Potential Economic Impacts of Low Level Presence (LLP) in the Global Wheat Market

William W. Wilson and Bruce Dahl

Introduction

Development of genetically modified (GM) crops has begun and is continuing on numerous fronts and in several countries. Wheat will be one of the first food grains where GM traits are introduced and will likely be a precursor to similar developments for other food grains. GM wheat is currently being developed in a number of countries (e.g., United States, Australia, United Kingdom, China) and by a number of companies (e.g., Monsanto, Bayer Crop Science, Dow Agrosciences, and Limagrain, in addition to several research organizations, including the University of Adelaide, CSIRO, and Victoria Agribiosciences Center—now AgriBio and in the United Kingdom). Traits under development using GM techniques include fusarium resistance (Huso and Wilson 2005; Tollefson 2011; Valliyodan and Nguyen 2006), drought resistance, and protein quality. Indeed, much of the groundwork in GM wheat development is emerging from Australia and setting the stage for development in other countries.

Since the late 2000s, all major agbiotechnology companies have made announcements indicating intentions to enter the GM wheat market, and there have been field trials by a number of companies in the United States during 2011–2013 and in Australia for 4 years. The most common traits being pursued include yield enhancement, drought tolerance (DT), and nitrogen-use efficiency.

The purpose of this chapter is to describe the new wheat partnerships that are forming and the challenges related to LLP that will be confronted as GM wheats are introduced. The first section below describes the reinvigoration of research on

W.W. Wilson (✉) · B. Dahl
North Dakota State University, Fargo, USA
e-mail: william.wilson@ndsu.edu

B. Dahl
e-mail: bruce.dahl@ndsu.edu

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developing new technologies for wheat. Most of these are in the form of partnerships between germplasm providers and technology companies. The second section summarizes the existing literature on models for coexistence of GM and non-GM wheat. The third section highlights recent issues that are emerging in wheat and the final section provides an analysis of issues related to LLP in wheat.

New Technology Initiatives in Wheat

Wheat has been losing its competitiveness relative to other crops, particularly those with GM technology, notably corn, soybeans, cotton, and canola (Wilson et al. 2003; Sosland 2012; Wilson 2008). While this is commonly recognized in North America, it is becoming more apparent in other countries.[1] The effect of this has been to induce most if not all the major technology companies to expand in recent years into technology development in wheat.

Wheat Research Partnerships

In the period prior to 2004 there were several firms working on GM wheat. Monsanto was working on commercializing Round-up Ready wheat (RRW), and Syngenta was working on fusarium resistant wheat (FRW). The development of RRW was technically feasible and ultimately was approved by the US Food and Drug Administration (FDA). However, there were numerous pressures against GM wheat which were apparent at that time. Notably these were issues related to Japanese importers and their resistance to GM wheat and positions taken by the Canadian Wheat Board, among others. In addition, it is important that GM wheat at that time would have to compete for acres with GM soybeans and canola. These were much more profitable at that time and had less consumer and agropolitical resistance. In response to these pressures, Monsanto chose not to commercialize RRW in mid-2005.

After suspending their commercialization efforts on Roundup Ready wheat, Monsanto was the first company to announce its re-entry into GM wheat research in 2009. This followed a period of time which included tightening of supply/demand fundamentals for most crops, and the further proliferation of GM technologies in other competing crops, notably soybean, canola and corn. It also followed a period in 2008 during which, due to crop shortages, wheat prices escalated very sharply.

[1] A recent workshop addressed similar problems in the European Union (Vigani et al. 2013). The concerns were about declining rate of productivity growth, prospects of climate change and they pointed to the decline in the wheat yield growth rate, especially in France, Germany and the UK.

Concurrent with that were efforts to provide agropoltical support for development of GM wheat in the United States, as well as other countries, including both producer groups and end-users. These ultimately provided further support to Monsanto about the potential for both broader based agropoltical support and demand for the technology.

