen drift involving GMO crops litigated to an appellate-level court on a trespass claim. However, cases involving comparable situations have been litigated. For example, in *Martin v. Reynolds Metal*,[14] the defendant was held liable for trespass onto the plaintiff's property for the emission of microscopic fluoride particles from the defendant's plant that rendered the plaintiff's land and drinking water unfit for livestock grazing. Also, another court has found a trespass for the invasion on the plaintiff's land of a cloud of silicon dust that had the potential to cause injury.[15] More recently, Texas law has been construed to allow property owners to recover on a trespass claim for contamination caused by the emission of airborne particulates.[16]

Nuisance. A nuisance is an invasion of an individual's interest in the use and enjoyment of land rather than an interference with the exclusive possession or ownership of the land. The concept has become increasingly important in recent years due to land use conflicts posed by large-scale, industrialized confinement livestock operations. Indeed, the industrialization of agriculture has given rise to nuisance suits brought by farmers against large-scale agricultural operations.

Nuisance law prohibits land uses that unreasonably and substantially interfere with another individual's quiet use and enjoyment of property. The doctrine is based on two

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[12] It is crucial to remember that the defendant's conduct must be proved to be the proximate cause of the plaintiff's damage. In *O'Donnell v. Moose Hill Orchards, Inc.* 670 A.2d 1030 (N.H. 1996), the plaintiff was denied recovery for failing to prove that the deaths of eight thoroughbred race horses were caused by eating apples from the defendant's adjacent apple orchard that had been sprayed with pesticides.

[13] *See, e.g.*, Monsanto v. Schmeiser, 202 F.T.R. 78, 12 C.P.R. (4th) 204 (2001), *aff'd*, No. A-367-019 (Fed. Ct. Can. Sept. 4, 2002); Monsanto v. Trantham, 156 F.Supp. 2d 855 (W.D. Tenn. 2001); Monsanto v. McFarling, 302 F.3d 1291 (Fed. Cir. 2002).

[14] 342 P.2d 790 (Or. 1959).

[15] Hall v. DeWeld Mica Corp., 93 S.E.2d 56 (N.C. 1956).

[16] Stevenson, et. Al, v. E.I. Dupont de Nemours & Co. 327 F.3d 400 (5th Cir. 2003) (only showing necessary for trespass claim is entry over land by some "thing;" however, evidence insufficient to support award of damages).

interrelated concepts: (1) landowners have the right to use and enjoy property free of unreasonable interferences by others; and (2) landowners must use property so as not to injure adjacent owners.

Nuisance law is rooted in the common law and has been developed over several centuries as courts settled land use conflicts. Nuisance law is always changing and the legal rules vary between jurisdictions. Nuisance law is important to agriculture because of the noxious odors produced by many farm operations, especially those involving livestock production, but also because nuisance could be invoked in pollen drift situations. Indeed, as noted above, a nuisance claim was involved in the Starlink™ litigation.

The two primary issues at stake in any agricultural nuisance dispute are whether the use alleged to be a nuisance is reasonable for the area and whether the use alleged to be a nuisance substantially interferes with the use and enjoyment of neighboring land.

"Nuisance" and "negligence" are not the same thing. Operating a farming or ranching activity properly and having all requisite permits may still constitute a nuisance if a court or jury determines the activity is "unreasonable" and causes a "substantial interference" with another person's use and enjoyment of property. Whether a complained of activity results in a "substantial" and "unreasonable" interference with another's property will depend on the facts of each case and the legal rules used in the particular jurisdiction.[17]

Because each claim of nuisance depends on the fact of the case, there are no easy rules to determine when an activity is considered a nuisance. In general, a court faced with a particular nuisance claim considers several factors. Primary among these factors is whether the use complained of is a reasonable use that is common to the area or whether it is not suitable.[18] Also important is whether the use complained of is a minor inconvenience which happens very infrequently or whether it is a regular and continuous activity. The nature of the property used being disturbed is also an important consideration. If the interference has a significant impact on the complaining party's use of their own property, such as the prevention of living in the complaining party's home, a nuisance will likely be found. Similarly, if the complained of use is preventing another landowner's use of their property that is a vital part of the local economy, the court will balance the economics of the situation and most likely conclude that the complained of use constituted a nuisance. An additional important factor, but not conclusive in and of itself is the issue of whether the complained of use was in existence prior to the complaining party's use of their property which is now claimed to be interfered with. A related concern, if the activity generating the alleged nuisance was in existence prior to the complaining party moving into the vicinity, is whether the nuisance activity was obvious at the time the complaining party moved in. Many courts also attempt to balance the economic value to society of the uses in question. If

[17] *See, e.g.*, Penland v. Redwood Sanitary Sewer Service District, 156 Or. App. 311, 965 P.2d 433 (1998) (defendant's composting operation held to be a nuisance; odors generated substantially and unreasonably interfered with plaintiffs' use and enjoyment of their property).

