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The Changing Face of the U.S. Grain System

Differentiation and Identity Preservation Trends

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The Changing Face of the U.S. Grain System

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Abstract

This report examines current trends in the U.S. grain industry. Many identity preservation (IP) grain systems have emerged recently, driven by a confluence of supply and demand factors. IP grain requirements for specific production protocols, marketing channels, and quality assurance depend on whether the crops are trait-specific, non-GM (genetically modified), organic, or pharmaceutical. Cost structures vary according to the relative importance of segregation and risk management. High information management, greater market coordination, and frequent reliance on contracts characterize IP grains. IP grain markets are also inherently riskier, with volatile supply, inelastic demand, and fluctuating price premiums. Increasing grain differentiation is altering the marketing structure of the U.S. grain industry and creating possible roles for government policy, particularly in market facilitation, standard setting, and regulations affecting food safety and biosecurity.

Keywords: Identity preservation, production differentiation, specialty grain, segregation cost, traceability, quality assurance, grain attributes, risk management, information management

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Summary

The U.S. grain system is increasingly marked by product differentiation and market segmentation. More specialty crops now require either some form of segregation or full-scale identity preservation to keep them separate from conventional commodities. Market segmentation within the grain system is driven by the need to preserve its market value, or ensure purity of the product. Internationally, U.S. grain markets must increasingly conform to a new regulatory environment reliant on traceability and identity preservation.

What Is the Issue?

Differentiated grain markets differ markedly from those for commodity grains. The commodity market is characterized by minimum common standards, a large number of buyers and sellers, and high flexibility. Price is the primary coordination mechanism, with commodity exchanges often the locus of price discovery. Pricing is with reference to standard grades (e.g., number 2 yellow corn) that are broadly accepted, enhancing market fluidity. By contrast, differentiated grain markets have fewer buyers and sellers, higher costs for segregation or full-scale identity preservation, and specific quality standards, compounded by higher risks in production and marketing. Differentiated grains usually command price premiums, based on the extra costs incurred by producers and shippers and willingness to pay at the processing or retail level. This report examines the economics of grain differentiation, including the cost implications of different protocols, the unique risk factors of adopting IP (identity preservation) grains, the use of contracts, and the role of government as a provider of market information and facilitator of product-differentiated markets.

What Did We Find?

To preserve the identity of a specialty crop, segregation from commodity grains or oilseeds is required. In some cases, this is necessary to protect purity and to preserve the value of the specialty crop. In other cases, the goal is to prevent contamination through accidental commingling (for example, biotech or not), or to protect products that are approved only for certain uses (for example, industrial use only).

The cost structure for IP grains differs with the degree of segregation and/or IP required. For high-value grains, costs encompass both segregation and identity preservation in the supply chain, and the costs to mitigate risks specific to IP grain markets. Volume shipped, shipping method, tolerance levels, testing, and documentation requirements can influence segregation costs. Costs associated with risk mitigation depend on the type of specialty crop as well as the purity level. Lack of compliance with a product specification can lead either to a price discount or rejection of a shipment by buyers.

Price setting under an IP grain system is characterized by premiums or discounts relative to standard commodities, whether or not production and marketing is under contract. Premiums are affected by various factors, including the proximity of suppliers to buyers and the cost and availability of substitutes. For many trait-specific crops, price premiums rise or fall depending on supply conditions for the generic commodity.

Differentiated grains require more coordination between growers and handlers or processors, and more sharing of information. This arises from the trait-specific quality attributes of IP grains: within the supply chain, information must be conveyed about raw materials, key ingredients, and production/manufacturing processes. Assurance of product quality and authentication of process/product claims is often required. Farm product suppliers (for example, seed producers) must demonstrate that product attributes are verifiable and show supporting documentation.

Production contracts are important for trait-specific grain to ensure that the attribute-specific commodity is delivered and that predetermined management practices are used. For the producer, contracts can ensure a return adequate to cover costs of identity preservation and any yield drag associated with trait-specific varieties. Contracts can also ensure that there is a market for a niche product.

Production and marketing of trait-specific grains involves risks associated with price, quality, and information. Testing and documentation bring greater transparency to the transactions (in terms of quality and production processes), but the loss of anonymity also exposes producers and handlers to new risks. Farmers' management ability can affect both yield performance and proficiency with contracts and relationships. On the buyer side, contracts help meet the demand for specific product qualities, improve cost efficiencies of product processing, and reduce transaction costs.

Risks are typically higher for specialty crops than for generic crops. Non-GM crops subjected to testing run the risk of rejection. Organic grain can be accidentally contaminated. Pharmaceutical crops are not licensed for food/feed use, so risk of contact with the food supply can make their handling far more costly. Sophisticated risk management practices are required to minimize the chance of potential gene outflow. This entails a closed-loop system with rigorous quality control and a tight chain of custody.

Increasing grain differentiation in the U.S. food and feed industry may put new demands on government, but it is not clear whether USDA's traditional roles in commodity markets should be extended to specialty grains. The collecting of price information for commodities is not easily extended to specialty grains, which are heterogeneous, small in scale, and locally concentrated. Moreover, price information can be proprietary, established through private supplier-buyer contracts. Likewise, USDA-approved grades for specialty grains may not be justified since desired traits are idiosyncratic.

As differentiated grain markets expand, the U.S. grain industry faces new demands for identity preservation, segregation, and product tracing. This will require adaptations in grain production and handling, closer market coordination, more extensive information systems, new risk management tools, a better understanding of costs, and more third-party services for auditing, verification, and quality assurance.

How Was the Project Conducted?

The project was based on an extensive analysis of the literature covering industry case studies, academic research, and government documents. Key findings—especially those relating to farm risk management, cost of segregation, and IP market dynamics—are drawn directly from analyses conducted at the Economic Research Service with outside collaborators.

The Changing Face of the U.S. Grain System

Differentiation and Identity Preservation Trends

Aziz Elbehri

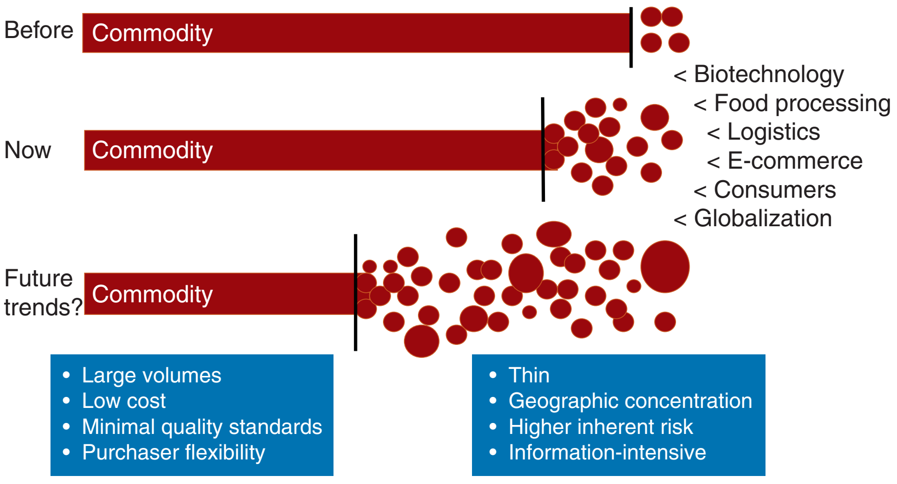
Introduction and Overview

The U.S. grain system is undergoing increased product differentiation and market segmentation (fig. 1). Over many decades, the production and marketing of corn and soybeans have reflected their relative homogeneity as bulk commodities used mostly for feed. While specialty crops (high-oil corn, food-grade soybeans) have long coexisted with commodities, industrial processing for the most part did not require segregation of varieties, while breeding favored input features or yield over output traits. Infrastructure and marketing were mostly in keeping with bulk-type products.

However, a number of forces—including biotechnology, industrial processing innovations, logistical advances, information and measurement technologies, and consumer preferences—have induced rapid market adjustments, creating more opportunities for differentiation and for the development of products with specific traits as farmers sought to diversify outside the commodity system. As markets responded to these economic incentives, cost-effective approaches to market segregation and identity preservation

Figure 1

Grain differentation trends and grain market characteristics



(IP) were implemented to meet the demand for trait-specific specialty grains and to capture price premiums.

Acreage of specialty crops has recently increased in the United States; the share of IP corn rose from less than 3 percent of U.S. corn in 1995 to 7.2 percent in 2003. However, the extent of acreage devoted to differentiated crops varies widely, from over a million acres (food-grade corn, low-temperature-dried (LTD) corn) to fewer than 100,000 acres (high-amylose corn, short-grain rice) (table 1). The number of specialty corn types is also expanding beyond the traditional niche markets for specialized animal feed.

