

# Product Differentiation Alternatives: Identity Preservation, Segregation, and Traceability

**Stuart Smyth**

*Ph.D. Candidate, Biotechnology, University of Saskatchewan*

**Peter W.B. Phillips**

*Professor of Agricultural Economics, NSERC/SSHRC Chair in Managing Knowledge-based Agri-food Development, University of Saskatchewan*

Numerous terminologies exist to describe product differentiation systems. The leading terms are *identity preservation*, *segregation*, and *traceability*. Frequently, the terminology surrounding these distinct systems is used interchangeably. This creates confusion within the agrifood industry. This paper offers working definitions and a practical taxonomy for identity preservation, segregation, and traceability.

**Key words:** identity preserved production and marketing, IPPM, segregation, supply chain management, traceability.

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## Introduction

The global agricultural commodity system is being revolutionized as an increasing number of cereals and oilseeds are being differentiated to ensure that their value or uniqueness is captured and maintained throughout the supply chain.

The definition of product differentiation can have several nuances, depending on the justification for the differentiation. Frequently the terms *identity preserved production and marketing* (IPPM), *segregation* and *traceability* are used interchangeably in biotechnology and supply chain literature. This is misleading. The misconceptions are about the distinct role that each of these systems has in the supply of agrifood products. This paper offers working definitions and a practical taxonomy for identity preservation, segregation, and traceability.

Section 2 examines the literature on product differentiation and provides definitions for each system. A detailed examination of the features that are unique to each form of product differentiation is offered in Section 3. Product differentiation methodology is examined in Section 4. Three product differentiation cases in Canadian agriculture are examined in Section 5 and the paper's conclusions are discussed in Section 6.

## Definitions of Product Differentiation

The purpose of this section is to identify definitions that exist in the literature to date and to suggest definitions where the literature is absent.

### **Identity Preserved Production and Marketing**

The first product differentiation system, identity preserved production and marketing (IPPM), has evolved over time in the grain and oilseed industry. Purchasers of raw products became more demanding about the quality and purity of the product they were purchasing,

so the grain handling system gradually developed distinct channels to market the differing grades of grains and oilseeds. All grains and oilseeds are purchased by a grading system in today's marketplace; this grading system has premiums that rise as one moves from low to high grades. The relationship of premiums to differing grades for private market incentives is the defining feature of an IPPM system.

Identify preserved production and marketing systems are initiated by private firms in the grain and oilseed industry to extract premiums from a marketplace that has expressed a willingness to pay for an identifiable and marketable product trait or feature. An IPPM system is a "closed loop" channel that facilitates the production and delivery of an assured quality by allowing identification of a commodity from the germplasm or breeding stock to the processed product on a retail shelf (Buckwell, Brookes, & Bradley, 1999; Lin, 2002). These IPPM systems are predominantly voluntary, private firm based initiatives that range between systems that are loosely structured (e.g., malting barley) with high tolerance levels and those with rigid structures (e.g., nonGM European markets) with minimal tolerance levels. Firms operating in minimal tolerance systems achieve this by developing and adhering to strict protocols that specify production standards, provide for sampling, and ensure appropriate documentation to audit the flow of product.

A survey of the literature on IPPM shows that although there is growing discussion about IPPM systems, there are very few working definitions. Lin (2002) suggests that an identity preservation system

is a more stringent (and expensive) handling process and requires that strict separation, typically involving containerized shipping, is maintained at all times. IP lessens the need for additional testing as control of the commodity changes

hands, and it lowers liability and risk of biotech and non-biotech commingling for growers and handlers. (p. 263)

This definition conflicts with the one offered in this paper, as Lin sees IPPM as having a limited role in the movement of grains and oilseeds due to extremely low tolerance levels. Lin's definition of IPPM and segregation still deals with the same system—one that is initiated voluntarily by private firms in an attempt to capture premiums. It is shown below how IPPM systems differ from segregation systems.

The remainder of the literature on IPPM systems relates to theoretical and operational uses of IPPM systems. Bullock, Desquilbet, and Nitsi, (2000) and Bullock and Desquilbet (2001) discuss differentiation between GM and nonGM products, and Herrman, Boland, and Heishman (1999) examine the feasibility of wheat identity preservation. Bender et al., (1999), Bender and Hill (2000), and Good, Bender, and Hill (2000) have released a series of papers on handling specialty corn and soybean crops, with costs being the focus, not the defining of the system used to handle the specialty crop. Additionally, Miranowski et al., (1999) offer some perspectives on the economics of IPPM, and Kalaitzandonakes, Maltsbarger, and Barnes (2001) provide a solid theoretical model for examining the cost of identity preservation.

Numerous IPPM systems operate around the world. Some extend only between the breeders and the wholesale market or processor, while others extend right up to the retailer. Their structure depends on the attribute being preserved. For instance, some novel oils, such as low linolenic oils that are more stable in fryers, only have value at the processing level, while others, such as high oleic oils, have health attributes that can be marketed to consumers. Identity preserved production and marketing systems are important for providing information to consumers about the provenance of a product, as those attributes are not visible or detectable in the product itself.

Many key players in the agrifood sector are involved in IPPM systems today. Cargill has an IPPM system in place to export the Intermountain canola variety to Japan. This canola variety gives off virtually no odor when used to fry food. General Mills operates an IPPM system for a variety of white wheat possessing a trait for "flake curling" when processed into breakfast cereal. DowAgro Sciences uses an IPPM system to export the Nexera canola variety to Japan, where it is sold into the specialty gift oil market. Later in this paper we docu-

ment one of the larger IPPM systems operating since 1995—the Warburtons wheat IPPM system.