[18] *See, e.g.*, May v. Brueshaber, 265 Ga. 889, 466 S.E.2d 196 (1995) (jury question presented as to whether two 40' x 500' chicken houses each housing 30,000 chickens consuming 350,000 to 400,000 pounds of food every six weeks constituted a nuisance when located within 250 feet of plaintiff's home).

the complained of use adds jobs and income to the local economy, the value to society of continuing the alleged nuisance may outweigh the negative impact it causes.

The courts have a great deal of discretion in establishing an appropriate remedy for a nuisance. The most common remedy is for the court to stop (enjoin) the nuisance activity. However, most courts try to fashion a remedy to fit the particular situation.

Nuisances are typically classified in two ways. A private nuisance is a civil wrong, based on a disturbance of rights in land. A private nuisance may consist of an interference with the physical condition of the land itself, as by vibration or blasting which damages a house, the destruction of crops, flooding, the raising of the water table, or the pollution of a stream or underground water supply. A private nuisance may also consist of a disturbance of the comfort or convenience of the occupant as by unpleasant odors, smoke, dust or gas, loud noises, excessive light, high temperatures, or even repeated telephone calls. The remedy for a private nuisance lies in the hands of the individual whose rights have been disturbed. A public nuisance, on the other hand, is an interference with the rights of the community at large. A public nuisance may include anything from the obstruction of a highway to a public gaming house or indecent exposure. The normal remedy is in the hands of the state.[19]

A nuisance can be classified as either temporary or permanent. A temporary nuisance is one that can be abated; a permanent nuisance cannot be abated. Damages can be awarded for a temporary nuisance if the complaining party can show that economically feasible techniques are available to the defendant to abate the nuisance to the degree where it is no longer a substantial interference with the plaintiff's use and enjoyment of their property, and the defendant has failed to utilize those techniques.

A nuisance may also be classified in terms of a nuisance per se which is a nuisance as a matter of law (such as by statute) under any circumstance. Relatively few nuisances are classified as a nuisance per se. A nuisance per accidens is an activity that only becomes a nuisance because of surrounding circumstances. For example, a lawfully operated feedlot may only become a nuisance because of peculiar environmental factors associated with it. Maintaining a pen of pigs at Fifth and Broadway in New York City would most likely constitute a nuisance but maintaining a similar facility in a rural location would not necessarily be considered a nuisance.

A fundamental question in all nuisance actions is whether a nuisance should be permitted where there is no present use on the plaintiff's land to form the basis of an objection. In other words, is there a property right to conduct an activity that would constitute a nuisance if there was someone around to object? This is a very important policy question particularly for livestock producers whose operations tend to emit obnoxious odors or for a crop producer growing a GM crop and there is no nearby crop that would be vulnerable. While a right to

[19] One court has upheld against a motion to dismiss farmers' private nuisance claim against a seed company for contamination of non-GMO crops. The court also ruled that a sufficient claim for public nuisance (contamination of the general food supply) had been stated. *In re* Starlink Corn Products Liability Litigation, 212 F. Supp. 2d 828 (N.D. Ill. 2002). In early 2003, the court approved a $110 million settlement of the matter. In general, eligible participants in the settlement are non-Starlink corn farmers that harvested non-Starlink corn in 2000 and/or had actual damage due to Starlink contamination.

engage in an activity that would constitute a nuisance if someone were present to object reduces the value of all surrounding property, the ultimate question would seem to involve the amount and intensity of the offensive condition passing from the defendant's property onto the land of another. If the societal policy is one of zero negative externalities, two results are possible. Buffering may occur whereby the landowner conducting an activity that might be deemed a nuisance purchases enough adjacent land so that there will be no offensive conditions crossing property lines. For example, a farmer producing GMO crops could create a buffer zone of sufficient size to assure that pollen would not drift on to others' property. This would in the short run, increase the cost of production, but may be the most economical decision in the long run if it avoids a costly nuisance action. A second possibility of a zero externality policy is that it will bring economic pressure to bear in the industry for technology to eliminate the potential condition.

