KNOWING WHERE IT'S GOING

BRINGING FOOD TO MARKET IN THE AGE OF GENETICALLY MODIFIED CROPS.

PROCEEDINGS FROM A WORKSHOP SPONSORED BY PEW INITIATIVE ON FOOD AND BIOTECHNOLOGY AND ECONOMIC RESEARCH SERVICE OF THE U.S. DEPARTMENT OF AGRICULTURE

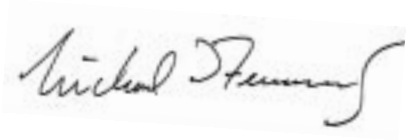
ERS

INTRODUCTION

The application of biotechnology to agriculture presents significant opportunities and challenges to all players in the production, marketing and distribution chain. The creation of new products with additional, highly specific genetic traits could lead to market opportunities for growers, processors and food manufacturers. But concerns about the potential negative impacts of bioengineering, both in the U.S. and abroad, have ignited demand for products produced *without* the use of biotechnology. So, the promise of new markets and new opportunities may be realized only if the identity of new crop varieties can be preserved as they move through the food production system.

Given this scenario, the Pew Initiative on Food and Biotechnology and the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) convened a recent conference with representatives from all parts of the food production and delivery system. The aim of *Knowing Where It's Going* was to identify opportunities and challenges associated with marketing agricultural biotechnology foods, to address some of the costs and benefits associated with these products, and to clarify areas where further research is needed.

Many of the thoughts and concerns articulated by those who participated are captured here in hopes of illuminating the challenges—and possible solutions—posed when food comes to market in the age of genetically modified crops.



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EXECUTIVE SUMMARY

The Pew Initiative on Food and Biotechnology and the Economic Research Service of the U.S. Department of Agriculture held a September workshop in downtown Minneapolis for more than 100 leading agricultural economists, technology providers, grain handlers, food manufacturers, consumer advocates and others. Speakers addressed the profound changes underway within the U.S. food system, identifying several important trends thought to be contributing to these changes, including the rapid development of biotechnology, which is creating the potential for many more specialized traits and products. Consumer demand is also affecting the food system. On the one hand, consumers are demanding more variety and choice in foods; on the other, at least some of them are also concerned about the use of genetically modified (GM) foods.

Together, these trends are leading to an increased interest throughout the food web in what have come to be known as identity preservation (IP) systems. IP systems keep crops with special traits (whether or not they are the result of genetic modification) separate from the bulk of undifferentiated grains in the food chain. Kosher and organic foods, for example, are made possible through identity preservation. The workshop explored the implications of these trends and possible responses of the food industry and bulk commodity system to them.

To understand the potential magnitude of the changes ahead, keynote speaker Susan Harlander, a well-known food consultant, began by describing the scale of the U.S. agricultural system. For example, in 2000, corn grown on almost 80 million acres had a market value of nearly $18 billion. In 1999, soybeans grown on 70 million acres were worth over $12 billion. Harlander pointed to a recent article in the *Minnesota Star Tribune* that said corn or soy ingredients can now be found in 70 to 85 percent of all processed foods, from chewing gum to baby foods.

The challenge of preserving a food product's identity is further complicated by the many times that ingredients and products change hands between the seed supplier and the food manufacturer. For example, a medium-sized food company has more than 1,000 suppliers of over 8,000 ingredients that go through more than 30 processing plants and end up in some 6,000 different finished products.

> "We have before us a tremendous challenge that we must respond to in a manner that enhances the value of our food products, increases customers' confidence in those products and allows a profit to be earned by those in the production system."
>
> —Marlyn Jorgensen, Jorg-Anna Farms

"This makes the food marketing system more of a web than a chain," Harlander said.

Acknowledging the complexity of the system and the profound changes taking place within it, workshop participants agreed on the need for several broad efforts:

<1> Better communication among all participants in the food web, leading to improved integration of knowledge;

<2> A more proactive approach in determining workable tolerance levels for accidental genetic modifications in non-GM food;

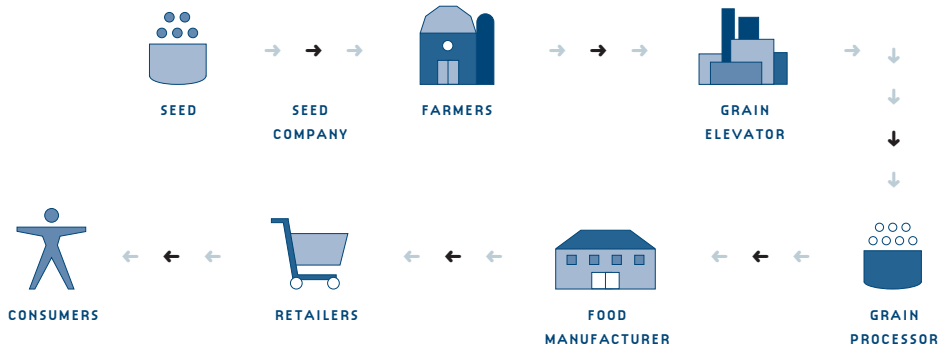
<3> An agreement among the national and global food industry regarding common processes and testing standards to confirm the presence or absence of GM traits.