### **Segregation**

The second product differentiation system, segregation, has frequently been applied incorrectly to the grading of different classes of grains and oilseeds in order to receive a higher price for the commodity than if it were allowed to be commingled. Segregation systems have a formal structure and, in fact, can act as regulatory standards. Segregation differs from IPPM in that the focus of the system is not on capturing premiums but rather on ensuring that potentially hazardous crops are prevented from entering supply chains that have products destined for human consumption.

Segregation can be viewed as a regulatory tool that is required for variety approval and commercial release of grain and oilseed varieties that could enter the supply chain and create the potential for serious health hazards. Segregation systems can be developed as part of a variety registration process, where government regulators use contract registration to ensure that certain novel varieties will not enter the handling system of like varieties. The private firm seeking registration of the novel variety has to demonstrate that there is a segregation system developed to ensure the containment of the variety.

Lin (2002) defines segregation as the requirement "that crops be kept separate to avoid commingling during planting, harvesting, loading and unloading, storage and transport" (p. 263). Segregation systems will be used when potential food safety concerns exist over the commingling of the segregated product and all other like products. In short, IPPM systems are used to capture premiums, and segregation is used to ensure food safety.

To clarify concepts, a well-established segregation system for high erucic acid rapeseed, operating in Canada since 1982, will be examined later in this paper.

### **Traceability**

The third product differentiation system, traceability, is commonly used in the food industry. Retail products found with unacceptable bacteria levels or intolerable levels of pesticide or chemical residues need to be quickly and completely removed from store shelves. Traceability systems allow for retailers and the supply chain to identify the source of contamination and thereby initiate procedures to remedy the situation.

The key focus of traceability is increasingly on food safety. For the purposes of this paper, traceability will refer to systems that focus on ensuring food safety. Recently, the focus for developing traceability systems for new sectors of the marketplace has shifted from food safety towards extracting premiums from the marketplace. Extracting market premiums could never be the driver for developing a traceability system. In and of themselves, traceability systems do not motivate quality—they simply trace it.

The International Organization for Standardization (ISO) defines traceability as the “ability to trace the history, application or location of an entity by means of recorded identifications” and Codex has adopted this as their working definition for all Codex standards (Codex Alimentarius Commission, 2001). The EU (2001) defines traceability quite clearly in relation to GM products. Directive 2001/18/EC defines traceability as

the ability to trace GMOs and products produced from GMOs at all stages of the placing on the market throughout the production and distribution chains facilitating quality control and also the possibility to withdraw products. Importantly, effective traceability provides a “safety net” should any unforeseen adverse effects be established. (p. 2)

The economic literature from supply chain management defines traceability as the information system necessary to provide the history of a product or a process from origin to point of final sale (Wilson & Clarke, 1998; Jack, Pardoe, & Ritchie, 1998; Timon & O'Reilly, 1998). Although Dickinson and Bailey (2001) suggest that their results from a laboratory auction market regarding features of meat traceability show there is willingness by consumers to pay premiums for traceability, the key focus is on food safety. Prior to adopting traceability systems, there must be a clear indication of specifically what aspects of food safety can be improved by the adoption.

Various traceability systems have been established in Europe, North America, and elsewhere. In Canada, traceability was developed in conjunction with a quality assurance system to reassure export markets about the quality of Canadian beef products. However, it should be noted that this system has been met with great resistance at the farm level, as producers do not want to allow government regulators onto their farms or provide regulators with any sensitive farm information. In a similar quality assurance effort, the Canadian grain and oil-

seed industries are conducting a two-year pilot project in 2002 and 2003 to evaluate the costs and benefits of an on-farm hazard analysis critical control point (HACCP)-based traceability system. We examine the implications of this proposed traceability system later in this paper.

### Options for Product Differentiation

Each product differentiation system has features that are unique, while also possessing features that are common to the other systems. Table 1 compares numerous features of product differentiation. These features are classified into those that apply to the complete supply chain and those that apply to three distinct stages of supply chains. The first stage includes seed development, production, first processing, and handling. The second stage includes processing and manufacturing; the third stage includes food retailing and consumption.

### Overall Supply Chain Management

Certain features of the various product differentiation systems are important to the entire supply chain. The objective of an IPPM system is revenue management. Premiums need to be available to attract participants, and the efforts of participants are directed towards receiving a share of the premium. Participation in these systems is voluntary. The lead stakeholders in IPPM systems are private firms seeking to capture the increased value of special traits. The role of the regulatory body is to ensure that industry standards are in place to prevent consumer fraud. The information may be asymmetric, as only the product seller can know with certainty what level, if any, of cheating has occurred in the delivery of the product. Moral hazards may be present due to the presence of premiums. Effective IPPM systems that span entire supply chains must have accurate two-way information flows. This means that information about purity and quality of the product flows downstream and that information coming from consumer demand flows upstream. Although the information flow in IPPM systems is two-way, the focus of these systems is downstream. Participants in the system want to ensure they are extracting a portion of the value of the special trait while they are involved with either the production, processing or retailing of the product. This means that each participant will focus on the needs of the next participant in the supply chain. Market failure can result in fraud charges for mis- or improper labeling and also create consumer awareness that certain brand names cannot be trusted. Testing and auditing is