Monsanto's re-entry was followed, within months, by announcements from BASF, Bayer Crops Sciences (BCS), Limagrain, and Dow (DAS).[2] Work on GM wheat had been initiated earlier in Australia by Victoria Agribiosciences Center (VABC, now AgriBio) and Commonwealth Scientific and Industrial Research Organization (CSIRO). Indeed, much of the initial and early work was done in Australia where the primary focus was on drought and, more recently, frost tolerance. These projects were in addition to nearly simultaneous development initiatives for GM wheat in China (Xia et al. 2012). Finally, GM wheat is also being developed in the United Kingdom with field trials during 2012.

In the case of wheat, which contrasts with other crops in which GM has been adopted, most of the germplasm that exists is in the public sector. While this varies around the world, and is still evolving, it important that (1) in the United States, most breeding programs have been public; (2) the Australian breeding system has recently evolved from largely public to largely private; and (3) pressures are emerging for finding varying ways of privatizing wheat breeding in Canada. The publicness of wheat breeding is important from a germplasm ownership perspective. In addition, in wheat there is a high degree of heterogeneity in quality, disease, and agronomic suitability which varies geographically. For all these reasons, a major challenge in developing new technology in wheat is access to germplasm.

As a result of these differences, most of the technology companies have approached development in the case of wheat through various forms of partnerships. A summary of these are shown in Fig. 1. Each of the companies has entered via combinations of germplasm acquisitions (e.g., Westbred by Monsanto), technology investments (e.g., Evogene by BCS), research partnerships (e.g., DAS and DEPI); and germplasm partnerships (e.g., Monsanto, BCS, DAS). These technology partnerships are in addition to those focused on hybrid development (e.g., Syngenta, DuPont). Ultimately, these partnerships and investments will result in substantial investment in new technology for wheat and, once development begins to evolve, substantial pressures for developing channels for commercialization.

Traits Under Development

Several technologies exist for improving wheat, including conventional breeding, marker-assisted-selection (MAS), gene-editing and genetic modification (GM). These

[2] The DAS announcements are available at: Business Wire (2013, 8 April) and Dow AgroSciences (2013). Retrieved 16 April 2013, from http://www.exzactprecisiontechnology.com/why/.

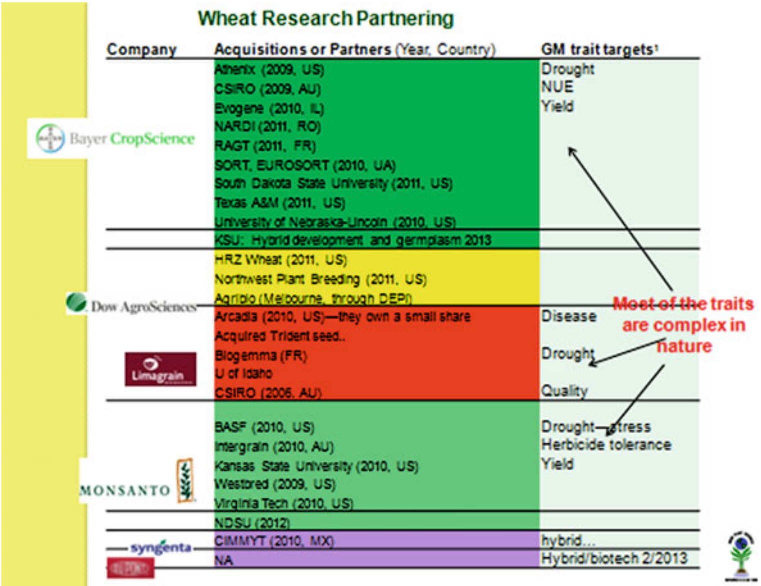

Fig. 1 Recent wheat research partnerships

are in addition to other advanced technologies [e.g., Apomixis, EXZACT™ as being used by Dow AgroSciences (2013)] being applied to wheat. Integrating these breeding technologies (conventional, MAS, gene-editing, and GM) has brought about a paradigm shift in crop development that is referred to as "seeds and traits." This is now a business function that combines novel genetic traits with elite germplasm to develop crops that thrive while expressing the desired trait. The steps include discovering novel genes; transferring them into plant cells; optimizing the genetic trait's expression in the correct plant tissues, at the appropriate time, and in sufficient levels; and incorporating the genetic trait, through breeding, into commercially viable varieties or hybrids. As a business strategy, the introduction of genetic traits using biotechnology neither reduces the importance of superior germplasm in the host plant nor replaces the need for plant science and breeding (Dow AgroSciences, n.d.; Kaehler 2006).