How strongly do consumers care about this issue? Will they be willing to pay the costs of IP systems, which will likely cause higher food prices? Ultimately, many at the conference agreed, consumers' willingness to pay higher prices will play a major role in shaping the market.

Some participants perceived a strong consumer acceptance of genetically modified foods; others saw the opposite. Yet all agreed that consumer trust is fundamental to the operation of the U.S. food system and the maintenance of this trust is essential as the market evolves.

Food Marketing System

Grain changes hands many times between the seed supplier and the food manufacturer



Food Marketing System — adapted from a slide prepared by Sue Harlander, BIOrational Consultants, Inc.

WORKSHOP AGENDA

Keynote:

From Seed to Sandwich: Tracing the Complex Path That Our Food Travels

Susan Harlander, president, BIOrational Consultants, Inc.

PANEL 1: SEPARATION ANXIETY

What we know about keeping food products separate in the marketing chain

> > Jean Kinsey, Department of Applied Economics, University of Minnesota

> > Denis Ring, Whole Foods Market

> > Ron Olson, General Mills Grain Division

> > Marlyn Jorgensen, Jorg-Anna Farms and Iowa Soy Specialties

PANEL 2: COSTS AND BENEFITS

The obvious, and not-so-obvious, costs and benefits of preserving the identity of bulk commodities through marketing channels

> > Nicholas Kalaitzandonakes, Department of Economics, University of Missouri

> > Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University

> > Ruth Kimmelshue, North American Grain and Oilseeds, Cargill

PANEL 3: HOW CAN WE BE SURE?

How public and private systems could operate to certify and verify that product identity has been preserved

> > Elise Golan, Economic Research Service, USDA

> > David Shipman, Grain Inspection, Packers and Stockyards Administration, USDA

> > Mark Condon, American Seed Trade Association

> > Lisa Leier-McHugh, Strategic Diagnostics

PANEL 4: CHOICES AND CHALLENGES OF IDENTITY PRESERVATION: UPSTREAM AND DOWNSTREAM

Ramifications for producers and consumers

> > Jim Houser, DuPont Specialty Grains

> > Ed Korwek, Hogan & Hartson

> > Allen Rosenfeld, M & R Strategic Services

PANEL 1:

SEPARATION ANXIETY: WHAT WE KNOW ABOUT KEEPING FOOD PRODUCTS SEPARATE IN THE MARKETING CHAIN

Systems to preserve the identity of specialized products in the food marketing chain are not new. For example, organic and kosher foods are already marketed through such IP systems. Specialized varieties of grain, such as high-oil corn or high-quality soybeans for tofu, are also kept separate from bulk corn and soy commodities throughout the food chain. Identity preservation is also used to segregate varieties that differ in ways affecting the taste and texture of food products. "You can change the sponginess of a cake by about 20 percent just by switching varieties of wheat," noted Ron Olson, vice president of grain operations for General Mills, in his presentation.

Keeping varieties separate from seed to table allows food manufacturers to capitalize on such differences. "Identity preservation is about creating value," Olson added.

As science identifies the genes for a range of traits, the food industry anticipates breeding and genetically engineering ever more specialized varieties. "This is transforming the food supply chain into a consumer demand chain," said Jean Kinsey, an economist at the University of Minnesota.

Right now, the industry is learning how to apply the lessons gained from relatively small-scale IP systems. More and larger-scale IP systems will be needed to capture the added value of new varieties and may also be necessary to separate genetically modified foods from non-GM varieties.

> "Identity preservation is about creating value."
>
> —Ron Olson, General Mills

> In the past, as a producer I took the grain to the elevator and had no idea about the end consumer. Now producers are being forced to look at the marketing system.
>
> —Marlyn Jorgensen, Jorg-Anna Farms

IP FOR WHEAT

In this context, Olson described changes taking place within General Mills. The company buys huge quantities of raw grain—wheat and oats—to manufacture its many products. In the past, General Mills purchased only bulk commodities. Today, he said, it is increasingly contracting for select varieties to be used in specific products.

“Our use of IP has grown from nothing three years ago to a fairly good size today. Within three to five years, half our total grain usage will be identity preserved,” he said.

But accomplishing this goal will require much stronger integration throughout the entire food chain, especially at the front end. “Quality starts with the seed,” Olson said. General Mills is transforming its relationships with seed breeders and farmers, he added, taking additional steps to clarify the grain characteristics they want and need. “We've become much more open in discussing what characteristics perform best for us,” he said. As a result, last year General Mills worked with breeders to test some 2,000 varieties of wheat and oats.