**Table 1. Comparing identity preservation, segregation, and traceability.**

	IPPM	Segregation	Traceability
<b>Overall management</b>			
Objective	Revenue management	Liability management	Product safety
Status	Voluntary	Mandatory	Voluntary or mandatory
Lead stakeholder	Private company	Regulator	Commodity group, standards organization, or regulator
Regulatory agency involvement	Consumer fraud	Regulatory oversight	Consumer fraud
Information	Asymmetric	Full	Asymmetric
Risk	Moral hazard	None	Moral hazard
Information flow	Two-way	Two-way	One-way
Supply chain focus	Downstream	Downstream	Upstream
Penalties for failure in product market	Consumer fraud charges; lost brand value	Criminal prosecution; mandated product recalls	Consumer fraud charges; exclusion from product category
Testing/auditing	2nd party/brand owner	1st party/regulator	3rd party/standards organization
<b>Production stage features</b>			
Production arrangements	Formal production contracts	Regulation and contracts	Membership in quality standard
Production controls	In-season agronomic rules vary with product	Formal buffer zones; post production land use controls	Process standards adopted and record keeping
Premiums for producers	Short and long term	Short and long term	Short term
<b>Processing stage features</b>			
Enforcement	Private	Public	Collective
Quality criteria based on	Product standards	Regulations and/or HACCP rules	Processes (e.g. ISO)
Tolerance levels	Variable	Set in law	Performance based
Testing/auditing	2nd party	1st party	3rd party
<b>Retail stage features</b>			
Provides access to	Branded product markets	Markets	Product categories
Information provided to	Consumer	Regulator	Regulator, retailer, or processor
Final market price premiums	Yes	None	None
Labeling	Private brands	None	Quality standard

done by second parties acting on behalf of the brand owner or developer of the special trait.

The objective of segregation systems is to manage any and all liabilities that may arise through the production and processing of the commodity. Participation is not optional—any producer or firm involved with segregated products must comply with standards established and approved by the regulator. The private firm has the responsibility of developing the actual system, but the regulatory agency is the final arbiter on approving the system for field use. Information is fully disclosed due to the importance of protecting food safety, which results in the removal of risks in the system. Segregation systems must have two-way information flow due to concern about food safety should commingling occur. The leading reason why the StarLink™ corn segregation failed is the lack of two-way flows of information. Aventis (now Bayer) and their agents presented the prin-

ciples of the stewardship program they had designed to ensure segregation and did not incorporate any feature to allow information about the actual operation of the system to return back to Aventis. The focus of product delivery within a segregated supply chain is downstream. Segregated commodities commonly have industrial value, so these products are supplied to meet the criteria of the processor. The costs of market failure would see a complete recall of all products and any products suspected of being affected. Market failure may also result in criminal prosecution in the most severe instances. Testing and auditing are vital features of segregation systems and are conducted by agents of, or acting on behalf of, the regulator. This process reinforces the level of trust with foreign export markets.

The objective of traceability systems is ensuring that products available for consumption are as safe as possible. Participation in a traceability system can be volun-

tary; this depends on where in the supply chain the participant is located. The closer the participant is to the start of the supply chain, the more likely it is that participation is voluntary. The lead stakeholder may be a commodity group demanding greater clarity in (or selection of) food products, a standards council comprising industry representatives from all sectors of the supply chain, or the regulator ensuring consumer protection. Information may be asymmetric due to the voluntary nature of the start of traceability supply chains. A moral hazard may also exist due to the inability to test fully for some traceability features. Traceability system information flows are one-way, as these systems are designed to react quickly to food safety concerns. If a product is discovered to exceed any defined tolerance level in the supply chain, traceability is used to identify the source of the problem and to locate any and all retail products that may be affected. This results in the focus of traceability systems being upstream. Market failures can also result in consumer fraud charges in addition to permanent exclusion from selling into that supply chain. Testing and auditing are conducted according to the standards developed by third-party organizations.

### **Production Stage Features**

Historically, this has been the starting point for supply chains, as seed development firms commercialize new crop varieties and market the benefits to agricultural producers. This push version of supply chains has had difficulty adapting to consumer demands for a pull supply chain.

Identity preserved production and marketing systems are developed voluntarily by private firms to ensure that all stakeholders in the supply chain for a specific product capture a share of the value from specialty traits. Private firms may use technical use agreements (TUAs) to protect the intellectual property of the specialty traits, or they may use production contracts that have specific conditions that producers must meet in order to receive relevant premiums. These systems are common for niche market and are typified by small acreage and low volumes. There is presently some debate as to whether long-run premiums for producers are sustainable, as they may be bid away through competition.

Segregation is focused on ensuring that the integrity of the special trait is not allowed to adventitiously commingle with other products destined for the food and feed supply chain. Production contracts are used by the private firms to ensure that all of the commodity being

segregated is collected and that the producer retains no amount of seed. Buffer zones are required for segregation systems as a preventative measure for reducing cross-pollination. Producers may also have restrictions placed on what crop varieties are allowed to be grown the following year on fields that produced segregated crops. Premiums are available in both the short and long term to ensure that product supply is maintained.

Traceability is very fragmented at the producer stage. Production arrangement is accomplished largely through membership in the organization established to create and manage the industry. Production control is accomplished through industry standards and stringent record keeping. The cost of initially becoming involved in a traceability system results in short-term premiums being available to attract producers. Long-term benefits are not evident, as the premiums evaporate when the desired number of producers become involved.

### **Processing Stage Features**

Processing stage features are those of firms involved in the manufacturing of food products. Most of these features contain aspects of quality assurance and industry-developed standards.