IP soybean acreage is hard to determine, but may range from 5 to 20 percent of total soybean acreage, depending on the extent to which sulfonylurea-tolerant soybeans (STS) are marketed as a specialty crop. Like corn, the number of specialty soybeans is growing, including food varieties (tofu-clear hilum) for Asian markets, soyfood products, and non-GM soybeans. Wheat and rice produced and marketed as IP have also been developed.

Table 1
Major specialty grains and oilseeds grown in the United States

Product type		Product name	Acreage (x 1,000 acres)	Marketing channels
Output-specific traits	Standard, with special handling	HES corn	150 (2003)	Segregation within bulk
		Food-grade corn	1,200-1,500 (2002)	
		Low-temperature dried corn	1,200 (2001)	
	Specialty type (nontransgenic)	High-lysine corn	100 (2000)	Segregation within bulk
		High-oil corn	500 (2002)	
		Nutritionally dense corn	85 (2003)	
		Waxy corn	700 (2003)	
		White corn	900 (2002)	
		Waxy wheat	NA	
		"Desert" durum wheat	264 (2003)	
		Short-grain specialty rice	34.7 (2002)	
		Waxy rice	NA	
		High-oleic high-oil corn	5 (2001)	Closed loop
		Low-phytate corn	NA	
		High-amylose corn	60 (2003)	
		High-sucrose soybeans	4.5 (2003)	
		High-isoflavone soybeans	12 (2003)	
		Low-saturate soybeans	11 (2003)	
		Low-linolenic soybeans	2 (2003)	
		Blue corn	NA	Contained/ bag shipping
		Clear hilum tofu soybean	970 (1997)	
	Transgenic (GM)	High-oleic soybean	10 (2002)	Closed loop
Absence of attribute (non-GM)		Non-GM corn	300-600 (2002)	Segregation within bulk
		Non-GM/STS soybeans	14,000 (2003)	
		Non-GM wheat	NA	
Organic	Nonconventional production	Organic corn	135 (2003)	Certification (ISO 65)[1]
		Organic soybeans	175 (2003)	
Pharmaceutical and industrial	Not approved for food/feed	Pharma crops	NA	Closed loop/ Containment
		High erudic acid ("Crambe")	8.5 (2001)	

NA = Not available.

[1] ISO 65 = ISO Guide 65 points general requirements for organic certification bodies.

Source: Various university and industry reports.

A number of forces affect the accelerated differentiation within grain markets. While these forces act principally at the intermediate levels of the supply chain (handling, processing and food manufacturing), consumer preferences are also at play. Consumers in industrialized countries, in response to dietary and health concerns, are more likely to demand variety- or attribute-specific grains. For example, the rising demand for low-carbohydrate food prompted greater interest in resistant starch (not easily digestible), hence offering much higher dietary fiber relative to carbohydrates. This starch, in turn, requires specialty grains that best meet specific starch requirements.

Not all product attributes are readily discernible by final consumers. “Credence” goods, like foods derived from organic grains, require process verification. By contrast, products with “search” or “experience” attributes can be distinguished either visually (e.g., clear-hilum soybeans) or through testing (waxy corn, high-extractable-starch corn). Better testing and measurement technologies have enabled food manufacturers and retailers to discern and demand attribute-specific food products and ingredients. Global supply chains are adopting new standards of safety and conformity, partly to meet trading requirements (such as sanitary and phytosanitary standards), but more often to place their proprietary consumer goods into differentiated-product markets.

Food processors’ demand for trait-specific crops derives from the need to improve production and processing efficiency, reduce costs, or enhance product value. General Mills, for example, now procures variety-specific wheat and oats, relying on contracts with a network of producers and cooperatives in several States. Warburtons, in the UK, has established contracts with Canadian wheat producers to deliver variety-specific wheat.

Demand for specialty grains is reflected in buyers’ willingness to pay a premium over conventional grains (see box on next page). Processors pay a premium for specialty/differentiated grains due to their production efficiencies. For farmers, such premiums must be sufficient to offset any yield drag associated with specialty grain varieties, as well as any additional costs of production or segregation.

Several supply-side forces also contribute to greater grain differentiation, including improved and novel varieties derived from biotechnology. To date, most biotech crops have involved agronomic traits (e.g., herbicide tolerance or resistance to pests). These crops do not require segregation in the U.S. marketing system, and no market premiums apply. However, consumer aversion to biotech in some markets can lead to premiums for nonbiotech grain, pushing retail chains and agricultural suppliers to separate biotech from nonbiotech products.

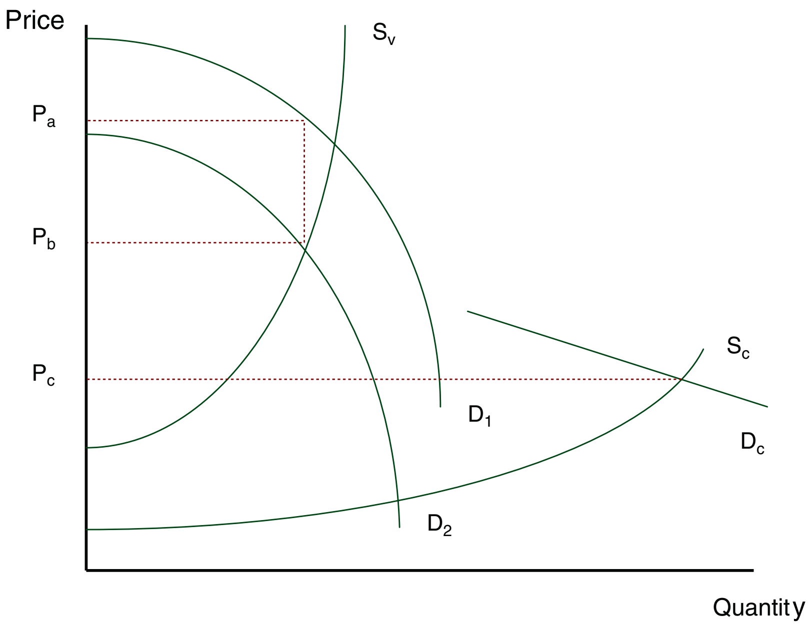
The number of output-trait grains using biotechnology that have reached the market remains limited. One example is low-phytate corn, a genetically modified corn naturally high in digestible phosphorus. Hogs fed this corn excrete less phosphorus in manure, so low-phytate corn can reduce pollution from hog farms. There are several reasons for the limited number of output-trait grains from biotechnology. Much of the early effort focused on input traits, given the huge market for feed crops and expected return on investments. Concern about consumer acceptance and limited food use for some crops may have slowed the development of output-trait varieties. Nevertheless, many output-trait

Price Determination for Trait-Specific Crops

Basic demand and supply for commodity and trait-specific crops is represented in the figure below. Supply and demand schedules for the generic commodity are denoted by S_c and D_c. The market clears at P_c. Farm-level supply of the trait-specific crop is S_v. Demand by processors (or other end-users) at the end of the marketing chain is D_1. Farm-level (derived) demand is D_2. The vertical distance between D_1 and D_2 (price P_a minus price P_b) represents the extra cost of segregation and IP in the supply chain. Also, producers earn a premium given by P_b minus P_c.

This model identifies the additional costs associated with trait-specific crops. The supply curve for the trait-specific crop lies above that for the generic commodity, owing to higher per-unit production costs. The vertical distance between supply curves S_c and S_v represents the extra farm-level costs for supplying a trait-specific crop, while the vertical distance between D_1 and D_2 represents identity preservation costs. Given inelastic demand for the trait-specific crop, small shifts in supply (S_v) can produce large changes in producer premiums. For a sufficiently large increase in supply, the producer premium can evaporate. Moreover, shifts in supply or demand in the commodity market also affect price premiums indirectly.

Price determination for value-enhanced crops



products are in the pipeline, with entirely new crop uses, both in food and feed (e.g., high-oleic-acid soybeans, modified-starch corn, low-phytate corn).

Biotechnology has also influenced grain markets indirectly—by yielding products (e.g., enzymes) that increase demand for specialty grains. For example, development of new genetically engineered enzymes has expanded corn processing, enabling the corn wet-milling industry to produce starches tailored to specific industrial and food uses (Hicks et al., 2002). This, in turn, has increased demand for trait-specific corn types such as waxy and high-amylase corn. Also, corn fiber is being investigated as a source of biobased industrial products, nutraceuticals, functional food ingredients, and biofuels. The current push to use crops for biofuels production, particularly from cellulose, is likely to spur the development of genetically modified crops with desirable cellulose characteristics to facilitate more efficient cellulose-to-ethanol conversion.