Because there are no genetically modified varieties of wheat or oats yet on the market, Olson said General Mills has been able to concentrate on learning how to use IP systems with traditionally bred specialty traits “without having to fight the regulatory issues” that present added challenges when genetically modified crops are used. This use of traditional crops has allowed the company to learn about costs, capabilities, responsibilities, testing and tolerances, and “how you get to mutual solutions” that work for growers and food companies. One big lesson learned has been the need to understand and share information across system participants, from seed producer to farmer to food manufacturer, so that every player understands the benefits of a particular specialty crop.

GREATER INTEGRATION

Others in the food marketing system have also found that the new environment calls for greater integration of the food chain. Jim Houser, director of Dupont's Pioneer Quality Crop Systems, said his company is trying to transition from viewing only farmers as its customers to seeing grain processors in the same light.

Marlyn Jorgensen, a farmer and the founder of Jorg-Anna Farms, described his changing perspective: "In the past, as a producer I took the grain to the elevator and had no idea about the end consumer. Now producers are being forced to look at the marketing system."

Doing so can open new opportunities for farmers. For instance, Jorgensen noted that three fast food companies are now demanding audits for the way hogs are handled in confinement and slaughtered. This will require an IP system, and can open a new added-value market for farmers.

While General Mills has been developing IP systems in a politically neutral environment, Whole Foods Market, a chain of 130 retail stores focusing on natural and organic sales, has decided to preserve the consumer's right to chose non-GM foods. While the chain does sell products with GM ingredients, it decided to hold its own house brands to a "higher standard," said Denis Ring, a partner at Whole Foods who oversees the company's line of house brand products, called "365".

When Whole Foods decided to offer a house brand that did not contain GM ingredients, the company began with a complete review of its "365" products. "Anything that had corn syrup as a sweetening agent was suspect," Ring said, because GM corn can so easily mingle with non-GM corn. So were products that used soy, canola or grains that may have been genetically modified. Even sugar ingredients were scrutinized, since some beet sugar has been genetically modified. To meet this higher standard, Whole Foods had to find new non-GM ingredient sources, reformulate products and even drop product lines.

Although the reformulations cost money and time, Ring said it has been worth it. "Whole Foods looks at this as a product integrity issue. We've had very substantial and clear customer feedback expressing their support for foods not from GM seed stock."

Whether companies are creating IP systems for specialized grain or developing integrated chains to supply non-GM products, the food system is adapting to new realities in the market. Said Jorgensen, "We have before us a tremendous challenge that we must respond to in a manner that enhances the value of our food products, increases customers' confidence in those products and allows a profit to be earned by those in the production system."

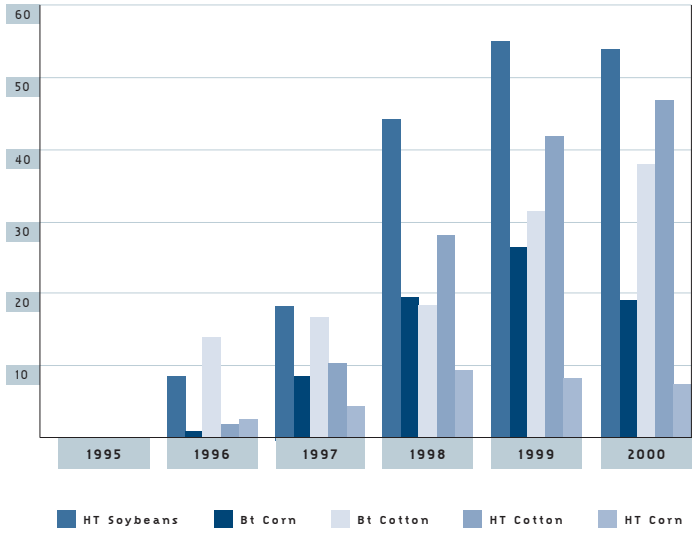
> "In some parts of the world, consumer trust in the food system has broken down. And maybe that is a good enough reason to proceed with identity preservation, apart from the market incentive to do so."
>
> —Prof. Jean Kinsey, University of Minnesota

Adoption of Genetically Modified Crops

Biotech Crops Planted from 1996-2001

United States, 1995-2000 (percent of acres)

Source: Data from ERS/NASS surveys.



Adoption of GM Crops — adapted from data provided by ERS/NASS surveys

What is Identity Preservation (IP)?

The ability to keep different varieties of the same product separate, from seed or field to final package, is known as identity preservation (IP). In contrast, most grains enter bulk commodity channels, where crops from dozens of farms can be mixed many times over and traded at one price, based on common characteristics. Although IP now affects only a small fraction of all grains, its share is growing.

"Identity preservation begins with the seed itself," said Lisa Leier-McHugh, a business development manager at Strategic Diagnostics, a company that produces kits used to test for the presence of GM crops. "Then there is monitoring through growing, accountability during harvest, testing upon receipt and distribution of the product."

IP at the farming level requires tackling challenges such as determining what to do with seed left over from the previous year's planting or grain that penetrates farm equipment, or how to deal with wind-blown pollen from nearby fields. Following harvest, crops produced through IP systems would need separate storage pits and grain elevators. Processing of grains—their cleaning, grinding, crushing and transportation—would also need distinct handling and equipment to ensure identities are preserved.