Quality standards are enforced by private commitment to industry standards, as the product value is greater given higher purity and/or protein levels. Standards enforcement is crucial, as products that do not conform to the desired quality level will not be accepted. Tolerance levels vary from product to product and also depend on the preferences of the final consumer. Testing and tolerance levels are important to ensure that the purity and the high quality levels of the product are maintained. Frequently, second parties conduct these tests.

Enforcement of standards is very important in segregation systems. To ensure that products that could be a hazard to the human food supply chain are prevented from entering that supply chain, functional operating standards must be agreed to by all participants. The enforcement of these standards needs to be rigorous. Quality is defined in regulations or is created through the implementation of a HACCP system. Tolerance levels for commingling are set by the regulator. Because of the importance of standards, the features of testing and tolerance levels are also important. Testing needs to be conducted frequently to ensure that segregation is being done properly and that none of the product is entering other supply chains accidentally. This is done by agents of the regulator.

The processing stage is very important for traceability, as this is the stage in the supply chain where traceability begins to be rigorously applied. Enforcement of standards is valued in traceability due to the nature of traceability to focus on increased food safety. The lack of high standards and careful enforcement of the standards results in costly recalls of products; therefore, the enforcement of standards is done collectively. Quality is focused on the production processes to ensure that the highest standards possible are maintained at all times. Tolerance levels exist for food safety reasons, as no product can be entirely free of potentially harmful effects, so tolerance levels are established at levels that ensure safe consumption. When tolerance levels are exceeded, a risk of harm to consumers develops; these products must then be recalled from the marketplace. The costs of recall are substantial. Not only does the firm incur the cost of gathering and disposing of the product in question, it may also incur a loss of consumer trust in its brand name that will require aggressive marketing campaigns to overcome. Testing and auditing of traceability systems are done by third parties.

### **Retail Stage Features**

The final stage of the supply chain is the retail stage. The features in this category apply to those firms that are involved with selling food products to consumers. This is the stage of the pull supply chain that is now seen as driving many modern supply chains.

Identity preserved production and marketing systems may play a large role in the introduction of new GM agrifood products. New GM products may be introduced without complete international market acceptance, and IPPM systems can be used to ensure continued market access. An IPPM system is able to provide consumer information on the uniqueness of the branded product. For an IPPM system to function properly and ensure that all stakeholders remain committed to the process, final market price premiums must be available. If this premium is not available for the retailer, an incentive is created for the retailer to no longer carry the product. Products of IPPM systems will need to be labeled, because if the consumer has no means of identifying the value of the product, the consumer will not pay a premium to purchase it.

Segregation systems are also used to ensure that market access is continually guaranteed. A coordinated education and marketing effort by regulators and private firms can be effective in creating trust in foreign markets that production of potentially hazardous products

can occur and not jeopardize export markets. Most segregated products are concluded at the processing stage; therefore, there are no final market premiums available, nor is labeling of the product a concern.

Traceability is crucial for providing access to new categories of products. Many markets have demanded documentation regarding product composition prior to allowing market access. Consumer information is fundamental for traceability systems, as they are designed to increase information regarding food safety to consumers. Information is also provided back up the supply chain to regulators and processors. Final market premiums are not available for traceability systems. Labeling is important to traceability to ensure high quality standards and allow consumers to identify with this feature.

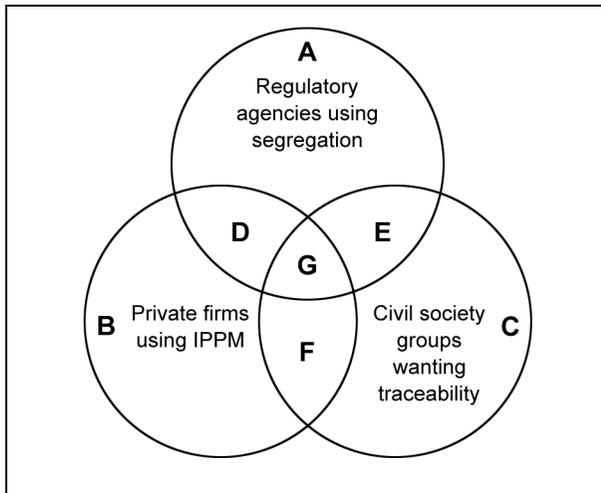
This attempt to identify features common to product differentiation classifies them as to how they pertain to identity preservation, segregation, and traceability. As is evident, some features differ depending on the system in which they are applied. It is important for those involved in product differentiation to examine what features are most commonly related to the product and how those features overlap. This model of comparison will assist with determining which system best relates to the identified needs of the product being differentiated.

### **Reality of the Marketplace**

Figure 1 shows how the various product differentiation systems have areas of overlap where jurisdiction and incentives can be difficult to discern. Each stakeholder has unique interests ensuring that their system successfully achieves the defined objectives and satisfies (both in financial and informational terms) the supply-chain participants and the final consumers.

The stakeholders involved with product differentiation are regulatory agencies, private firms, and civil society groups. Each stakeholder correlates with a stage of risk analysis. The regulatory agency is responsible for risk assessment; private firms deal mainly with risk management; and civil society groups focus on risk communication. Regulators decide to segregate commodities that pose negative health impacts; private firms use IPPM systems to capture value of special traits; and civil society groups seek traceability to inform consumers about important health issues.

Section A is typified by commodities requiring strict segregation due to concerns about potential health hazards that may arise due to adventitious commingling. This is done using scientific assessment processes and is the risk assessment stage of a complete risk analysis.