Innovations in transportation, logistics, and information technologies have also facilitated the marketing of differentiated grains. For example, Web-based bin-monitoring software can remotely assess the quantity and quality of grain inventories in a supplier's storage facilities. Communication networks and increased reliance on the Internet are also cutting transaction costs, especially for third-party authentication.

Differentiation is expected to grow as commodity markets respond to new economic opportunities from high-value production. Nearly 70 percent of U.S. grain industry leaders forecast in 2002 that identity preservation would be important in 5 years (compared with 20 percent who thought it was important at the time of the survey). Likewise, 76 percent thought that diagnostic systems for quality attributes would be important in 5 years, compared with 31 percent at the time of the survey (Shipman, 2003).

Overall, differentiated grain markets differ markedly from those for commodity grains, notably in market liquidity, price premiums, cost structure, the need for segregation, diversity of standards, and the nature of and approaches to risk management. These differentiated markets are characterized by identity preservation systems, with different implications for competition and market structure than commodity markets. Consequently, the policy implications and the public role may also be different from the government's traditional role in commodity markets. In this report, we examine the economics of grain differentiation—the cost implications of different protocols, the unique risk factors of adopting IP grains, the use of contracts, and the role of government as a provider of market information and facilitator of product-differentiated markets.

Marketing Channels and Quality Assurance

Grain product differentiation occurs both to preserve desirable traits in a crop variety (e.g., milling yield of wheat into flour) and to exclude traits perceived as undesirable by some users, such as GM content. Differentiated grains are further distinguished from commodity grains by market prices and underlying cost structures. An identity preservation (IP) system ensures that producers, handlers, and processors keep trait-specific grain separate from other grain types throughout the supply chain. IP crops fall into four broad categories based on production requirements, specialized marketing, and quality assurance schemes (table 2).

Production Requirements and Marketing Channels

Production requirements for IP crops vary from simply using a specific variety (trait-specific crops) to specialized production methods (organic crops), from protection against GM contamination (non-GM crop) to crops that require an elaborate set of safeguards and confinement practices (pharmaceutical and industrial crops). The production requirements for IP grains are influenced by such factors as the degree of purity required, the volume shipped, and market acceptability. Marketing channels for IP crops can be separated into several types (table 3).

Segregation by Channeling

Specialty corn and soybeans produced in large volumes are segregated by channeling, which uses the existing commodity marketing system with slight modifications. Segregation by channeling flows from farm to truck/rail to elevator. The effort to minimize commingling varies from simply running equipment empty before switching varieties to designating

Table 2
Grain identity preservation system: Main features and product types

	Output-specific traits	Absence of attribute (GM)	Certified organic	Pharmaceutical/ industrial (federally regulated)
Example	High-oil corn	Non-GM corn	Organic soybean	“Cystic fibrosis” corn
Production protocol	Specific variety	IP production controls Inspections	Certified organic seed Multistep inspections	IP protocols/Isolation Dedicated equipment Field inspections
Quality assurance	Testing (Near reflectance)	Non-GM testing Auditing Certification	Non-GM testing Auditing Certification (National Organic Progam)	3rd-party audits Certification Recordkeeping Source verification
Marketing channels	Segregation within bulk	Segregation within bulk	Certification	Closed loop/ containment

Table 3

Major marketing channels for indentity-preservation grains

Marketing channel	Channel features	Specialty crop type	Examples of IP crops
Bulk	Large volumes Blended for minimal quality Low cost/flexibility	Standard corn/soybeans	Yellow # 2 corn Traditional soybeans
Channeling	Separate sites/days/cleaning Impurity threshold: 1-5%	Enhanced value traits GM-free	White corn, high-oil corn, yellow food grade corn, waxy corn, non-GM corn
Closed loop	IP controls extend to farm Direct transfer to end-user Lower threshold: 1%	Trait-specific Limited-approval GM	High-oleic soybeans High-amylose corn Stacked GM corn
Container	Closed IP/direct end-user delivery 20-foot container/bags Lower threshold < 0.5%	Food grade Non-GM/low threshhold	Blue corn Tofu/clear hilum soybeans
Certified (ISO standards)	Certification regulations IP practices in production, handling Inspections along supply chain	Organic crops Seed production	Organic corn & soybeans Organic tofu/clear hilum Certified seed
Segregation/ Isolation	Confined production Spatial/temporal separation Zero tolerance for commingling	Industrial crops Pharmaceutical crops	High-erudic acid rapeseed “Anti-hepatitis" corn

certain days of the week or alternate sites for receiving and shipping these specialty crops. Crops handled by this method include white, waxy, yellow food-grade, high-oil, and non-GM corn; non-GM soybeans; and “desert” durum wheat (grown in the Southwest and valued for its quality attributes).

Closed-Loop System

A closed-loop system provides more controls than mere channeling, and better protects the value of a specialty crop such as high-sucrose soybeans, high-oleic soybeans, or high-amylose corn. Production occurs almost exclusively under a contract between the grower and end-user. Typically, these production contracts mandate delivery of all production to a specified location, and require midseason inspections and return of all unused seed to the seed company. Third-party auditors also verify that the system is in fact a closed loop and that all requirements have been adhered to throughout the system.

Container-and-Bag Systems

For very small quantities of an identity-preserved grain, the container-and-bag system is an effective means of transporting and marketing. It has been used for several decades in the seed industry and in exporting tofu/clear-hilum food-grade soybeans to Asian markets. With this system, 20-foot shipping containers are loaded and sealed on or near the farm where production occurs. This guarantees more stringent purity levels (< 0.5 percent of GM or foreign content) than with the closed-loop system. Specialty crops and seed marketed under the container-and-bag system are produced under direct contracts with end-users who take full charge of handling and shipping from farm to delivery. These contracts and handling arrangements normally encompass testing and tolerance/certification requirements, carried out either by the end-user or a third-party agent.

Quality Assurance

The degree of quality assurance varies widely among IP products, ranging from a simple Near Infrared Reflectance (NIR) test at the point of entry into the supply chain to a highly regulated system of verification, certification, and assurances for products under full confinement.

Whenever feasible, seed testing for specific attributes is essential for marketability of the IP product. Testing is one of the main vehicles for ensuring identity and quality of trait-specific grains and oilseeds. Sampling and testing procedures are often specified in production contracts. Testing for waxy corn types requires a single iodine-and-water test conducted by an elevator (buyer) at harvest. In many cases, a third party may also be involved in sampling/testing at selected stages along the supply chain. NIR tests have been widely used to test for protein and oil content in grains. Moreover, advances in measurement and computing, such as digital imaging (DI) techniques, are enabling tests of very small or even single-seed samples for specific variety identification.

Developments in the IP grain market and the burgeoning quality certification systems may indirectly affect the marketing of commodities, requiring an adaptation of existing grades and standards. As IP grain markets expand and their production and infrastructure become more widespread, it is likely that the grain commodity system itself would be altered by placing greater emphasis on quality (facilitated by better measurement technologies). The current grading system, which relies primarily on tests for visual traits such as cleanliness or damage, may be expanded to recognize intrinsic quality of grains and oilseeds.

When testing is not feasible (as for credence attributes), auditing, certification, and traceability systems may be needed (Dunahay, 1999). For example, organic crops rely exclusively on certification for ensuring product integrity. Organic producers are certified for observing production protocols that cover pesticides, fertilizers, cropping histories, and biotechnology. Their farms and fields are subject to inspection by certifying agencies, which are private businesses and government agencies accredited by the USDA National Organic Program (Greene and Kremen, 2003).

An IP system may or may not include source verification or full traceability, defined here as the ability to track the product backward from the point of final sale to its point of production. Full traceability is often driven by food safety management. Traceability does not affect the quality of the product; hence, identity preservation and traceability are not synonymous (see report on traceability by Golan and colleagues, 2004). The IP system for grain does not guarantee a continuous chain of custody from the final loaf of bread on the supermarket shelf back to the farm or field where the grain was grown. Under IP, testing is common at all points of transfer to verify quality, safety, or absence of GM event (attribute) or quality trait, but the specific grain origin (individual farmer) is lost.

The current U.S. grain market does not observe full traceability of grains from field to shelf. Nevertheless, the regulatory environment is changing significantly. The U.S. Public Health Security and Bioterrorism Preparedness and Response Act of 2002, the European Union's traceability and labeling directives beginning in April 2004, and the Biosafety Protocol on Biodiversity starting in 2006 are all inducing agribusinesses, particularly those at the start of the supply chain such as grain elevators and grain warehouses, to track shipments and supplies more than before. These regulations are expected to require that food and feed manufacturers, processors, transporters, and importers keep records of the (immediately previous) source of food, feed, or ingredient being accepted; the transporter who delivered it; the next recipient of the firm's product; and the transporter delivering it to that recipient. For grain markets, this partial traceability approach can lead back to the food/feed ingredient supplier or a group of elevators/farmers in the event of a food recall (Farm Foundation, 2004). A fully traceable system, as exists in the seed industry,[1] can develop only if there are strong economic incentives, such as foreign buyers with specific food safety concerns who are willing to pay very high premiums.