According to Prof. Jean Kinsey at the University of Minnesota, companies have historically implemented IP systems for several reasons: To capture higher profits; to fill a consumer demand for a product with special characteristics; to build brand loyalty, or to generally inform, protect and build trust.

In the case of IP systems that would preserve the identity of non-GM foods, the goal would be both to allow consumer choice, and to protect companies from liability and integrity issues, Prof. Kinsey said.

> > > PANEL 2:

TRADE OFFS. COSTS AND BENEFITS

Costs and benefits of IP systems could be considerable, depending both on one's position in the food web, and on how the market develops.

As long as IP remains a residual market, costs will be manageable. According to Nicholas Kalaitzandonakes, an economist at the University of Missouri, those costs now range from .5 to 5 percent of the total value of a product (see table). In addition, as long as change remains primarily market driven, experts say that only those processes and products for which consumers are willing to pay will be adopted. On the other hand, "Sudden regulation can place a large stress on the system," said Kalaitzandonakes.

COSTS

The highest costs could result from regulation imposed through export requirements or other governmental action. The European Commission's traceability proposal (July 2001) requires the ability to trace all ingredients from their origin to final products. Its purpose is to ensure the absence of GM material from non-GM goods, within certain tolerance levels.

In general, the lower the tolerance, the higher the anticipated cost: a 5 percent tolerance is far more manageable than 1 percent. Below 1 percent, costs would increase exponentially, according to Kalaitzandonakes. Zero tolerance would not only be prohibitively expensive, but also physically impossible, given problems such as the drift of pollen from GM fields to non-GM fields.

Obvious IP costs would derive from such things as the need for separate grain handling infrastructure, more rigorous processes (such as cleaning of machinery), and more frequent and stringent testing.

> "The food supply chain can easily adapt to anything, as long as consumer demand is substantial enough to cover the costs of adaptation."
>
> —Ruth Kimmelshue, Cargill

> Zero tolerance is no longer attainable once a specific 'transgenie' is out of the bottle.
>
> —Prof. Dirk Maier, Purdue University

Hidden costs also lurk. For example, Kalaitzandonakes pointed to possible costs in underutilization of grain elevator storage capacity caused by the need to accommodate separate IP crops. Another potential cost might be the need to meet specific delivery dates set by IP contracts, which would mean relinquishing the option to hold grain until it can sell at a better price.

When producers convert from a standard commodity market to an identity-preserved market based on genetically engineered traits, they must consider multiple risks. According to Dirk Maier, an agricultural engineer at Purdue University, these include purity and agronomic performance, as well as hazards at the grain handling and marketing levels. Farm management issues, such as crop insurance and dispute resolution, raise yet additional risks.

"A large-scale shift toward specialized grain markets will affect nearly all phases of grain production and distribution," Maier said.

The Possible Costs of IP Systems

CROP	IP APPROACH	COUNTRY	YEAR	IP COST £/t	% OF PRICE *)	
Soybean	GM quality traits: low linolenic, high oleic, low saturate, high protein, high sucrose	USA	(1997)	1.6 – 3.3 £/t	0.6 – 1.3%	(1)
Soybean	Non-GM; STS herbicide tolerant	USA	1998	6 £/t		(2)
Soybean	Non-GM (ERS estimation)	USA	2000	20.6 £/t **)		(7)
Corn/Maize	Quality trait (convent.) waxy maize	Europe	(1997)	3.2 – 8.0 £/t	2 – 5%	(1)
Corn/Maize	Quality trait (convent.) high oil content	USA	1997	1.0 – 1.8 £/t	1.0 – 1.7%	(1)
Corn/Maize	Quality trait (convent.) high oil content	USA	1998	2.1 £/t		(2)
Corn/Maize	Non-GM (ERS estimation)	USA	2000	9 £/t **)		(7)
Oilseed rape	GM traceability; herbicide resistance	Canada	1996	4.7 – 6.9 £/t	2.8 – 4.1%	(1)
Sun-flower	Quality trait high oleic	USA	1997/1998	1.6 – 3.3 £/t	0.6 – 1.3%	(1)

*) farmgate price **) marketing cost from country elevator to export elevator, incl testing

Sources: (1) Buckwell et al. 1998; (2) Bender et al. 1999; (7) Lin 2000

The Possible Costs of IP Systems — adapted from a slide prepared by Dr. Nicholas Kalaitzandonakes, University of Missouri

Future Visions: The Evolving Food Infrastructure

Many analysts predict that IP systems will cause a fundamental shift in the overall food network, transforming it from a bulk commodity system with a few niche areas to an arrangement with multiple niches, including biotechnology. Beyond this basic vision, however, ideas diverge on how, and how quickly, such changes will take place. A range of views was expressed at the workshop:

"I do not see the niche market comprising more than 10 percent in the next five years. The majority of corn and soy produced today is for the feed market, and feed markets are not very amenable to high margins."
—Nicholas Kalaitzandonakes, University of Missouri