Each firm and organization has made claims about the traits it intends to develop, including yield, drought tolerance (DT), and nitrogen-use-efficiency (NUE). Most likely, these choices were a result of experiences with other crops, plant stress, and anticipated geographical production changes, in addition to concerns about future water availability and cost (Rice Today 2012; James 2011; Sindrich 2012).

Trait development strategy is fraught with randomness and extended periods of development, resulting in substantial risks. Typically, the trait pipeline is referred to as having phases ranging from proof of concept to regulatory approval. Each step is costly, takes several years, and has an uncertain outcome. Finally, revenue streams from trait development do not ensue until a period following regulatory approval, and they are random. GM commercialization also is impacted by regulations regarding GM content, not only in the home country but by all major importing and exporting countries.

Drought tolerance (DT) is an example of a stress trait and has been described in numerous articles.[3] In the case of corn, DT has been a target for many years using non-GM techniques, and Mertens (2012) indicated that "research in the past decades has yielded plants that are much better at withstanding [drought] conditions…" Longer-term results indicate that "today's corn is three times more drought tolerant than varieties from the 1930s" (Mertens 2012). It is unclear the extent to which water efficiency can be improved using conventional or GM breeding techniques, or a combination of the two (Leber 2012). GM trait development for DT involves prospective genes being identified as activated by drought. The efficiency gain by the drought-resistant gene is realized when drought occurs and avoids any yield penalty that potentially could occur with non-drought activated genes in normal conditions. It is thought that "drought tolerant crops look to be one of the most promising upcoming biotech traits in the pipeline, providing the ability to produce 'more crop per drop' of water" (Fatka 2008).

Work with DT corn is more accelerated than other crops, including wheat (Rice Today 2012) and rice (Reyes 2009). Monsanto's GM DT corn was deregulated in 2011, and large-scale field trials were started. Early results were anecdotal but suggested efficiency gains. The 2012 field trials indicated that "corn farmers will lose one-quarter less of their crop than they did during the 1988 drought" (Mertens 2012). Results in Texas and Kansas illustrated up to a 6-bushel advantage over competitor hybrids (Monsanto 2012), and another observation in Indiana suggested "a significantly higher yield, by 30–50 bushels" (Leber 2012). A few studies have alluded to these issues. One pointed to the multiyear implications of drought and irrigation (Peck and Adams 2010) and Diaz indicated that "nearly half of all droughts in the U.S., for example, are multiyear events" (Diaz 1983).

GM wheat continues to be a focus of agricultural technology development in Australia. Since 2005, there have been 17 GM wheat products brought to field trial stage in Australia. Primarily two Australian organizations have relatively advanced GM wheat technologies with current field trials, specifically Agriculture Victoria at AgriBio and CSIRO. Current trials are evaluating a number of traits including abiotic stress (drought, heat, salt, aluminium); increased yield and yield stability; nitrogen use efficiency; altered grain composition and resistance to fungal disease.

A challenge in valuing GM traits is that development time is long, that it is highly risky as a result of uncertainties for numerous random variables, and that it is costly (Shakya et al. 2013; Wilson et al. 2015). Typically, trait development, including regulatory review, takes about 10+ years, costs about $100 million, and consists of a number of distinct phases. Estimates of these costs are difficult because they are ultimately firm-level activities and information is not always published. Goodman (2004) estimated that developing a GM trait costs $60 million and can

[3] As examples, see: Kesmodel (2012), The Economist online (2011), Tollefson (2011) and Wall Street Journal (2012).