E-Commerce and Third-Party Services

The use of IP protocols requires that critical steps in production, shipping, and processing be observed and documented and that transaction information be managed. As a result, databases including information-tracking software are critical. The Internet can lower transaction costs managed by third-party data service providers.[2] A number of Internet-based service organizations have emerged to help facilitate the marketing of specialty grains and oilseeds, including testing/certification, matching producers with customers, information tracking, and e-commerce services.[3]

[1] In seed production, individual lots of seeds are catalogued by variety for each stage from breeder to seed registration and certification. Involved parties, including growers and seed companies, keep all records of production, field inspections, inventories, transportation moves, cleaning, certification tags, etc., for a minimum of 3 years. Compliance is verified either by third-party auditors or by crop improvement personnel from seed companies.

[2] Internet-based service providers record the performance of the critical steps and the results of the trait tests from remote producer, shipper, buyer, and laboratory locations. The Internet also provides a cheap way to process and save the recorded information and to make it immediately accessible to all market participants.

[3] For example, Genetic ID, an Iowa-based certification firm specializing in identity-preserved food and feed products, serves as go-between for grains and ingredient suppliers (such as Cargill, ADM, Kerry, or Cerestar) and food manufacturers and retailers (such as Sainsbury, Nestle, and Safeway). Genetic ID offers a proprietary package service *CertID* that includes testing, validation, inspection, documentation, and certification with a proprietary seal. Such services certify that shipments are non-GM, organic, or have specific traits, depending on the client.

Costs of Segregation

Technological, processing, and logistical innovations have created opportunities for specialty products that command premium prices. But an identity preservation market is predicated on farmers willing to grow such products and handlers to market them to end-users at acceptable costs. To earn the IP premium, those involved must incur added segregation costs and bear the risks inherent in IP production and marketing.

The cost structure for identity-preserved crops differs from that of commodity crops in two important ways:

(1) the added costs of segregation and identity preservation in the grain supply chain; and

(2) the costs to mitigate risks specific to IP grain markets, risks rising from the characteristics of differentiated-grain markets, and the specific requirements for production and marketing.

Sources of Segregation Costs

IP costs derive from the volume of grain handled, levels of purity required, handling infrastructure, and the extent of risk and risk sharing. The relative impact of these factors on IP costs also differs by the type of specialty grain, and can vary at each stage of the supply chain.

Basic IP costs involve the physical separation of grain, including dedicated storage, handling, and transport of harvested products. The main sources of added costs over conventional varieties are seed (including technology fees) and special transportation, handling/drying, storage/segregation, and management. (Farm surveys show that these segregation costs differ widely among specialty grains.) For high-oil corn, the largest additional cost is seed, as proprietary seed commands a technology fee, while the ease of testing for oil level makes physical segregation unnecessary (Fulton et al., 2003). For waxy, white, or food-grade corn, IP costs are more substantial for physical segregation (transportation, handling and drying, and storage). For specialty soybeans like tofu or seed soybeans, the main additional costs are seed technology fees and transportation.[4]

IP costs are also affected by whether verification claims are required. Testing or documentation requirements are particularly important for crops marketed as non-GM, which require additional steps to avoid accidental commingling on the farm. In practice, this means growing border fields and staggering harvests to avoid pollen drift and contamination from non-GM fields. In the long run, farmers who choose to produce differentiated grain must also incur fixed costs in buying storage bins and drying/harvesting equipment.

Grain elevators typically store and mix grain of varied quality and grades, in response to market signals. Identity preservation and segregation preclude these practices. Additional costs derive from physical separation, including separate storage and identity verification.[5] Marketing costs of IP products

[4] USDA's Agricultural Resource Management Survey (ARMS) for 2001 shows that the additional expenses of storage, segregation, and transportation are substantial for specialty corn, while cleaning of planters and combines is negligible.

[5] For identity verification, the costs include processes to review and record details of delivered loads and supporting certification, and costs to validate claims about IP (Maltsbarger and Kalaitzandonakes, 2000).

include expenses associated with contract negotiation and the procurement of suitable grain or oilseeds from farmers.

Hidden or opportunity costs for IP elevators include loss of margins from forgone opportunities and from underutilized storage capacity, which are significant for some elevators (Bullock et al., 2000; Qasmi et al., 2004). Maltsbarger and Kalaitzandonakes analyzed segregation options for high-oil corn at the elevator stage and broke out separation costs into coordination, logistical, and indirect categories. They found that the average IP cost varies widely with volume handled and that the relationship between IP cost and IP volume is determined mostly by the physical configuration of the storage facilities. Indirect costs account for over half the total segregation cost and are higher with larger volumes, highlighting the loss of efficiency and revenue to accommodate IP inflows. Other studies have examined the indirect costs of delayed deliveries and loss of flexibility in moving large volumes of grains during the peak harvest period.[6]

Variation in Cost Factors

The impact of **volume marketed** on IP costs depends on the grain-handling infrastructure. Elevators that are able to segregate most effectively have many bins of varying capacity, as well as multiple pits and elevator bucket legs; these features enable the elevator to dedicate units to specialty grain, reducing the likelihood of commingling (Herrman et al., 2002). The volume of IP grain within the infrastructure is significant in selecting the optimal segregation strategy, including whether to designate elevators as IP-only facilities. For grains and oilseeds in Indiana, low-volume flows make it cost effective to designate IP facilities only when the processor of the product is local (Vanderburg et al., 2003). In IP-dedicated plants, the increased transportation and handling costs (of getting more specialty grain from farther away) are more than offset by the elimination of segregation costs.

The **method of grain shipment** also influences IP costs. Containerized IP shipments are becoming the preferred response to the growing demand for segregated specialty grain (Reichert and Vachal, 2000). While bulk systems (train/barge) have historically been a cheaper way to move grain because of economies of scale, containerized shipping reduces time in transit. This is particularly important to customers requesting just-in-time service. Other advantages include better inventory management along the supply chain and better matching of supply with demand (and hence lower seasonal price fluctuations).

The **tolerance level for impurities** allowed in grain also affects IP costs. The higher the degree of purity required, the higher the cost to validate compliance (table 4), especially for non-GM grain (Giannakas and Kalaitzandonakes, 2005). Segregating grain into biotech and nonbiotech entails greater marketing risks than trait-specific grain such as high-oil corn.[7] Under generous threshold requirements (95 percent or higher product purity), segregation costs are manageable within the current handling infrastructure (Lin et al., 2000). At higher purity thresholds (99 percent or higher), production and marketing of specialty crops can add significantly to IP costs.

[6] Herrman et al. (2002) report that delays associated with segregating wheat during harvest accounted for 15.8 to 27.5 percent of total segregation costs.

[7] Oil content that is lower by 1 percent might reduce price premiums paid to high-oil corn producers; 1-percent biotech content in a non-GM grain shipment could cause rejection—a much bigger penalty for noncompliance, particularly for exporters.

Table 4

Estimated costs of segregation at a grain-handling facility from previous studies

Author(s)	Commodity	Year	Volume handled (bu.)	IP system	Costs ($/bu.)
Herrman, Boland, and Heishmann	Wheat	1999	6,500/hr. (model A)[1]	High-quality HRW	0.053-0.056
			7,500/hr-10,000/hr (model B)[2]	High-quality HRW	0.023-0.032
Bender, Hill, Wenzel, and Hornbaker	Corn and soybeans	1998	n.a.	High-oil corn STS soybeans	0.06 0.18
Good, Bender, and Hill	Corn and soybeans	1999	n.a.	Non-GM corn Non-GM soybeans STS soybeans	0.01 0.078 0.117
Smyth and Phillips[3]	Canola	1999	n.a.	Non-GM canola	0.6 (1% tolerance level)
Maltsbarger and Kalaitzandonakes	Corn	2000	200,000 to 500,000 during peak harvest	High-oil corn	0.164-0.274
Wilson and Dahl[3]	Wheat	2002	n.a.	Non-GM wheat	0.0145 (5% tolerance) 0.0336 (1% tolerance)

[1] Model A: the elevator is characterized by 1 drive, 1 elevator bucket leg, and 2 dump pits.

[2] Model B: the elevator is characterized by 1 drive, 2 elevator bucket legs, and 2 dump pits.