Another policy option for handling cost externalities is a market-based approach. The U.S. economy is based heavily on the fact that markets are the most effective and efficient way to allocate resources and distribute income. The market rewards low cost producers, those who produce what consumers want. However, letting the market prevail in winnowing out high cost producers works *only if the producers are bearing all of the costs attributable to their operations*. Unfortunately, that is not the case where the producing firm creates offensive conditions. The costs external to the producing firm, i.e. costs associated with pollen drift, odors, ground water pollution and stream pollution, are being borne by others. Economists call these cost externalities and these costs prevent the market from functioning perfectly.

The task is how to cause these external costs to be charged back to the firm responsible for the external problem in the first place. Historically, reliance was placed on the law of nuisance. In recent years, attention has been focused on regulation by state and federal governments of the level and type of pollution allowed. Within the past few years, attention has shifted to creating economic incentives to induce firms to control their externalities.

Historically, society has followed two fundamentally different solutions in dealing with externalities in addition to relying on nuisance. One approach has been through regulation, i.e. simply limit, somewhat arbitrarily, the amount and type of pollution. This approach has usually involved establishment and monitoring of an extensive set of environmental regulations by a governmental bureaucracy. Over the years, this approach has received low marks for the expense involved and for the resulting inefficiencies caused by the regulations. The other approach has been to use economic incentives to establish the desired result by encouraging firms to do the right thing. Slowly, at the national level, we have been inching in this direction. Most concede that, when the administrative costs are manageable, this approach can be less costly and more efficient.

One way to implement an incentives approach is to ensure property rights are defined as to what is not desired to occur and to take the necessary steps to develop a market in property rights. The approach was pioneered by Nobel prize-winning economist Ronald Coase more than three decades ago.[20] From this perspective, those generating odors (or pollen) are infringing

[20] Coase, R., "The Problem of Social Cost," 3 *J. Law &Econ.* II (1964).

upon the property rights of the surrounding neighbors. Compensation for infringement of this right can be recovered.

While the legal system has long recognized limits on the extent to which odors, noise, dust or other offensiveness has to be borne by adjacent landowners under the law of nuisance, arbitrarily imposing limits for "unreasonable" interferences typically does not produce an economically efficient outcome. Consequently, two key objectives of any solution to offensive odors should be: (1) to create economic incentives to cut down on the level of offensive pollen passing over property lines and (2) to provide compensation to those who choose to endure some level of pollen drift.

One way to meet both objectives is to create a framework in which those responsible for the condition and those who would have to endure them are free to negotiate an outcome. The principles are fairly clear: those not polluting do not pay; those polluting a little pay a little; those polluting a great deal pay a lot.

Under this approach, each resident within a specified distance would be free to negotiate a result with the agricultural operation producing the offensive condition. Perhaps the best solution for a particular offended person might be to accept a modest payment and endure some negative effects. Others might prefer to accept higher levels of the offensive condition and receive more payment.

What results would this approach encourage? Paying compensation for conditions they generate would cause operations to use the very best management to control the condition, to employ the most effective technologies, to "buffer" the operation by locating production facilities in the middle of larger tracts and, in general, to seek a least-cost solution to the problem. Conceivably, an operation could control enough land to reduce pollen levels at the boundary to zero.

Although not involving negotiation, legislation was introduced in 2002 and again in 2003 in Iowa that would have created a fund to pay corn and soybean farmers for damages caused by GMO contamination of their non-GMO crops. The fund would have been financed by mandatory fees levied on farmers. Some farmers opposed to GMO crops being grown objected on the grounds that they should not be assessed to pay for their own damages; rather, the damages should be paid by the commercializing companies. The bills failed to get out of committee.

There are no common law defenses that an agricultural operation may use to shield itself from liability arising from a nuisance action. However, courts do consider a variety of factors to determine if the conduct of a particular farm or ranch operation is a nuisance. Of primary importance are priority of location and reasonableness of the operation.