take 15 years. Estimates for deregulation costs are in the $6–15 million range (Bradford et al. 2006; Just et al. 2006). A recent study (McDougall 2011) indicated that the average cost of GM trait development is $136 million and that it takes 13 years, although there is substantial variability for these estimates across firms and traits. Monsanto indicated that it will spend at least $150 million on its wheat initiative; this cost includes germplasm and breeding in addition to MAS and GM. These costs reflect what are commonly referred to as discovery, proof of concept, early and advanced product development, and the regulatory phase, although the labels for these functions vary across firms. Given these phases, costs and risks, the models by Shakya et al. (2013) and Wilson et al. (2015) provide a real options framework for valuing technology in GM corn and wheat respectively, at different stages of the product development process.[4]

Alternatives for Mitigating Risks in GM Wheat Marketing

In response to the anticipated commercialization of GM wheat in the mid-2000s, there were a number of studies that examined varying ways of facilitating coexistence in wheat marketing channels between GM and non-GM varieties. Generally, these studies sought to identify strategies that could be used to provide incentives and contractual relationships necessary to keep non-GM wheat segregated from GM wheat. A summary of some of these studies is described below.[5]

Methods of testing and tolerance for GM wheat were examined by Wilson and Dahl (2005, 2006) and Wilson et al. (2007, 2008b). Wilson and Dahl (2005) determined optimal strategies to induce segregation in the US marketing system for export. These studies represent work that sought contract/market based solutions to control GM contents; though close to LLP initiatives, discussed in Sect. "Alternatives for Mitigating Risks in GM Wheat Marketing", these are not the same. The models included risks of adventitious comingling at various stages in the marketing chain and determined optimal sampling and testing strategies to minimize disutility of additional system costs due to testing and rejection that can occur throughout the

[4]In addition to these, similar methodologies were used by Wynn (2014a, b, c, d) using of real options and Monte Carlo simulation to estimate the Australian market value of canola that had been genetically modified to be drought tolerant. The results showed the GM canola to be more profitable than conventional canola and also quantitatively demonstrated that a yield advantage across rainfall levels is necessary for the trait to have market value. Other studies (Wynn 2015a, b, c, d) demonstrated use of real options, Monte Carlo simulation and multicriteria analysis to estimate the global market value of canola that has been genetically modified to be drought tolerant. The results showed the GM canola would be more profitable than conventional varieties and also quantitatively demonstrated that it would not be profitable to pursue commercialisation of GM canola in certain regions, such as Europe.

[5]These are in addition to numerous other studies that had addressed these issues in varying ways and claims regarding segregation. See, as examples: Furtan et al. (2003), Carter et al. (2005) and Bullock et al. (2000).

marketing chain. The studies illustrated that the risks and costs of segregation increased as the tolerance level decreased. These are illustrated in Figs. 2 and 3 and discussed below.

These studies were specified as stochastic optimization models with risks of sampling where random tests were assumed to have accuracies less than 100 %, introducing risks of false positives and false negatives which impacted both buyers and sellers risks. Growers were assumed to declare varieties at the point of first entry into the marketing chain and their declaration was subject to a probability distribution, i.e., grower truthfulness was assumed to be random. Risks of