[3] Costs of segregation entail those from growers to those from either importers or domestic end-users.

n.a. = Not available,

Under a stricter tolerance level (99 percent or higher purity), the high risk of rejection induces greater testing costs. IP costs are incurred in both the commodity and IP systems when the IP product is either unapproved or unacceptable in some markets (i.e., Starlink corn variety approved for feed but not food in the United States). By contrast, fully acceptable IP products (i.e., GM crops approved in all types of uses and all markets) incur costs only in the IP system. The smaller the tolerance or acceptance of a product in a market, the greater will be the effort—and cost—to maintain perfect isolation.

Risk Management

The IP cost structure is also contingent on managing risks inherent in IP markets. These risks can arise from pricing factors (price premiums, quality, and information), production contracts, longrun investments, and farmers' management ability, which affects both yield performance and proficiency with contracts and relationships. The nature and scope of risk vary depending on the type of IP crop. These risks are examined for three categories of IP crops: trait-specific, non-GM, and pharmaceutical/industrial.

Risks Associated With Trait-Specific Crops

Farmers face several risks when they grow trait-specific grains. These fall under four broad categories: market, production, business, and financial risks (table 5).

- **Market risk** arises either from uncertainty in finding buyers or rejection of shipments if specific grain standards and characteristics are not met. Market-type risks include base price risk common with commodity crops and price premium risk specific to IP crops.
- **Production risk** includes both yield and quality risk. The quality risk may arise from inadvertent commingling of grains with different characteristics or from unfavorable weather. Deviation from pre-specified quality may result in lower premiums, discounts, or outright rejection by the buyer.
- **Business risk** includes possible contract default by producers or contractors, as well as potential liability for any problems that arise with the grain. Critical relationships may also be strained or broken under specialty grain production.
- **Financial risk** is associated with investment risks due to variability in returns and loss of the asset. Trait-specific grain production may include investment risk above that expected for traditional commodities due to specialized equipment or facilities. Long-term returns on these investments may be uncertain since production contracts are typically for a single year. If the producer loses the contract or if the economics of the product become less favorable, the returns on the investment may be reduced.

Bard and colleagues (2003) ranked these risks using an Illinois farmer survey and found that the top three risks faced by IP producers are related to price premiums (39 percent of respondents), yield (25 percent), and quality (22 percent). The key factor that draws farmers into and out of specialty corn is the price premium.

Farm surveys conducted by the U.S. Grains Council (1996-2001) show a high degree of entry and exit into and out of specialty crop production each year (Stewart, 2003), as much as 30 percent in the case of corn (fig. 2). The decision to enter or exit the specialty grain market may be linked to yield performance (fig. 3). Exiting farms may be either poor production managers or have unsuitable land or growing conditions. The high degree of entry and exit mirrors the higher fluctuations of supply and demand in differentiated grain markets.

Table 5

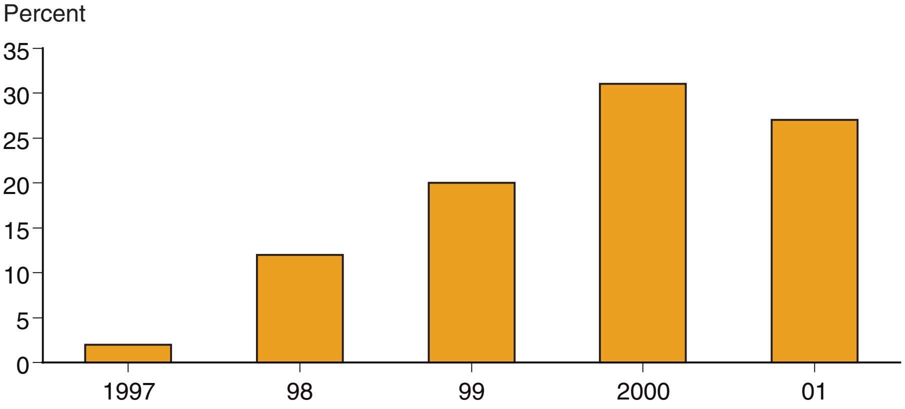
Producer risk in specialty grain: A typology

Risk type	Risk category	Risk common with commodity	Definition	Sources of risk
Base price	Market	Yes	Risk of lower-than-expected grain prices other than changes in expected market price premiums	
Price premium	Market	No	Risk of a change in premium without a change in quality within the crop year	Risk in producing value-enhanced grain (VEG) in open market
Market access	Market	No	Risk of not having a viable market for the crop • Short run: for either a VEG crop not grown under contract or the overproduction of a VEG crop • Long run: risk of VEG disappearing from market following specific investments	
Quality	Production	No	Risk of an unexpected quality level in the grain that affects the grain's value through discounts or reduced premiums Risk of rejection from low quality	Chemical composition and test weights; contamination risk (GMO) Storage quality risk post-harvest; measurement risk (testing)
Yield	Production	Yes	Risk of lower-than-expected production (different from yield drag)	Weather conditions, variety, unknown yield drag, soil fertility, pest pressure, and timing of field operations
Contract	Business	No	Risk of contract default by producer/ contractor	Default during crop year from lack of performance; termination of multiyear contract after 1 year; risk of nonpayment upon delivery
Relationship	Business	No	Risk of adversely affecting critical relationships with buyers, suppliers, or other resource providers (unique to VEG; determined by contracts or outside contracts)	Losing access to landlord/lender, supplies, technology, knowledge, and markets
Product liability	Business	No	Risk that a producer will be liable for problems	Contamination with GMO or food safety; with grain liability specified in contracts; GMO contamination in organic will prevent organic labeling
Investment	Financial	No	Risk associated with returns on a long-term asset	Variability in returns (annual changes in costs and revenues); loss of the asset (fire, theft, natural disaster); uncertain long-term returns on investments

Source: Bard et al. (2003).

Figure 2

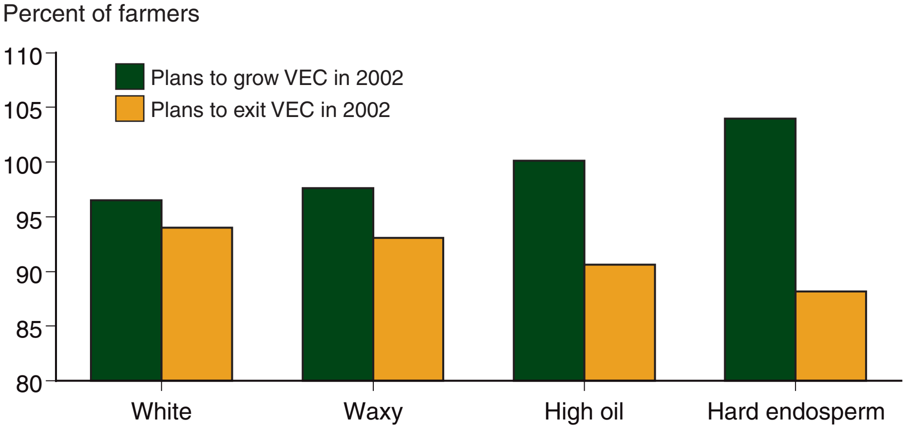
Share of corn growers exiting specialty grain markets, 1997-2001



Source: U.S. Grain Council.

Figure 3

Specialty corn yields for farmers who maintain versus those who exit value-enhanced corn (VEC) production, 2002



Source: U.S. Grain Council.

Risks Specific to Non-GM and Organic Crops

Non-GM crops are subject to the added risk of testing for purity, which could result in rejection of shipments. The risk level depends on the testing technology and the purity threshold required. The less accurate the testing or the higher the purity threshold, the greater the risk.[8] This is a greater risk than with trait-specific grains, which incur only price discounts for inferior quality. Buyers risk receiving non-GM crops accidentally commingled with GM varieties, and so specify testing/segregation methods through contract terms, test specifications, and penalties (Wilson et al., 2005).

Organic grain producers face risk from accidental commingling with GM crops since organic regulations prohibit genetic modification. In addition, the threshold for purity in organic crops can be more stringent than for non-GM IP crops. These stringent private standards are common for exports to Europe or Japan, where some buyers may demand near-zero tolerance,

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[8] Testing for GM presence can be done through detection of proteins associated with transgenes, or detection of the transgene itself in DNA. The relative ease or complexity (and hence cost) of a test depends on the nature of the product (whole-grain, semi-processed, or processed) and the amount of target protein or DNA that can be detected. The higher the amount of protein and the more accurate the measurement technology, the lower the probability of false-positive results.

while others may allow small amounts of impurities (generally above 99.5-percent purity thresholds). Organic farmers use numerous management strategies—including buffer zones, careful timing of crop planting, and crop monitoring—to minimize the possibility of accidental contamination, but the effectiveness of these management strategies varies by crop. Self-pollinated crops such as soybeans or barley pose less of a problem than open- or wind-pollinated crops like corn.