**Figure 1. Interrelation between IPPM, segregation, and traceability.**

*Note: Modified from Putting Institutional Economics to Work: From Participation to Governance, by R. Picciotto, 1995, World Bank Discussion Paper 304.*

This process has been used in Canada to mandate the segregation of high erucic acid rapeseed. This variety of rapeseed requires segregation due to the amount of erucic acid. Canola, by its own definition, must contain less than 2% erucic acid; high erucic acid rapeseed contains over 50% erucic acid (Canadian Grain Commission, 1998). In the US, segregation of StarLink™ corn was required by the Environmental Protection Agency, as this variety had not received regulatory approval for human consumption.

Section B is dominated by private firm initiatives to capture a share of the value associated with a special trait as a return on investment. The IPPM systems that operate can range from rudimentary systems with high tolerance levels (e.g., malting barley) to rigid systems with minimal tolerance levels (e.g., nonGM shipments to Europe). Firms identify a segment of the marketplace that is willing to pay a premium for a product with a specific feature, and these firms use IPPM systems to deliver the specified product. A British bakery, Warburtons, has identified a segment of the UK bread market that is willing to pay a premium for high-quality baked bread. The wheat for this bread is grown in Canada and shipped to the UK using an IPPM system.

Section C is characterized by products present in the marketplace with traceability systems for food safety concerns. One of the more common uses of traceability systems is in the meat and dairy sectors, where products can be recalled using bar codes if bacteria levels are too high.

Section D is the overlap between private firms and regulatory agencies. This is typified by cooperation between regulatory agencies and private firms to ensure that commodities that could be harmful to the bulk or pooled systems are effectively segregated. Systems that develop and operate in this area would be HACCP-based, as these systems are initiated by the private sector with the close involvement of food safety authorities. Molecular farming (when it arrives) will be associated with this area. The regulatory bodies will be very involved in the regulation of molecular farming and will demand segregation in numerous cases; the biotechnology firms will want aspects of IPPM systems to ensure that the value is captured.

Section E is associated with mandatory nutrition labeling that is required by law through regulatory agencies for the benefits of consumer health. The trend in basic nutritional labeling is to require that all food products provide consumers with basic information regarding their contents. The labeling that occurs in this area is not done for health safety reasons (as in Section C), but rather for health improvement reasons. By providing nutritional information it is hoped that consumers make healthier food purchases.

Section F is the overlap between private firms and civil advocacy groups and is defined by firms using enhanced nutritional or product quality to extract premiums from consumers. The systems operating in this section are for small niche market products that have aspects of IPPM and are labeled within the principles of traceability. Organic products and products marketed as GM-free would fit in this category. None of the above products can make any substantiated claims about increased food safety, so they use increased product information as a marketing tool to create price premiums. Quality assurance is also an important issue in this area, as private firms use ISO standards as justification for including premiums. Country-of-origin labeling would also be located in this section, as it provides firms with the opportunity to market this information.

Section G is the small area at the center of the model, where all stakeholders overlap. This section has aspects of identity preservation, segregation, and traceability. The introduction of GM wheat would fit in this area. It is presently anticipated that the introduction of GM wheat will have greater regulatory requirements than GM canola; the biotech industry hopes that GM wheat will involve price premiums (e.g., Monsanto has publicly pledged to produce GM wheat using an IPPM system); and consumer groups are calling for aspects of traceability for any products resulting from GM wheat.

**Table 2. Costs and benefits of the Warburtons IPPM system.**

Participant	Costs	Benefits
<b>Producers</b>	Purchase certified seed annually Specific crop management practices Additional paperwork	C\$20/t premium Grower contract to purchase entire crop
<b>CWB</b>	Increased administration Reduces quality of remaining wheat	Collects premium (C\$2–3/t, est.) Guaranteed market
<b>Agricore</b>	Writing and monitoring contracts Liability for commingling Underutilized storage space Loss of blending opportunities	Certified seed sales Additional specified input sales Marketing opportunities Receives fee for IPPM services (C\$7.50–10/t, est.)
<b>Warburtons</b>	Expenses to producers, CWB, Agricore (C\$29.50–33/t, est.) Quality control program including a testing lab in Manitoba	Higher premiums on sales (45p–50p/loaf or C\$1–1.10/loaf) Stable, dependable supplier Guaranteed delivery of high-quality milling wheat

*Note: From "An Examination of Bread Wheat Quality and its Effect on Vertical Co-ordination in the Wheat Supply Chain," by J. Kennett, 1997, University of Saskatchewan.*

This attempt to visualize the various methods for product differentiation within the grains and oilseeds market can also be applied to other sectors of agriculture. The role of government within this model may well vary according to the level of trust that consumers have in the product. If consumers have a low level of trust in the private firm or the nature of the product, regulatory agencies may become involved by using segregation standards to bolster public confidence. Conversely, the private firm may also seek to have regulatory agency involvement with segregation standards to show that public concerns are recognized. Many in the agrifood industry agree that the sector is moving towards greater product differentiation. The question that will need to be addressed is which method provides the greatest level of benefits—both financial and in terms of information—to the greatest number of participants and consumers.

### Examples of Functioning Product Differentiation Systems

Using Canadian production practices, operating examples of each product differentiation system can be given. The focus of these examples will be to examine the costs and benefits of each system.