Every state has enacted a right-to-farm law that is designed to protect existing agricultural operations by giving farmers and ranchers who meet the legal requirements a defense in nuisance suits. The basic thrust of a particular state's right-to-farm law is that it is unfair for a person to move to an agricultural area knowing the conditions which might be present and then ask a court to declare a neighboring farm a nuisance. Thus, the basic purpose of

a right-to-farm law is to create a legal and economic climate in which farm operations can be continued. Right-to-farm laws can be an important protection for agricultural operations, but to be protected, an agricultural operation must satisfy the law's requirements.

Right-to-farm laws are of three basic types: (1) nuisance related; (2) restrictions on local regulations of agricultural operations; and (3) zoning related. While these categories provide a method for identifying and discussing the major features of right-to-farm laws, any particular state's right-to-farm law may contain elements of each category.

The most common type of right-to-farm law is nuisance related. This type of statute requires that an agricultural operation will be protected only if it has been in existence for a specified period of time (usually at least one year) before the change in the surrounding area that gives rise to a nuisance claim. These types of statute essentially codify the "coming to the nuisance defense," but do not protect agricultural operations which were a nuisance from the beginning or which are negligently or improperly run. For example, if any state or federal permits are required to properly conduct the agricultural operation, they must be acquired as a prerequisite for protection under the statute.

The second type of right-to-farm statute is designed to prevent local and country governments from enacting regulations or ordinances that impose restrictions on normal agricultural practices. This type of statute is usually contained in the state's agricultural districting law. Under this type of a statute, agricultural operations are required to be located within a designated agricultural district in order to be protected from nuisance suits. However, agricultural activities, even though they may be located in an agricultural district, must be conducted in accordance with federal, state and local law or rules in order to take advantage of the statute's protections.

A third type of right-to-farm statute exempts (at least in part) agricultural uses from county zoning ordinances. The major issue involving this type of statute is whether a particular activity is an agricultural use or a commercial activity.

In some states, agricultural activities receive nuisance-type protection through zoning laws wholly separate from the protections of a right-to-farm statute.

In late 1996, the Frederick County, Maryland Commissioners took a novel approach to addressing agricultural nuisances by adopting an ordinance designed to limit the circumstances under which agricultural operations may be deemed to constitute nuisance. The ordinance took effect January 1, 1997, and specifies that a nuisance action may not be brought against an agricultural operation if the agricultural operation was, at the time the interference is alleged to have arisen, conducted substantially in accordance with generally accepted agricultural management practices. The novel aspect of the ordinance is that it establishes a committee designed to arbitrate and mediate disputes between agricultural operations and disaffected neighbors. Any controversy between landowners concerning an alleged nuisance of the agricultural operation must be submitted to the committee in writing. A majority decision of the committee is binding on the parties involved, but the decision is appealable to the county circuit court for a bench trial. The ordinance also establishes that upon any transfer of real property, the transferor must provide the purchaser or lessee a statement specifically advising the purchaser or lessee of the existence of the ordinance. A violation of the ordinance is punishable by a fine of

up to $100. It is believed that the ordinance will facilitate negotiation between farmers and nonfarmers with respect to the conduct of agricultural operations and thereby limit the number of nuisance lawsuits filed against farmers in the county.

The "base line" state

One issue, which is highly relevant, is what society (and the legal system) consider to be the base line for offensive conditions. Is it zero externalities? Little authority exists for that base line. Most determinations, regardless of the theory pursued, do not recognize the presence of small amounts of externalities to be actionable. It tends to be a facts and circumstances test. In some instances, as with organic production, the base line state may be near zero externalities.

Possible outcomes

The development and production of transgenic crops is known to be a costly process. The process can only be supported, economically, if there is a robust revenue stream from sales of resulting products.

If consumer resistance stabilizes or wanes, the three economic relationships are likely to produce—(1) niche markets for non-GMO crops, in part on a country-by-country basis where gene flow from pollen drift and from mechanical contamination can be rather easily controlled; (2) a modest premium for non-GMO crops (sufficient to produce the supply to serve that market); and (3) disputes over trade rules imposed by countries which restrict GMO seed and commodities as to whether such rules constitute barriers to trade.

In the event consumer resistance increases, the countries with high rates of GMO plantings will be confronted with the choice of—(1) relinquishing the non-GMO market to other countries; (2) gearing up for simultaneous production of GMO and non-GMO crops (and maintaining acceptable levels of segregation of the crops); or (3) reducing GMO plantings. The outcome is almost certain to be resolved on an economic basis, in light of the three basic economic relationships outlined earlier. Any one of the three outcomes is likely to produce a reduced revenue flow to the commercializing companies.