Risks Associated With Pharmaceutical and Industrial Crops

Unlike other genetically engineered crops grown for food or feed uses, pharmaceutical crops require a production license from USDA/APHIS, and must include a containment plan for pharmaceutical plants during their production, handling, and movement in and out of the field. APHIS reviews and pre-approves all plans for seed production, timing of pollination, harvest, residue destruction, shipment, confinement, and the storage and use of equipment. Field inspections can take place up to five times during the growing season, coinciding with critical periods of the growing season. Farmers contracting with biotech companies that hold an APHIS license are required to undergo training in license requirements and implementation.

Risk management drives the cost structure for pharmaceutical crops. Sophisticated production and handling aim to (1) contain the potential gene outflow and impacts on nontarget organisms, as well as workers' health; (2) create a tight closed-loop system to minimize any possibility of commingling with the food supply; and (3) create a set of quality control procedures with a tight chain of custody to satisfy the isolation and confinement requirement. Given the potential risks and liabilities associated with accidental commingling of pharmaceuticals with food grains, and with the daunting task of insuring the 100-percent containment requirement, food and biotech industries have taken a precautionary approach to pharmaceutical crops and risk assessment-based regulations (Elbehri, 2005).[9]

[9] The incident involving ProdiGene, Inc., a biotechnology firm, illustrates the kind of risks facing the food industry. In Nebraska during the 2002 season, APHIS inspectors discovered "pharmaceutical" corn from the previous season growing in the midst of a soybean field. As a result, both the harvested soybeans (500 bushels) and the entire soybean load of 500,000 bushels in the local elevator were quarantined and ProdiGene was fined.

Information Intensity and Market Coordination

Key to successful risk management for identity-preserved crops is the ability to manage the abundance of information required as the product moves along the supply chain. The need for more information arises from the high specificity of quality attributes in IP grains. Quality traits of IP crops fall into several categories:

(1) Increased levels of one or more of the desirable components in grain (protein, oil, starch, minerals);

(2) Absence or reduction of a problematic component of grain (phytate, linoleic oil);

(3) Modifications to include a desirable or specialized composition;

(4) Ingredients not previously sourced from plants (pharmaceuticals); and

(5) Modifications to generate completely novel crops (nutraceuticals).

Information Intensity

The need for more detailed information concerning grain-based food ingredients forces all agents in the supply chain to monitor quality and convey information about raw materials, key ingredients, and production/manufacturing processes, and to provide assurance of product quality and authentication of process/product claims. Farm product suppliers must demonstrate that product attributes are verifiable and show supporting documentation. For example, non-GM soybeans (other than sulfonylurea-tolerant soybean varieties) require documentation showing when the tests are required by food manufacturers and validation test results. Non-GM soybean ingredients in food products must also be accompanied by third-party certification that demonstrates their non-GM origin.

With increased differentiation, information flows become critical to mitigate risk and capture higher market value. Information management thus enters into the cost structure of IP production. Testing and third-party certification add to transaction costs. Moreover, information adds to the riskiness of the IP market. Compared to the highly efficient traditional commodity system, the differentiated information-intensive system is more transparent as more information accompanies the grain shipment. But this increased transparency brings new risks in the form of liability, intellectual property protection, performance accountability, and business relationships (Beurskens, 2003).

Market Coordination: Role of Contracting

The more information required during transactions along the supply chain, the greater the need for market coordination. Traditionally, less perishable products such as grains, oilseeds, and cotton (with the exception of niche markets) have relied mostly on open or spot markets. Storage and buffer stocks have facilitated vertical coordination and hedged against spikes in supply and demand. For grain commodities, spot markets have been sufficient for price discovery, as price and standard grades capture all the information required by buyers and sellers. Under this system, generic commodity cash markets and forward contracts (which specify volume and price only) have sufficed.

However, with the growth of information-intensive IP grain and oilseed markets, contracts have become more important (table 6). The rules of competition are being redefined between suppliers and customers, as well as between customers and among competitors. The greater the information flow along the supply chain, the greater the need for production contracts.[10]

Producers use contracts to ensure compensation for additional IP costs and any yield drag associated with trait-specific varieties—and to guarantee a market for the niche product. The producer is thus able to reduce financial and marketing risk, access new technologies and markets, and lock in price premiums.[11] Buyers use contracts to help meet the demand for specific product qualities (including food safety), improve cost efficiencies of product processing, and reduce transaction costs (Jackson and Cuppy, 2000). The buyer is thus able to maintain quality control and manage supply. In some cases, contracting also meets a need to protect intellectual property.

Production Contracts: Specifications and Types

Contracts for IP grains are typically for one season and are contracted between farmers on one hand and seed suppliers, handlers, intermediary firms, and processors on the other. Most contracts stipulate a specific variety, delivery time, delivery place, and dedicated storage of the crop on the farm (table 7). Specifications for delivery locations (in 89 percent of contracts) and dates (in 74 percent) were the most common requirements in both production and marketing contracts. In production contracts, quality control is handled through variety specification (71 percent of contracts) or through sampling and quality testing (42 percent).

Table 6
Benefits and risks of contracting specialty grains

Producer benefits	Contractor benefits
Reduced financial risk Access to new technologies Access to new markets Price premium Reduced marketing risks	Quality control and supply management Reduced financial risk Control of technology and markets
Producer risks	**Contractor risks**
Long-term investments and short-term contracts Payment risk Limited returns Reduced management control Identity-preservation requirements	Finding amenable parties Litigation possibilities Control over technology Producer reliability

Source: Jackson and Cuppy (2000).

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[10] In some cases, specialty grains have become “commoditized” (white corn, white wheat) and spot markets endure.

[11] Fulton et al. (2003) found that for Indiana growers of specialty grain, the dominant reason for entering into production contracts was additional revenue (92 percent of respondents), while a third indicated market access as a reason. About 28 and 21 percent of respondents, respectively, cited access to seed and reduction of risks as important.

Table 7

Specialty grain contract provisions and less desirable aspects of contracts (Indiana farm survey)

Contract provisions (% respondents)	Least desirable aspects of contracts (% respondents)
Delivery to specific location (89)	Delivery date unknown (49)
Delivery on specific dates (74)	Delivery location (33)
Plant variety from designated list (71)	Additional costs (30)
Store crop on farm (71)	Yield penalty (27)
Provide samples for quality testing (42)	Quality standard (27)
Specific pricing method (e.g., forward contracts) (40)	Identity preservation (25)
Specific pricing window (e.g., Sept.-Jan. only) (37)	Loss of control (22)
More intensive production management (31)	Timing of payment (15)
Specific handling equipment and instructions (29)	Additional investment (9)
Specific harvesting equipment or technique (27)	Input requirements (9)

Source: Fulton, Pritchett, and Pederson (2003).

Contracts may also differ in how they handle property rights. Contracts between farmers and seed suppliers preserve seed developers' intellectual property rights for new varieties. An example is DuPont Optimum seed for high-oil corn, used as an input to livestock feed. High-oil corn meeting certain standards earns a price premium in the market. Developers of seeds with higher oil content seek to maintain their property rights and generate rent in the form of a technology fee. The innovating firm (DuPont) grants a license to seed companies. The contract specifies a premium and requires growers to provide evidence of applying specific inputs.

Contracts also differ in how they are enforced in case of a breach or lawsuit (Sporleder and Schmidt, 2003). Some contracts call for penalties for noncompliance or even indemnification of the buyer. Others have process and quantity specifications, but failure to comply involves no legal liability. For example, organic contracts in Illinois are highly specific and third-party verified, but involve no legal liability for failure to deliver. In the case of poor performance, producers forgo the premium and are dropped from a list of select suppliers. The most common contracts specify minimal management processes (variety/hybrid and quantity) and do not require third-party verification.

Risk management is one of the main motivations behind contracting. However, contracts also bring some risks of their own (Bard et al., 2003). Among these, the failure to produce to contract standards will result in loss of a contract's premium rates, or nonrenewal/termination of the contract (Hayenga and Kalaitzandonakes, 1999). Under contracts, farmers might feel a loss of independence in submitting to certain terms (permitting field inspections by buyers or designated third-party certifiers, applying certain production practices, planting specified varieties, etc.).