#### **Identity Preserved Production and Marketing**

The Canadian Prairies are consistent producers of high-quality milling wheat. England has a long history of importing wheat from Canada; the baking firm Warburtons imports roughly 200,000 tonnes per year. Prior to the 1995 crop season, Warburtons initiated discussions with the Canadian Wheat Board (CWB) and the Canadian Grain Commission (CGC) in an attempt to ensure

the purchase of superior qualities of milling wheat (Kennett et al., 1998). An agreement was reached with Manitoba Pool Elevators (now United Agricore) to administer the IPPM program under the auspices of the CWB. All of the wheat purchased was grown with the use of producer production contracts. In 1995, producers received a premium of C\$30 per tonne to compensate them for the "extra cost and effort of growing contract wheat, and to attract farmers into the program" (Kennett, 1997). In the following year, the premium dropped to C\$20 per tonne and has remained at this level (Table 2). This premium is to compensate producers for the costs of purchasing pedigreed seed and for storing wheat for longer periods than normal.

In 1996, Warburtons opened a laboratory and pilot bakery in Brandon, Manitoba to ensure that the contracts being purchased met the quality standards demanded by the company (Kennett, 1997). The laboratory tests the quality of the wheat samples provided by the producers and also performs bake tests. Investment for testing, whether for quality or purity, is a key component of this IPPM system. In addition to conducting their own testing, Warburtons also pays the standard CGC testing rate of C\$4.50 per tonne. The CGC is responsible for testing and certifying all wheat exports.

The CWB played a critical role in this IPPM system because of its monopoly over wheat exports. Initially, the CWB was concerned that a system such as this would lead to the "cherry-picking" of top quality wheat (Kennett, 1997). Once the volume of wheat sales was determined, the level was deemed to be of such a low volume that this concern dissipated. For its role in the exporting of this wheat, the CWB charges Warburtons an additional premium (C\$2–3/t grain industry estimate,

R. Cooke, personal communication, January 30, 2001) above and beyond the premium provided to producers, which is “intended to offset any additional administration or logistical costs caused by the program” (Kennett, 1997, p. 65). This premium operates as a cost-recovery program. The CWB incurs additional expenses to ensure that this high-quality milling wheat is exported via an IPPM system and, for this, the CWB receives a premium that covers these costs.

The combination of the three premiums that Warburtons pays ranges from C\$29.50–33 per tonne. With a ten-year average price for wheat of C\$183 per tonne, the cost of this IPPM system is 16%–18% above conventional wheat marketing costs. This cost is reflective only of the costs incurred to have the wheat loaded on ocean-going vessels. Warburtons could experience additional IPPM costs once the wheat reached England.

The fact that this IPPM system has been operated since 1995 would indicate that all the participants are extracting enough benefit to continue with the operation of the system. Producers continue to participate, as the premium must offset the added costs of certified seed purchase costs and on-farm segregation costs. The CWB’s administrative costs are covered, and they have a growing market that requires no marketing costs to maintain. United Agricore is able to generate additional producer input sales via the contracts. Although the management fee is undisclosed (estimated to be C\$7.50–10/t above the standard handling tariff of C\$11/t), one would assume that it must provide enough compensation to United Agricore to allow them to continue managing the IPPM system. (This is not necessarily always true. Beard [personal communication, February 5, 2001] argues that the Western Canadian grain industry is facing such tremendous competitive pressure that some companies are doing things to protect producer and customer market share that may not be completely rational from a purely economic perspective.) Finally, Warburtons is able to sell a superior high-quality loaf of bread in the UK at a higher price, thus justifying the producer premium, fee expenses, and the quality assurance program they have implemented. Loaf bread in the UK is typically in the price range of 33p–39p, compared to 86p for Warburtons bread. It would appear that, so far, the benefits of this IPPM system have been distributed throughout the system, which ensures the future participation of all stakeholders.

### **Segregation**

High erucic acid rapeseed (HEAR) was bred out of conventional rapeseed because of the industrial value of the high erucic acid content. General rapeseed in the 1970s had erucic acid levels that ranged from 30%–40%, which were not high enough to be valued for industrial applications (Natural Sciences and Engineering Research Council, 2001). The University of Manitoba developed a rapeseed breeding program that sought to increase the level of erucic acid to 55%. The first HEAR variety was commercialized in 1982 in conjunction with CanAmara Foods. Erucic acid oil is valued for its lubricant qualities by the plastics industry.

Producers are required to grow HEAR under contract registration. The Canadian Food Inspection Agency (CFIA) mandated this requirement at the time of varietal registration. Under contract registration, regulators from the CFIA have the right to inspect all HEAR fields to ensure compliance with segregation requirements. This requirement has resulted in some producers not proceeding with production contracts, as they do not want to allow government officials access to their farms.

The total annual acreage for HEAR is in the range of 100,000–150,000 acres. Producers receive financial benefits in three distinct forms (Table 3). First, they receive a price premium of C\$1 per bushel (or C\$44/t) above the market price for canola at the time of delivery or contract price lock-in. Second, all producer freight costs (f.o.b. farm) are paid by CanAmara. This amounts to around C\$10/t for producers located in western Canada. Finally, producers are compensated at the rate of C\$25/t for dockage. This final compensation results from the very limited weed control options that producers have with this rapeseed variety. Previously, the largest cost for producers has been the size of the buffer zone. The required isolation distance was initially set at 100m, but private research by CanAmara on commingling due to cross-pollination with canola has resulted in the distance being lowered to 5m. Producers may still be required to harvest this portion of the crop separately and sell it as animal feed, thus losing the opportunity of premiums for 1.13% of the yield from a 160-acre production contract. There is some additional paperwork that is required with the production of HEAR. Producers must complete postseeding surveys and map all fields under production. Producers are required to purchase pedigreed seed on an annual basis from the Saskatchewan Wheat Pool (SWP). This variety of rapeseed is very susceptible to most agricultural chemicals;