Concerns about patenting

In recent years, concerns have been growing about the control being exercised over germ plasm by a few firms in the highly concentrated seed/chemical sector of the agricultural economy. This development is partly related to the changing role of the land grant universities, partly to the ability in recent years to manipulate germ plasm through genetic engineering, and partly to the consequences of the ability to obtain a monopoly-like position over unique life forms and over the process of genetic manipulation.

- For decades the land grant universities developed the basic genetic lines and made those lines available to the seed industry. Because of limitations on university funding and the near-revolution in genetic engineering, the private sector several years ago began pouring more money into basic research. Developments have progressed to the point that the payoff from research and development funding can no longer be used to compare the present with prior periods. Payoffs are expected to flow more readily than when biotechnology was in its infancy.

• The advent of genetic engineering meant that scientists could manipulate genetic composition—not through conventional crop breeding techniques but through laboratory procedures—to change the genetic makeup of plant and animal life. That has produced herbicide-resistant crops, for example.

• Finally, the U.S. Supreme Court in a 1980 landmark case determined that life forms could be patented.[21] In addition to the federal Plant Variety Protection Act (PVPA),[22] the Plant Patent Act of 1930[23] and simply shrouding research efforts with secrecy, the ability to patent life forms provides a powerful tool to keep competitors at bay. On December 10, 2001, the U.S. Supreme Court examined the scope of plant patenting[24] and held, in a 6-2 decision, that the intellectual property in seeds for new plants developed through genetic engineering or other breeding techniques could be protected under federal patent law. The court held that the Plant Patent Act of 1930[25] and the Plant Variety Protection Act of 1970[26] were not the exclusive means to protect intellectual property rights in seeds. The court ruled that seeds could be patented under general utility patent law which does not have a "saved seed" exemption and no research exemption.

VI. Solutions for Countries With Multi-Track Aspirations

With the odds currently favoring increasing consumer resistance, exporting countries with substantial plantings of GMO crops and a reputation as a GMO supplier are expected to gear up for simultaneous production of GMO and non-GMO crops with intensive effort devoted to (1) maintaining acceptable levels of segregation of the crops and (2) developing a reputation, worldwide, as a dependable supplier of both GMO and non-GMO crops.[27] For countries nudged in that direction, several steps can be taken to facilitate the task.

Zone a region

One superficially attractive solution is to zone a country for crops on the basis of genetic modification. This is expected to be unworkable for several reasons. No area within a country wants to be on the losing side of an evolving market. Moreover, such a move is antithetical to the time-honored tradition of producers being given free rein to produce what they want.

What could emerge, is a form of de facto zoning as producers, on a local basis, voluntarily agree to limit their plantings to non-GMO crops in order to be positioned to take advantage of non-GMO markets. This would require buffer areas unless natural barriers (such as

[21] *Diamond v. Chakrabarty*, 447 U.S. 303 (1980) (bacterium having unique genetic characteristics is patentable subject matter under the general patent statute).
[22] Pub. L. No. 91-577, 84 Stat. 1542 (1970), 7 U.S.C. §§ 2321-2581. See generally 12 Harl, *Agricultural Law*, Ch. 110 (2003).
[23] Pub. L. No. 71-248, 46 Stat. 376 (1930); 35 U.S.C. §§ 161-164.
[24] J.E.M. Ag Supply v. Pioneer Hi-Bred International, Inc., 534 U.S. 124 (2001).
[25] See note 12 *supra*.
[26] See note 11 *supra*.
[27] See generally, Foster, Max, Peter Berry and John Hogan, "Market Access Issues for GM Products: Implications for Australia," ABARE Reprint, Department of Agriculture, Fisheries and Forestry—Australia, July, 2003.

rivers or mountains) limit sufficiently gene flow from pollen drift for crops for which that can be a problem.

Notification of production of unapproved crop

Another step that could be taken is for the regulating agencies to require the ultimate purchasers of seed that has not been approved for all uses and approved for export as well as domestic use, to advise in writing well in advance of planting all producers within at least one mile (or more) from every field planted to the limited registration crop. The requirement should also require the grower planting the limited registration crop to obtain the approval of all other growers within the specified distance to signify approval of the planting of the limited registration crop which could involve negotiated payments.