"In terms of the export market we see approximately three percent being in some form or fashion identity preservation. I see that increasing...to as much as 30 percent."
—Ruth Kimmelshue, Cargill

"Our IP has grown from nothing three years ago to a fairly good size today. Within three to five years, half our total grain usage will be identity preserved."
—Ron Olson, General Mills

"I don't see a replacement of our infrastructure. What we do observe is that as people make improvements to their facilities both on the farm and at the grain handling level, they are considering how to respond to the need for segregation. What size bins, how many, things like that."
—Dirk Maier, Purdue University

"The timing is uncertain. The certainty is in the fact that it will happen. This transformation of the commodity market into a variety of different segregated markets will occur."
—Ruth Kimmelshue, Cargill

> Market analysts have been predicting growth of specialty markets, but few foresaw that the avoidance of transgenic characteristics, as opposed to the promotion of the special properties, would be the initial driving force.
>
> —Prof. Dirk Maier, Purdue University

BENEFITS

Substantial benefits also lay ahead, for both producers and companies in a position to capture added value through specialty traits. “Technology is allowing industry to offer, and consumers to demand, ever increasing value-added qualities without relaxing expectations of quality and performance,” said Ruth Kimmelshue, team leader for livestock solutions at Cargill, an international marketer, processor and distributor of agriculture and food products. It is through this differentiation that U.S. agribusiness will be able to maintain its competitive advantage in the marketplace.”

Cargill has developed its own IP systems, which Kimmelshue said proved their value during the crisis in the year 2000 over StarLink corn. (StarLink corn is genetically engineered to produce is own pesticide, but not approved for human consumption. The corn found its way into the human food supply, forcing the recall of some 300 food products and costing the industry millions of dollars in lost profits). Cargill's InnovaSure program, an IP system for corn dry milling at Illinois Cereal Mills, was able to provide StarLink-free corn products to customers like Kellogg's, General Mills and Frito-Lay. InnovaSure works with 400 growers in Illinois and Indiana, contracting for specific varieties of corn that are handled to meet customers' specifications for corn grits and flour used in the manufacture of tortillas and snack foods.

Marlyn Jorgensen, who helped found Iowa Soy Specialties, an IP company that produces both GM and non-GM soybeans, also focused on the positives of IP. Jorgensen noted that the non-GM soy produced by Iowa Soy Specialties found a steady and premium market in Japan, consistently meeting a 5 percent tolerance threshold. “If we can look at this as an opportunity rather than as an obstacle, I think that we will all be better off,” Jorgensen said.

> The GMO issue has really provided the impetus for us to remake our entire marketing system. This is the silver lining in the GMO cloud.
>
> —Marlyn Jorgensen, Jorg-Anna Farms

HOW CAN WE BE SURE?

How can we be sure that IP systems are working? Most IP systems to date have been based on process verification: the idea that a well-conceived process, regulated and documented, will reliably accomplish its goals with minimal product testing for verification.

Continued reliance on process verification is even more important given the emerging complexities of testing. While it is relatively easy to test grain for the presence of a single, desired trait, it is more difficult to assure the absence of any genetically modified trait. Furthermore, as more GM products enter the market, it will become more challenging and expensive to test for the absence of genetic modification.

PROCESS VERIFICATION AND TESTING

The seed industry provides a good example of process verification. Breeders produce commercial seed to meet a 98 percent to 99 percent purity level. Farmers can therefore reliably buy seed of a particular grain variety knowing that, at the very most, only 2 percent of the seed may be a different, unknown variety.

The seed industry spent decades refining the processes that assure such high levels of purity. To meet purity certification standards, growers must conform to set isolation distances of their fields and established inspection techniques. Some growers have even moved their production offshore to attain the best possible isolation and fields with the cleanest history, said Mark Condon, vice president of international marketing at the American Seed Trade Association.