**Table 3. Costs and benefits of HEAR segregation system.**

Participant	Costs	Benefits
<b>Producer</b>	<ul style="list-style-type: none"> <li>• 5m buffer zone that may have to be harvested separately and sold as feed</li> <li>• Additional paperwork</li> <li>• Purchase certified seed annually</li> <li>• Reduced weed control options</li> <li>• Inefficient use of storage space</li> </ul>	<ul style="list-style-type: none"> <li>• C\$44/t premium</li> <li>• Freight (f.o.b. farm, C\$10/t, est.)</li> <li>• C\$25/t compensation for dockage</li> </ul>
<b>Saskatchewan Wheat Pool</b>	<ul style="list-style-type: none"> <li>• Liable if the rapeseed seed and canola seed become commingled</li> </ul>	<ul style="list-style-type: none"> <li>• Certified seed sales</li> </ul>
<b>CanAmera</b>	<ul style="list-style-type: none"> <li>• Grain confetti provided to each producer</li> <li>• Random audits as required by and conducted by CFIA</li> <li>• Crushing facility must be cleaned before and after HEAR processing</li> <li>• Producer education</li> <li>• Complete policy manual submitted annually to regulatory agency</li> <li>• Expenses of C\$82-84/tonne</li> </ul>	<ul style="list-style-type: none"> <li>• Guaranteed industrial market</li> <li>• Only processor of high erucic acid rapeseed in Canada</li> </ul>

*Note: From T. Slusar, Grain Manager for CanAmera Foods, personal communication, May 27, 2002.*

as a result, most farmers are not able to spray for weed control. This can create weedy fields for the subsequent crop and thus raise the cost of subsequent-year weed control. Producers are also required to bin all HEAR separately from other crops; this can result in underutilized on-farm storage.

The SWP has been contracted by CanAmera to multiply and sell certified HEAR seed for producers. This provides the SWP with additional seed sales. The costs for the SWP are almost nonexistent, as the only potential cost would be if some canola seed were inadvertently mixed with HEAR seed. If this were to occur, the SWP would have to compensate producers should the level of erucic acid not meet the minimum standard of 47% erucic acid demanded by CanAmera.

CanAmera is the only processor of HEAR in Canada, giving them the potential to exercise monopoly pricing powers. Given the low acreage, CanAmera has a guaranteed industrial market for the entire annual production of erucic acid. CanAmera purchases grain confetti and distributes it to each product contractor. Additionally, CanAmera pays for any costs associated with the random audits by the CFIA. The crush of HEAR is coordinated to follow a scheduled shut down and cleaning of the processing plant. The HEAR is processed and then the plant is shut down and cleaned again before it starts to process other oilseeds. The cost of this has been estimated to be C\$3–5/t (Smyth & Phillips, 2002). CanAmera has also devoted some resources to assist in educating producers about the mandatory segregation systems for HEAR and the procedures and conditions that will apply if they sign a production contract. Finally, CanAmera is required annually to submit a

complete policy manual regarding the structure of the segregation system to the CFIA for review.

The total identifiable cost to CanAmera for this segregation system ranges between C\$82–84 per tonne. The canola price in western Canada over the past five years has been C\$346, which is a cost increase to CanAmera of 24% above the cost of handling conventional canola. The cost of this segregation system may have ranged as high as 30% of the market price in the early to mid 1990s, when canola prices were lower. The value that CanAmera receives from the plastics industry for supplying erucic acid must exceed C\$85 per tonne to justify continuing the HEAR program.

### **Traceability**

The demand for traceability systems originated in meat and dairy products. Concern about unsafe bacterial levels of *E. coli* or *Salmonella* resulted in systems to ensure that products sold to consumers had acceptable tolerance levels. These systems then moved to fruits and vegetables, as concern about chemical and pesticide residues developed. Presently, Canada is examining the merits of transferring traceability systems into the grains and oilseeds sector of agriculture.

Canada is presently in the initial stages of launching a traceability system for grains and oilseeds. The goal of the Canadian On-Farm Food Safety (COFFS) program is to provide assurance to export markets and domestic consumers that the production and marketing of Canadian grains and oilseeds have the highest standards possible. The initiators of this program are citing the rising level of concerns about quality and food safety coming

from foreign export markets as the driver of this program. The argument being used to justify this program is that the entire supply chain has to accept responsibility for food safety.

The leading hazards that have been identified are biological, chemical, and physical. Biological hazards are those that can cause illness or death due to the presence of microorganisms. The presence of bacteria, yeast, mold, viruses, parasites, and mycotoxins in processed food can have serious health implications. Chemical hazards are residues from farm chemicals, cleaning fluids, drugs, lubricants, heavy metals, and any naturally occurring toxins. Physical hazards are foreign objects that may cause physical injury to a consumer. Common foreign objects in grains and oilseeds are things like glass, wood, stones, metals, noxious weeds, and insect and rodent fragments. The focus of the COFFS program is to reduce or eliminate the presence of any of these hazards, which is crucial for the marketing of high quality Canadian grains and oilseeds.

Ultimately, this system will be used as a marketing tool by Canadian export firms to extract premiums under the guise of increased food safety. Table 4 outlines the costs and benefits of the grains and oilseeds traceability system.