Factors Affecting Contract Use and Frequency

Contracts are more likely to emerge for products with attributes that are difficult or expensive to measure than for products that have easily verified attributes and that can be traded more efficiently via open or spot markets (Hayenga and Kalaitzandonakes, 1999; Chambers and King, 2002). STS soybeans, for example, had been grown under contract up to 2001 as a distinctly non-GM variety. However, development of easier and cheaper testing for GM content in soybeans has lessened the allure of STS soybeans, which have become largely “commoditized” since 2001.

A second factor affecting frequency of contracts is the specificity of product use and the willingness of contractors (buyers) to pay a premium for the specialty grain or soybeans. Processors desirous of high quality and purity levels will pursue very structured contracts. Maintaining ownership of the seed and crop is a strategy that many companies use to protect proprietary intellectual rights. Specialty crops that command high premiums, such as high-amylose corn, have 100 percent of their acreage under contracts.

Also affecting the frequency of contracts is ease of entry. In the case of organic grains, most are not grown under contracts because the organic grain market is contestable, with numerous global suppliers willing to produce and sell these grains (Ginder et al., 2000a). This may also be facilitated by the existence of a standard USDA label verifying that products are organic.

Given the diversity of factors affecting recourse to contracts, it is not surprising that the frequency of contracts will vary greatly between IP crops. A farm survey by Bender et al. (2000) showed that specialty grains purchased via farm contracts ranged from 71 percent for food corn to 80 percent for food soybeans and 96 percent for high-oil corn. Good and Bender (2001) found in a survey of corn and soybean handlers in Illinois that the share contracted varied from 9 percent for non-GM corn up to 95 percent for high-oil corn. The low rate for non-GM corn is partly due to the ready availability of corn that can be tested cheaply for non-GM content. The protection of intellectual property rights explains the frequent contracting for high-oil corn (despite readily available technology to identify high oil content).

Effect of Contracting on Price Risk and Risk Sharing

The two most commonly cited reasons for entering into contracts are managing risk and minimizing production and/or transaction costs (Ahearn et al., 2003). If either party at the time of contracting knows the value of the product, or if there is unequal information available to contracting parties, risk aversion may lead to risk sharing. Production contracts for specialty grains determine how risk is shared between producers and buyers. Establishing a price or price formula at contract time can protect both sides from adverse price changes. However, different price formulas are used.

Ginder et al. (2000a; 2000b) identified three common types of contracts, based on the method by which the specialty grain price is determined (table 8). The most common is *market price plus a premium*. This leaves the farmer with all the yield and price risk associated with commodity production, but adds a fixed premium to cover the additional costs of specialty production. This type of contract is typically used with relatively high-

Table 8

Types of contract by specialty corn and soybean variety

Crop	Market price plus premium	Flat price per bushel	Flat payment per acre	Combination of premium methods	Other premium method
	Percent of contracts				
Corn					
High oil	76	6	2	8	8
Waxy	62	14	*	*	24
White	53	35	*	6	6
Yellow food grade	33	67	*	*	*
Non-GM	33	33	*	*	33
Organic and pesticide free	*	100	*	*	*
Soybean					
Tofu or clear hilum	73	10	3	7	7
Organic and pesticide free	20	70	*	*	10
STS	61	28	6	*	*
Non-GM	36	45	*	*	19

May not sum to 100 percent because of rounding. * = less than 1 percent.

Source: Ginder et al. (2000a and b).

volume specialty varieties that exhibit a small yield drag. Examples include high-oil corn, low-temperature dried corn, white corn, and waxy corn.

The second contract type stipulates a *flat price per bushel* produced. These contracts place the market price risk with the buyer while the farmer retains the yield risk. Flat-price-per-bushel contracts have been used in situations where there is a large yield drag, as with organic or certain specialized hybrids. For organic grains, yields may not always be substantially lower than for conventional grains. However, Ginder et al. (2000a; 2000b) found that organic corn (and soybean) yields were about 30 (25) percent lower than the corresponding average yield for the surveyed specialty (non-organic) crops. Flat-price-per-bushel contracts can be effective because they give farmers extra incentive to improve yields.

The third contract type stipulates a *flat price per acre*, which provides farmers a fixed payment regardless of the market price or yield situation. The yield and price risks are borne by the buyer. In this case, the buyer-contractor provides the seed and holds legal ownership of the growing crop through harvest, when the entire crop is delivered to the contractor at the agreed price. Such contracts were a very small portion of those surveyed, possibly due to price support programs and farmer perceptions that they limit autonomy. Buyers also face high risk with these contracts and may use them only with strict management requirements for the farmers. Moreover, flat-price-per-acre contracts are offered only in geographically specific areas with relatively low yield risk. Specialty grains and oilseeds grown under these contracts (high-amylose corn, low-saturate soybeans, and high-sucrose soybeans) tend to have lower volume and expected yields. Hence, paying producers per acre of production is a way to transfer risk from the more risk-averse producers to the less risk-averse buyers when yield drag is high enough to discourage production.

Price and Market Dynamics

In IP grain and oilseed markets, premiums can vary significantly among farms for the same crop, due both to differences in quality and in farmers' negotiating abilities. Fulton et al. (2003) reported that median price premiums for specialty corn and soybeans ranged from $0.13 to $0.36 (5.37 to 14.87 percent) per bushel. For some specialty corn types (waxy and high-amylose corn) that command high price premiums, direct contract negotiations between growers and corn processors reflect unequal bargaining power, affecting the price premium received by growers. Within this vertically coordinated structure, the price-affecting power (oligopsonistic behavior) of processors may dampen prices and farmer returns (Elbehri and Paarlberg, 2003).

Annual swings in price premiums are related to higher variability in supply and demand for IP than for conventional grains and oilseeds. For many specialty grains, price premiums go through cycles. At first, premiums are high as buyers entice producers to enter into the production process. Prices then decline as more producers enter the market, until price premiums stabilize. For example, high-oil corn acreage expanded in the 1990s, reaching 1 million acres in 1999, before falling to 600,000 acres in 2001 and then stabilizing. Lower premiums and reduced demand due to substitution of less costly fats and oils in livestock feed were behind the drop in acreage.

Excess supply also erodes price premiums, particularly for non-GM crops. For example, non-GM corn has seen its premiums swing substantially due to large supply and demand imbalances between years. Unlike trait-specific specialty grains, non-GM grains can experience market conditions where price premiums fail to emerge, irrespective of the added IP costs involved in segregation. Moss et al. (2002) showed that one reason price premiums for non-GM corn are small—relative to IP costs—is an excess of non-GM corn after food-corn demand is met. Non-GM corn experienced a sharp decline in its price premium from 2000 to 2001, partly due to an oversupply, but also to the ease of testing for GM presence. In recent years, as corn prices have increased due to rising biofuels demand, it would take significant price premiums to lure corn producers to specialty corn.

The Role of Government in Differentiated Grain Markets

Since accelerating grain differentiation reflects the market response to changing consumer preferences, technological advances, and increased globalization, what role(s) should the government play? Is there a clear "public good" or "efficient market" argument for government intervention? Are there identifiable market externalities (either negative or positive) that would cause social costs or benefits to diverge from private ones and would, therefore, justify public intervention?

Under the "efficient market" argument, the government role would be market facilitation. How would this apply to IP grains characterized by small size, low liquidity, and undeveloped open pricing mechanisms? One government role currently applied to commodities is price collection. Prices quoted for standard grades, collected and published by USDA's Agricultural Marketing Service (AMS), are, however, of limited use to producers or traders of trait-specific crops. Price information for differentiated crops is more difficult, or expensive, to obtain. Moreover, it is not clear whether premiums or discounts should be reported on a real-time basis or based on periodic surveys. More important, there is no clear "efficient market" argument for public disclosure of private contract terms.

Similar issues arise in the context of insurance programs. Current insurance policies designed for commodity crops are based on market prices, historical yields, and public grade standards. Adapting these insurance programs for specialty grains would require additional information on expected price premiums or discounts, quality traits beyond minimum grade standards, and expected yield differentials. The lack of universal quality standards for specialty grains, and the unavailability of publicly collected prices, may render the extension of crop insurance to specialty crops very difficult.

Currently, most available information on specialty grain markets has come from university or private industry surveys. For large specialty grain markets, direct public provision of national market information, even if desirable from the "efficient market" argument, may be less effective than through a third-party provider (university or trade association). For example, USDA-AMS has contracted with Iowa State, North Carolina State, and Cornell Universities to survey organic grain producers and with (seed) dealers in Midwestern States to ascertain planting and harvesting intentions beginning in 2003.