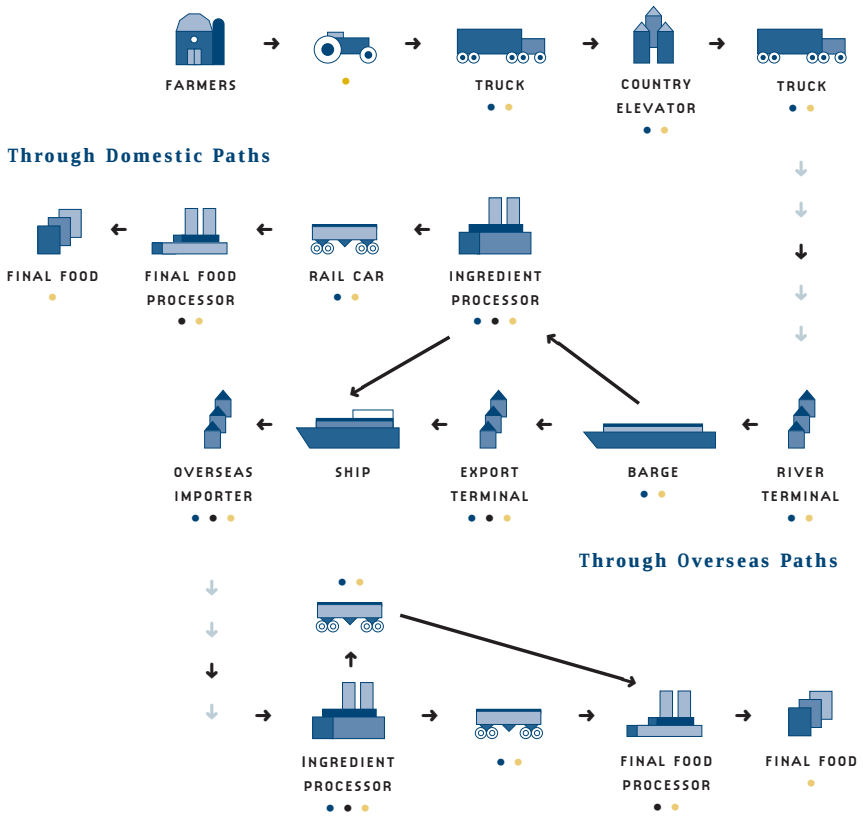
But Condon said the seed industry, like others in the food chain, must increasingly rely on testing, as pressure mounts to verify higher levels of genetic purity. “It's not the way we want to go,” he said.

The most rigorous IP systems have multiple testing points. “Any place you could have contamination, movement or transfer points, you have to test or you have to track,” said Lisa Leier-McHugh of Strategic Diagnostics. Companies can choose from a variety of different testing and tracking methods (see illustration). “The intensity with which you sample and inspect is directly proportional to the premium that will be paid for the product,” said Leier-McHugh.

> “We can only be sure of a system if we have buy-in from all the players that are involved as to why and how traceability should and can be achieved.”
>
> —Lisa Leier-McHugh, Strategic Diagnostics

IP Pathways & Movement

Verifying Source and Purity from Farmer to Final Food



IP Tools Key

- Postmark
- Trait
- GMO
- mPOWER³/Crop Verify

IP Pathways and Movement — adapted from a slide prepared by Lisa Leier-McHugh, Strategic Diagnostics

IP systems and their verification can be voluntary or mandatory, with varying roles for the government, private companies and third parties. For example, kosher certification is done entirely through private companies. Organic certification is done through a mixture of federal, state and private entities.

The U.S. Department of Agriculture (USDA) recently sought public comment on how it could continue to best foster the marketing of agricultural goods, in light of changes in the evolving marketplace. According to David Shipman, a deputy USDA administrator, the department received some 3,000 comments reflecting a broad consensus for USDA to help standardize testing methodology and foster the development of quality assurance processes—steps that would enhance the integrity of the system.

Many experts see an increased role for third parties. For instance, third-party certifiers could review quality standards and evaluate testing or IP records to ensure that standards have been met. “Third party enforcement can include watchdog services, decertification or legal action,” said Elise Golan, an economist with the USDA's Economic Research Service.

Regardless of the public/private combination, successful IP systems need to be sensitive to consumer preferences as well as technological advances. In the end, “The value of the service depends on the credibility of the provider,” Golan said.

IP Testing Methods Available

IMMUNOASSAY STRIP TEST	ELISA IMMUNOASSAY MICRO TITER PLATE
>> Robust, reliable and low cost	>> 2 - 4 hour test
>> Perform analysis in the field rapis, result	>> Laboratory or field based
>> Cost around $3.00 per sample	>> Cost around $2.50 - $4.00 per sample
>> Qualitative	>> Quantitative test
>> PCR (polymerase chain reaction)	>> Cost $125.00 - $300.00 test
>> Can achieve low levels of detection	>> Minimum TAT 3 days
>> Laboratory based method	>> Qualitative methods, good second method
>> Higher degree of training required	lab-based confirmation of field programs

IP Testing Methods Available — adapted from a slide prepared by Lisa Leier-McHugh, Strategic Diagnostics

> "Perception is as big as science in the marketing world."
>
> —Ron Olson, General Mills

Consumer Trends

Susan Harlander posed this question: "Does labeling really matter to consumers and are they willing to absorb the cost of an IP system for commodity-based ingredients?" The question is critical to the planning of producers and manufacturers.

The market for organic foods may point toward one answer; it increased 20 percent a year in the 1990s. Some experts view this as an indication of increased consumer interest in food origins and production. However, a complex picture evolved of consumer views and their interpretation.

- A comparison of two consumer research polls conducted by the Pew Initiative on Food and Biotechnology in January 2001 and June 2001 suggests that consumer awareness of GM crops may be increasing. Fifty-five percent of respondents polled in June 2001 reported they had heard a "great deal" or "some" about genetically modified foods sold in grocery stores. This was an increase of 11 percent from the January 2001 poll.