Clearly, the cost of an on-farm HACCP-based food safety system will outweigh the benefits. Premiums may be available initially to attract producers to the traceability program. This was the case in the Scottish Quality Cereals (SQC) program that is operating in Scotland. To attract producers of malting barley to the SQC program, a premium of 1GBP was offered in the first year of the program (Fearne & García Martínez, 1999). This premium was discontinued in the second year, as the desired number of producers had been attracted to supply high-quality malt barley. Producers may ultimately have no choice but to join the program to ensure that they continue to have market access. If enough foreign markets demand traceability features, all on-farm grain and oilseed sales may have to be done under the standards of the COFFS system.

The cost to producers will be the main barrier to entry. The cost of documenting and recording every single operation related to planting, spraying, and harvesting a crop will be substantial. Many producers will have to make capital investments for new equipment and computers to allow them to participate. Annual certification and audits by CFIA regulators will also be a substantial cost. As in the segregation case, producers are extremely reluctant to allow federal regulators access to their property. This may well be a major hurdle for the

**Table 4. Costs and benefits of the COFFS traceability system at the producer level.**

Costs	Benefits
<ul style="list-style-type: none"> <li>• Time devoted to increased record keeping</li> <li>• Infrastructure investment costs to upgrade to meet new standards</li> <li>• Annual certification</li> <li>• Failure to comply with standards</li> <li>• Annual audit procedure</li> <li>• Reduced ability of producer to sell produce if not a member</li> <li>• Increased potential for liability</li> </ul>	<ul style="list-style-type: none"> <li>• Premiums for early adopters, but likely to disappear when sufficient numbers have adopted</li> <li>• Continued market access</li> </ul>

*Note: From Canadian Grains Council Food Safety/IP/Traceability Workshop, Winnipeg, Manitoba, February 11, 2002.*

COFFS system; historically, Canadian agriculture has not been regulated to the level that is common in Europe. The failure to comply with the predefined HACCP standards may result in producers finding themselves in the situation where their grain or oilseed crop does not meet the traceability standards and therefore may have no option to move the commodity. If traceability standards develop to the same level for animal feeds, producers would not be able to sell unacceptable grains or oilseeds into either the grain and oilseed or animal feed industries. The only remaining option for the producer would be to burn or otherwise destroy the entire crop. The final cost—increased potential for liability—may in itself be enough to deter participation. Any lawsuit that claims harm from consuming a processed food product would potentially be able to trace the cause of the harm back to the producer of the grain or oilseed. This would result in individual producers being included in litigation suits, where substantial financial costs can be awarded for harm and suffering.

This is an example of a traceability system being developed to attract premiums from export markets. The initiators of the COFFS system have not provided examples of how food safety will be increased, but instead are focusing on extracting price premiums from foreign buyers of Canadian grains and oilseeds. This clearly goes against the justification for traceability systems and the success of the COFFS system may never be realized.

## Conclusions

This review of existing product differentiation systems offers a number of lessons for both industry and government.

First, the examination of product differentiation systems has shown that the use of these systems is rising in agriculture. The increase in these systems and the growing role of regulatory agencies in on-farm standards will continue. Essentially, a more vertically integrated supply chain for produced and marketed products is developing. As an increasing variety of commodities are produced using product differentiation systems, producers will face a wide array of options that may complicate their farming operations. Industry and government may need to assist farmers to gain the expertise to evaluate properly their options.

Second, although we know that these systems are costly to develop and manage, it is not clear that the current estimates would reflect the costs of significantly expanded use of product differentiation. The cost figures for IPPM systems that have been documented range between 15% and 25% above the cost of conventional products. It is crucial to remember that these IPPM systems operate at low volumes—usually less than 300,000 tonnes a year—and no system has been documented operating at a substantial volume (say, above one million tonnes). This has led some (both within the biotechnology industry and academics) to suggest that the cost of operating product differentiation systems at a level that has a substantial volume has been greatly underestimated. If this is the case, then it is questionable whether large-scale product differentiation systems could achieve economies of scale that would support long-term use. This may have an impact on the introduction and commercialization of future GM crops.

Third, products that require product differentiation must earn a return high enough to justify the expense. The absolute and relative costs will vary greatly depending on the agronomic traits of the crops, tolerances chosen, and base value of the crop. There are examples of product differentiation systems that have been established that do not earn the necessary value in the marketplace, causing the systems to be abandoned. So far, all of these systems have been purpose-built and rely solely on the capacity of their managers. There can and should be ways to reduce the costs of these independent systems by pooling certain activities and seeking scale economies.

Fourth, the cases highlight that to succeed, the systems not only need to cover all of the costs, but the benefits need to be distributed so that no one in the chain is worse off than they would be outside the system. This is necessary not only to keep participants involved in the system but also to reduce the risk of cheating by participants that would undermine the system itself. With the

approach of third-generation GM crops that contain valuable output-based traits, product differentiation systems will become crucial. The StarLink™ corn example shows that a product differentiation system is only as strong as its weakest link. One participant or group becoming lax and allowing commingling to occur not only destroys the system but also inflicts significantly larger costs on the marketplace. The studies suggest that although effective product differentiation systems may be costly to develop and run, they are cheaper than failure.

Finally, the on-farm assurance of crops appears to be one potential area of weakness. It certainly contributed to the StarLink™ corn failure and plagued the Monsanto and Aventis systems for canola. As more crops are contracted, there is significant potential for conflicting and confusing information to be disseminated to producers. There is ample room for industry and government to consider how they might assist in managing this aspect of product differentiation systems.

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