Testing at every point of commingling

A multi-track system of crop production, involving both GMO and non-GMO varieties, will likely produce acceptable results only if there is low cost, quick and reliable testing of the presence of GMO germ plasm at every point of commingling of the crop. This is clearly not possible at present and is likely to be unattainable in the near term although the development and implementation of testing protocols could be accelerated in the face of economic pressure brought on by loss of markets for crops.

Uniform certification

As an interim measure, a certification procedure, of the type developed in the autumn of 1999 by Iowa State University and the Office of the Iowa Attorney General would provide a helpful paper trail albeit with some shortcomings. The Iowa "Uniform Certification Procedure," involves a pre-delivery certification segment which requires a declaration of the particular varieties planted, where they were planted and the seed lot (for tracing any gene flow problems in the production of the seed); that reasonable care was utilized in planting, harvesting, handling and storage of the crop; and a disclaimer of implied warranties of merchantability and fitness. The post-delivery portion is completed upon delivery and associates the scale tickets (and any sample identification for samples obtained for later testing) with the pre-delivery portion of the certification. The obvious shortcomings are—(1) a stack of certifications does not assure that the crop is uncontaminated (particularly in light of misrepresentations in a market environment of significant premiums for non-GMO crops); and (2) once samples are tested, and the load has already been dumped into a bin based on the representations made, the potential exists for large-scale contamination.

USDA, in late August, 2002, indicated that the agency was considering setting up a voluntary certification program for corn and soybean exports. The program would be limited to certifying the process involved, not the purity of the crop.

A protocol in place before commercialization

The Grain Industry Group on Genetically Modified Wheat of the Canadian Wheat Board issued a report on February 5, 2003, entitled, "Conditions for the Introduction of Genetically

Modified Wheat." The full test of the report is included as Appendix C. As explained in the Executive Summary of the report—

> "…the Working Group endeavored to develop a definition of market acceptance. Rather than define a list of countries or a certain percentage of wheat markets that must be wiling to purchase GM or co-mingled GM and non-GM wheat, the condition developed by the Working Group is that there must be identified markets for the entire production of GM or co-mingled wheat for multiple years. In addition, anticipating that demand for non-GM what in many markets will continue for the foreseeable future, there must be the ability to meet requirements in non-GM wheat markets, including the establishment of achievable tolerance levels for GM wheat in non-GM wheat shipments.
>
> Consideration was given to a situation where it may not be possible to maintain all current non-GM markets. This would happen, for example, in markets where there are no established tolerance levels for GM wheat (i.e. zero tolerance). It is possible that in some cases the loss of some markets is more than compensated for by potential benefits, agronomic or otherwise. Because the loss of markets could be irreversible, this would have to be carefully evaluated by conducting a comprehensive cost-benefit analysis, outlined below.
>
> In order to maintain access to non-GM wheat markets, it is imperative that an effective segregation system be developed. It was envisioned that if GM wheat was introduced, part of the solution would be to introduce it through a closed-loop segregation system that attempts to ensure the entire production goes to identified GM wheat markets. This is only part of the solution, however, and the greater challenge would be segregating and monitoring conventional or non-GM wheat shipments from farmer to customer.
>
> Central to such a monitoring system is accurate, inexpensive and quick technology capable of detecting the presence of GM wheat at the primary elevator and beyond. It was envisioned that quantitative and qualitative technology would be required at different points in the wheat value chain.
>
> The development of the condition for segregation systems raised some very difficult issues requiring further discussion, such as the establishment of clear lines of accountability and liability through the appropriate mechanism. The conditions document also identifies that costs must be identified and shared appropriately among industry participants. However, rather than define who pays and through what mechanism, options for further considerations are outlined. It was pointed out that regardless of who pays at first, ultimately farmers pay all these costs. The question is then to which farmers the costs should be directed, those who adopt the technology or those who do not.

In 2003, wheat certification bills were introduced in Kansas, Montana, North Dakota and South Dakota requiring that, prior to the introduction of GMO wheat, a commercializing company must have received certification from the state department of agriculture stating that the product would not cause environmental or economic harm to the state. The Montana bill failed in committee and no action was taken on the South Dakota or Kansas bills. The North Dakota proposal was defeated on the floor of the state senate.