- In the January 2001 Pew poll, 75 percent of consumers said it was "important," "somewhat important" or "very important" for them to know whether a product contains genetically modified agricultural products.

- Prof. Jean Kinsey noted that consumer opinion differs based on how questions are framed. For example, when consumers were asked if it is a good idea to use biotechnology in the food system, 70 percent said yes. When asked if it is a good idea to genetically modify foods, 56 percent said no.

> > > PANEL 4:

CHOICES AND CHALLENGES OF IP

Life science companies are identifying strategies to develop applications of biotechnology. At the same time, biotechnology and the challenge of identity preservation raise complex legal and liability issues, as well as fundamental questions about what consumers want.

Dupont and its company, Pioneer Hi-Bred, develop and market seed for value-enhanced grains to produce differentiated feed, food and industrial products. Jim Houser, with Pioneer Quality Crop Systems, described his company's approach to biotechnology product development.

The company views biotechnology products as falling into three main categories:

> > *Products with agronomic (input) traits that improve yield or reduce growers' production costs*. An example of this kind of product is corn seed that has incorporated insect resistance traits, so farmers can use less insecticide. The company has several products like this currently on the market.

> > *Products with output traits that improve the grain's function to a processor or feeder*. An example is corn with less phytate than traditional corn that, when fed to pigs, produces waste less toxic to the environment than waste from pigs fed a diet of traditional corn. The company is just beginning to enter the market with these kinds of products.

> > *Products with consumer (output) traits that confer direct consumer benefit*. An example would be tomatoes that are enriched with lycopene, a nutrient thought to reduce the likelihood of developing some forms of cancer. The company is at least five years away from producing these kinds of products.

Houser said the most important advances in the next ten years for Dupont will be in the processor/feeder output category. This would include new traits that benefit different industrial processes, such as increased efficiency of starch extraction from corn kernels. Since traits that directly benefit consumers are farther away, he cautioned against relying on such products as the "silver bullet" that will win consumer acceptance of GM foods.

> "For IP to expand nationwide it will have to be demanded by the large manufacturers and retailers. If it is viewed as a way to build trust in the food system in general, it will receive widespread support."
>
> —Ruth Kimmelshue, Cargill

> The only thing you can do is have adequate liability insurance,
>
> —Ed Korwek, a lawyer with Hogan & Hartson

He said the company is moving toward segregation and identity preservation for complex reasons. “It is not simply driven by GM/non-GM, but is part of an ongoing drive for efficiency, testing and brand protection,” he said.

LIABILITY

Issues of liability constitute an important and changing arena in the biotechnology-driven market. How IP verification systems are designed and implemented may affect the allocation of liability, which will be segmented across the entire food chain, according to Ed Korwek, a partner at the law firm Hogan & Hartson.

“The business paradigm for liability is one of shifting it across the chain to the deep pocket” he said. “From technology provider to seed developer, to farmer, to grain producer, grain handler, to food company—that's the chain, and there are a lot of potential deep pockets.” Korwek said companies cannot prevent liability lawsuits. “The only thing you can do is have adequate liability insurance,” he said.

Basic legal principles can be brought to bear in any one of a number of possible scenarios involving food biotechnology and IP systems. Tort law, contract law and state commercial transaction law can all come into play. Possible damage claims could include those for failure to warn or for negligence. “Creative lawyers will get very creative on the damages,” Korwek warned.

Failure of IP systems at any stage could cause a co-mingling of products in the food supply. This could result in product mislabeling, thus also exposing food companies to lawsuits. A failure to successfully segregate GM products could also open IP providers and testing services to liability, as well as risking the loss of consumer confidence.

CONSUMER CHOICE

Although many consumers may ultimately benefit from bio-engineered traits that increase nutrition or bolster health, the delivery of such products is many years away. Until then, the debate about consumer choice continues.

Allen Rosenfeld, a senior vice president and economist with M&R Strategic Services in Washington, DC, said consumer choice is impeded by the growth of GM crops. “The widespread genetic modification of the food supply represents a reduction in food quality,” he said, because IP systems are the only way that consumers who want to avoid GM crops can do so. Under the current system, he said, the cost of segregating GM and non-GM foods is absorbed by the few consumers who want non-GM food. This raises several questions, among them: Do the costs of non-GM foods exceed the benefits? Who should pay these costs?

According to one Arizona State University study, the vast majority of consumers who buy GM products will have a minimal price savings (about 1 percent) because GM crops cost less to produce. Other studies have also shown that a significant portion of consumers are willing to pay a premium for non-GM foods, and a smaller portion will pay even more for organic foods that are most reliably non-GM. When the costs paid by these select members of the consuming public are compared to the savings experienced by all consumers, Rosenfeld concludes that the costs are greater than the benefits. “Despite slight reduction in retail food prices driven by genetic modifications, consumer costs would greatly outweigh consumer benefits,” he said.

Since the costs of GM penetration are borne by GM-averse consumers, choices of IP systems have equity implications. This leads to still more questions, such as: To what extent can the GM food supply internalize the costs of IP? And, to the degree that it cannot, how can IP systems costs be minimized?