Another government function currently in use for commodity markets that may not be easily extended to specialty grains is the establishment of standards for grain grades and quality. The grading system for grains and oilseeds has served the homogeneous market well for many decades. These standards specify USDA-approved sampling, inspection, and measurement procedures that are well accepted, quick, and relatively inexpensive. However, this approach may not be entirely suitable for differentiated grain markets with product-specific traits and attributes. Testing for value-enhanced crops requires using genetic markers to identify specific varieties and tests to verify the presence of added or altered traits or nutritional properties. Currently, private standards and contractual specifications are used in IP markets to meet desired attributes. While some harmonizing of these private standards might be warranted, standards themselves are privately decided between sellers and buyers, and direct government intervention may be neither justified nor demanded by market agents.

The "efficient market" argument for government role is more supportable in harmonizing and standardizing test methodologies, ensuring consistent and reliable measurements within the IP grain system. The current function of USDA's Grain Inspection, Packers and Stockyards Administration (GIPSA)—certification and harmonization of measurement technology—can be extended to differentiated grain markets. USDA is standardizing testing methodologies, evaluating testing and laboratory services, and developing new testing and analytical methods for end-use quality attributes. This not only facilitates domestic markets, but can help gain acceptance of U.S. products by foreign buyers. USDA's Process Verification Program is another example of market facilitation, applying internationally recognized standards to certify private firms' claims about quality control. This helps producers, marketers, suppliers, and processors to assure customers of their processes to provide consistent quality products.

An example of the "efficient market" argument justifying a public role is USDA's National Organic Certification Program begun in 2002, which provides consistent labeling of organic products. This program simplifies consumers' choice (through a clearly identifiable USDA organic label) and safeguards producers who abide by a specific production protocol in return for likely price premiums.

The "public good" argument in favor of public intervention in differentiated grain markets is evident with the need to prevent disruptions to food markets and/or to provide safety assurances to the public. This need translates into government regulations at the marketing or even production stage. As an example, the production and processing of plant-made pharmaceuticals are directly regulated via licensing by both USDA and FDA. In this case, regulation both safeguards potentially large economic and health benefits from plant-based pharmaceuticals and protects against potential liabilities and market disruptions due to inadvertent contamination. Under this tight regulatory environment, the growth of these crops will depend on strong and adaptable regulatory oversight, along with technological solutions to the containment challenge (Elbehri, 2005).

Another public imperative is national security. Here, the 2002 U.S. Bioterrorism and Biosecurity Act, intended to safeguard the U.S. food system against accidental or terrorist attacks, falls under the "public good" argument. This regulation requires "step-back/step-forward" traceability for all food and feed moving within commercial channels and encompasses both commodity and IP grain. Implementation of these traceability requirements is likely to stimulate IP grain markets by further justifying data tracking and information infrastructure along the supply chain.

The government role in harmonizing standards, labeling, and tolerances also extends into the international arena, the source of most demand for U.S. IP grains. The international regulatory environment is also changing rapidly.

Among the recent changes is the new European Union food traceability and labeling law, and the implementation of the Cartagena Protocol on Biosafety.[12] All these developments require more traceability and identity preservation, heightening the need for harmonization and recognition of mutual standards. The latter can be achieved through negotiations—whether through multilateral standards-setting organizations such as Codex, bilateral negotiations with economic partners (such as the European Union), or within the context of regional free trade agreements.

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[12] The Cartagena Protocol on Biosafety was adopted on 29 January 2000, signed by 107 parties, and by September 2003 was ratified by 50 countries, the minimum required for the Protocol to enter into force. Countries that ratified the Protocol became Parties to the Protocol and are required to comply with and implement all of its provisions. Countries that have not signed but that export Living Modified Organisms (LMOs) to member countries are encouraged to comply with the Protocol's provisions implemented in the importing country.

Conclusions

The trend toward more differentiated grains is a result of economic, technological, and structural forces. This trend has accelerated recently with an increasing number of specialty grain markets requiring identity preservation systems with separate marketing channels. Identity preservation is driven by the need to protect either the purity, and thus the value, of the specialty crop itself or the main (i.e., non-GM) commodity from contamination through accidental commingling. A market for identity-preserved products arises when buyers are willing to pay more for a trait-specific product and when farmers and handlers respond to market premiums.

Biotechnology is one of the major drivers of grain differentiation. Genetic engineering has enabled end-use applications for crops with specific attributes. For example, low-phytate corn, a genetically modified corn naturally high in digestible phosphorus, generates less phosphorus in manure and hence lowers pollution from hog farms. Biotechnology has also facilitated other innovations, such as industrial processing of crops and enzyme advances, which enable greater differentiation and increase the demand for specialty crops. Innovations in logistics/transportation and structural changes in the retail industry are also enabling the development and marketing of differentiated products, cutting transaction costs and making the information-intensive systems required economically feasible.

Communication networks and the Internet have introduced buyers to agricultural products with specific traits and allowed them to verify actual characteristics against product claims. Moreover, consumers in high-income countries are demanding more specific products, motivated by changing dietary and health concerns, concerns for food safety, and social or ethical considerations. The ability to meet these consumer demands is enhanced by upstream innovations in the food industry. For example, increased demand for low-carbohydrate food signals demand for fiber-rich grains, which is met by technological innovations in specialty starches and the crops that provide them (e.g., modified-starch corn).

The cost structure for identity-preserved crops differs from commodity grains and includes both the added costs of segregation and the costs to mitigate risks specific to IP grain markets. The risks derive from one or more pricing factors (price premiums, quality, and information) and production contracts, which are more prevalent in IP than conventional grains. Contracts specify production protocols to ensure IP. The nature and scope of these protocols increase in complexity depending on the type of IP crop, growing more complex from trait-enhanced specialty grains to non-GM crops, to organic grains, and finally to pharmaceutical/industrial crops that are not approved for food or feed use.

At the producer level, segregation costs may include specialized storage and transportation, or measures to prevent accidental commingling with GM crops. Growers of IP grains face much larger price swings (from the more variable supply and demand) than growers of commodity grains. Hence, success in IP grain production depends on the producer's ability to secure market access, capture high price premiums, maintain acceptable yields (with minimal drag), and work in a business environment driven by contracts and closer relationships. The many factors affecting IP grain producers' likelihood of success explain the high rate at which farms move into and out of specialty crop production each year. Farmers that are successful at IP grain production stick with it; those that are not return to commodity grains.

Handlers of IP grains incur indirect costs from loss of flexibility in forgoing grain mixing and the resulting underutilization of storage capacity. The magnitude of IP costs at the handling stage is influenced by the volume of grain handled, levels of purity required, handling infrastructure, and the extent of risk and risk-sharing.

With increased differentiation, grain attributes require more information management and documentation. This added transparency brings new risks and potential liability to suppliers. Depending on the type of IP grain, testing or process certification can be applied for quality assurance. Moreover, as quality becomes more critical in buyer decisions, even commodity grades for grains and oilseeds may need to be revised to reflect intrinsic qualities valued by end-users and to reward farmers capable of producing such grades. When testing is not feasible (credence attributes) or is prohibitively expensive, certification may be necessary.

The distribution of benefits from value added in the differentiated grain market has not received sufficient attention from economists outside studies on GM corn and soybean varieties. At the farm level, IP costs and yield drag may not be covered by price premiums. In this case, only high-performance farmers may earn adequate returns, and the high turnover of farmers in specialty crop production attests to this. Handlers/buyers determine their share of value captured through contracts, and technology holders can capture much of the value through intellectual property rights.

Increasing grain differentiation in the U.S. food and feed industry has raised questions about public roles. The argument for public interventions to make markets more efficient, as when USDA facilitates commodity markets, may not hold for IP grain markets. The collecting of price information for commodities is not easily extended to specialty grains, as the latter are heterogeneous, small scale, and locally concentrated. Moreover, price information can be proprietary, established through private supplier-buyer contracts. Information on specialty or IP markets has come mostly from university or private industry surveys. Likewise, USDA-approved grades for specialty grains may not be warranted since desired traits are idiosyncratic.

The public can play a supportive role in certification/testing of specialty traits and process quality, not in standard setting per se, but in providing standardized certification of privately administered testing methods.

Where direct public regulatory roles have become justified—as in the areas of public health (mad cow), safeguarding the food supply against costly disruptions (biopharmaceutical crops), and national security (bioterrorism)—resulting regulations have created new demands for identity preservation and traceability systems likely to stimulate the growth of IP grain markets. For example, the U.S. Bioterrorism and Biosecurity Act of

2002 calls for “step-back/step-forward” traceability for all food and feed moving within commercial channels. U.S. grain exports, including IP grain, are now subject to fast-changing regulatory laws that also require more traceability. Examples include the EU food traceability and labeling law and the Cartagena Protocol on Biosafety. Improving U.S. competitiveness requires government involvement in negotiations to harmonize standards, labeling, and tolerances and to fashion equivalent standards for crops, plants, and commodities entering international commerce.

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