VII. Are Genetically Modified Crops Needed to "Feed the World?"

The statement is often heard that genetically modified crops are necessary to feed a burgeoning population. The data are clear that shortages in the supply of crops have rarely been

the problem in modern time and certainly not in recent decades. Moreover, the supply response to price incentives is substantial.

The problems of hunger and malnutrition are not related to the adequacy of food supplies but rather in the ability of low-income consumers to access food in a market-oriented system of food distribution. The three most important factors in solving the problems of hunger and malnutrition are income, income and income. Those genuinely concerned about the problems of adequate nutrition for the world's poor should be supportive of efforts at enhancing, as rapidly as possible, the pace of Third World economic development.

The major food producing countries are prepared to feed the world—at least so much of the world as can afford to be fed adequately.

In late August, the World Bank announced a new international consultative process on the risks and opportunities of using agricultural science "to reduce hunger and improve rural livelihoods in the developing world…." The initiative will focus on "a broad range of issues, such as organic agriculture, traditional plant breeding techniques, new farming technologies, and biotechnology."

VIII. Conclusions

Clearly, every group involved significantly in producing, handling, processing and distributing foodstuffs as well as the regulatory agencies with oversight responsibility need to be fully aware of the highly dynamic nature of the problems posed by the introduction of genetically modified hybrids. The problems of being able to mask the identities of some genetic features to avoid detection in testing adds to the concern and complicates the public policy response.

Moreover, every group with an interest in the operation of the food system should be aware that the outcome ultimately depends upon the three basic economic relationships outlined above.

Obviously, the prudent course would be to adopt some contingency plans with an eye to a less-than-best case scenario, at least in countries with heavy plantings of GMO crops.

APPENDICES

A. Proposed Uniform Certification Form (pre-delivery and post-delivery)

B. Proposed Purchaser Certification Form

C. Canadian Wheat Board Report

PROPOSED UNIFORM CERTIFICATION
(PRE-DELIVERY PORTION OF CERTIFICATION)

I, _____, residing at _____
(Name of Producer) (Address)

_____, have delivered _____ in the amount of _____ bushels.
(corn or soybeans)

The delivery(ies) are represented by scale ticket numbers and sample numbers which will be specifically identified after delivery is completed in the "Post-Delivery" portion of this Certification.

With regard to the above-referenced grain, by placing my initials in the corresponding blank, I hereby certify and affirm the following:

1. The above-referenced grain was grown from the following varieties of seed:

	Seed company	Variety No.	Lot	Where produced*
a.				
b.				
c.				
d.				
e.				;

_____ 2. I used ordinary care to clean my harvesting equipment prior to harvesting the above-referenced grain;

_____ 3. I used ordinary care to clean my on-farm storage facilities prior to placing the above-referenced grain in said facilities;

_____ 4. I used ordinary care to clean the transportation delivery vehicles prior to using said vehicles to deliver the above-referenced grain; and

_____ 5. (Other) _____
_____
_____

No other warranties, express or implied, including implied warranties of fitness and implied warranties of merchantability, are made as to the commodity in question with respect to the commodity's nature, genetic composition, fitness for a particular purpose or use or otherwise.

_____ _____
Name Date

_____
Address

_____ _____
Telephone No.

* Legal description or informal field designation

Source: Office of the Iowa Attorney General and Iowa State University.

(POST DELIVERY PORTION OF CERTIFICATION)

The delivery(ies) made pursuant to this Certification are evidenced by scale ticket number(s) _____, and sample number(s) _____.

_____ _____
Name Date

_____
Address

_____ _____
Telephone No.

PROPOSED PURCHASER CERTIFICATION STATEMENT

I hereby certify and affirm that the lot of _____ which is the subject
(corn, soybeans)
of this statement, described as containing approximately _____ bushels and sold this _____ day of _____, 1999, was harvested from seed represented by the seed supplier as non-genetically modified, and that the commodity in question was not the product of seed represented by the seed supplier as genetically modified. The undersigned has on file certifications of producers indicating the variety planted in each case and certifying that ordinary care was used in harvesting, handling, drying and storing the commodity in question to avoid contamination with genetically modified varieties. The undersigned further certifies that reasonable care was used in receiving, handling, storing and shipping the commodity in question.

No other warranties, express or implied, including implied warranties of fitness and implied warranties of merchantability, are made as to the commodity in question with respect to the commodity's nature, genetic composition, fitness for a particular purpose or use or otherwise.

_____
Purchaser

_____
Address

_____
Date