Rosenfeld pointed to the nation's organic foods certification programs, which ensure the credibility of food production and marketing *processes*, rather than guarantee an absence of inadvertent contaminants. The application of such “process” models provides an excellent opportunity to minimize IP system cost.

> “Events happening far, far away are affecting us very much. And that is true with everything we do with food as well.”
>
> —Nicholas Kalaitzandonakes, University of Missouri

Trait Catagory Analysis

	ABILITY TO DEFINE VALUE	BUSINESS SYSTEMS	TOTAL PRODUCT DEVELOPMENT COMPLEXITY	TIMEFRAME	SEGREGATION STRATEGIES	TOTAL DEVELOPMENT COSTS	CONSUMER ECONOMICS
Agronomic (input)	well-defined	established	LESS	current	production/ market segmentation	$	indirect
Processor/Feeder (output)	under development	conventional-established biotechnology-exploratory	MORE	near-term 3-5	'contract' based partnerships	$$	
Consumer Markets (output)	exploratory	conventional-established biotechnology-exploratory	MOST	long-term 5+	integrated food systems	$$$	direct

Trait Catagory Analysis — adapted from a slide prepared by Jim Houser, DuPont Specialty Grains

WHAT WE KNOW AND DON'T KNOW

The workshop confirmed that a wide range of issues essential to the policy-making process warrant further research. In fact, many of these research topics target *what we don't know* and flow directly from *what we do know* about marketing GM crops.

WHAT WE DO KNOW

Consumers' willingness to pay will help determine how deeply IP systems will penetrate commodity and food markets, as well as how fast the infrastructure will adapt to such change.

Very little is known about consumer preferences with respect to genetically engineered food. Opinion surveys (the most popular consumer research tool used to date) cannot predict market behavior.

WHAT WE DON'T KNOW

Research question(s): What are consumers willing to pay for IP under various conditions?

WHAT WE DO KNOW

For IP to work well, there must be excellent communication among all participants in the food web: seed firms need to be in touch with end consumers; food processors have to talk to farmers and ranchers, etc.

Although it is suspected, it is not known if stronger vertical and horizontal communication chains and IP processes will lead to further integration, consolidation and concentration of agricultural and food systems.

WHAT WE DON'T KNOW

Research question(s): What are the structural implications of increasing market differentiation through genetic engineering?

WHAT WE DO KNOW

Over time, the farm value portion of final prices for food products has shrunk as more and more of the cost of food comes from processing, packaging, transportation and marketing.

It is not known how the costs and benefits of IP are distributed among those who produce seed, commodities, food products and food services.

WHAT WE DON'T KNOW

Research question(s): What new institutional arrangements would facilitate the sharing of opportunities and benefits?

WHAT WE DO KNOW

A range of forces, genetic engineering being only one, is encouraging the food system to shift its focus *from* commodities *to* products, leading to the evolution of more highly differentiated markets.

It is unclear when a bulk commodity grain market with a few niches shifts to a series of highly differentiated markets that share little in common besides basic biology.

WHAT WE DON'T KNOW

Research question(s): What trigger signals the transition from a single market to a web of specialty markets?

WHAT WE DO KNOW

Identity preservation, whether for genetic trait avoidance, preservation or other differentiation purposes, will be costly.

It is unknown exactly how costly IP will be.

WHAT WE DON'T KNOW

Research question(s): What are the specific direct and indirect costs of switching from bulk to IP handling, and how will costs vary according to regulatory dictates and market conditions?

WHAT WE DO KNOW

Players in the private sector are actively involved in developing, selling and conducting diagnostic tests to detect the absence or presence of genetically engineered materials, as well as other traits.

The diagnostic industry establishes neither the standards that its tests gauge and the expected levels of testing validation, nor any food industry standard sampling protocols for the use of the tests. It has not yet been determined who should take responsibility for these criteria.

WHAT WE DON'T KNOW

Research question(s): How are the roles of the public and private sectors best allocated in this arena? What are the economics of sampling for the absence or presence of GM material?

WHAT WE DO KNOW

The vast majority of IP now in use is contracted, either directly between entrepreneurial farmers and niche marketers, or between processing firms and farmers or their intermediaries.

As contracting for IP and market differentiation by genetic and other traits becomes the rule rather than the exception in grain markets, it is unknown if the meaning of “spot” and “futures” prices for formerly bulk products will come into question.

WHAT WE DON’T KNOW

Research question(s): How is price discovery likely to occur in the absence of standard markets?

WHAT WE DO KNOW

Some minority of American consumers has a preference for non-GM food products.

It is not known if the absence of labeling (e.g. providing these consumers the basis for choice between GM and non-GM products) does, or does not, constitute a market failure.

WHAT WE DON’T KNOW

Research question(s): Despite the fact that the number of consumers who want labeling is probably too few to cover the costs associated with labeling, what are the market implications of not labeling food products?

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