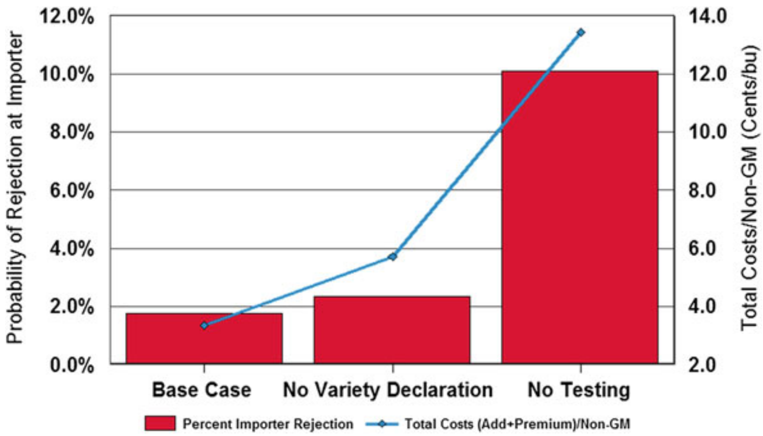

Fig. 2 Effects of variety declaration on adventitious comingling in wheat

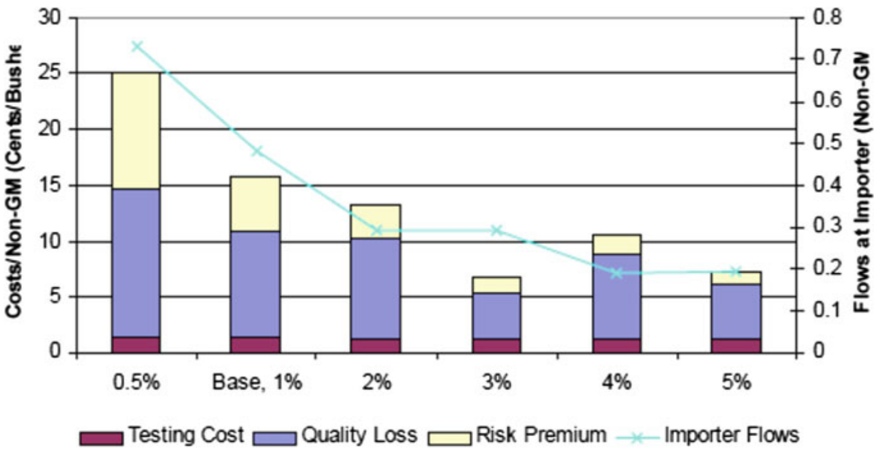

Fig. 3 Effects of importer tolerances on costs and importer flows for non-GM bushels

adventitious comingling were introduced at various points within the marketing chain where comingling can occur. Lots rejected by the importer were assessed a penalty or rejection cost, while those diverted earlier in the marketing chain were assumed diverted to GM wheat segregations.

The base case was a system of testing and tolerance assuming 20 % GM adoption and farmer variety declaration resulted in seller risks of 1.75 % (lots rejected at importer), and buyer risks of 0.02 % (percent of lots exceeding tolerance entering importer flows) at a cost of less than $0.02/bu with the testing and tolerance adding a risk premium of about $0.01/bu over a commodity flow without GM. Total costs for this system per non-GM bushel were about $0.034/bu.

Wilson et al. (2007) expanded the analysis of Wilson and Dahl (2005) by including choice of testing technology or tolerance applied at locations throughout the marketing chain. The optimal testing strategy involved testing at less restrictive tolerances at country elevators and at more restrictive tolerances for ship holds. This strategy results in seller risk of 2.83 % where flows are rejected at importer which do not exceed tolerances, and buyer risk of accepting flows exceeding tolerances of 0.000154 %. Total costs of this system including the risk premium were about $0.16/non-GM bushel.

Wilson et al. (2008b) focused their analysis on EU traceability conformance. Wilson et al. (2008b) found an optimal testing strategy conforming to EU traceability standards would result in increased costs of about $0.50/non-GM bu with a risk premium for the dual traceability system of about $0.21/non-GM bu over a system with no traceability. Seller risk was about 1.7 % of shipments that would be rejected when they are within tolerance limits and 0.01 % of non-conforming flows entering the EU marketing chain.

Testing and tolerance strategies can result in strategies that have low costs and risks to both buyers and sellers. However, test technology and tolerance limits have improved and, as Stephens (2011) notes, current technology allows identification of dust from other crops to indicate positive results for unapproved traits. This results in increased risks of false positives for sellers, which should increase costs as part of the added system costs are rejection costs. The alternative to these types of strategies is trade disruption/exclusion.

Rogue Oregon Wheat and Recent GM Cargo Rejections

Concurrent with accelerated technological development in wheat are two important sets of events, both of which will impact commercialization of new technologies. One can be referred to as the Rogue GM Wheat Found in Oregon; and the other as the Persistent Chinese Rejection of GM Corn Shipments. Each is discussed.

Rogue GM Wheat Found in Oregon

In late April 2013, an Oregon grower detected volunteer wheat that did not die after the field was sprayed with glyphosate. Samples were tested by an Oregon State University weed scientist and determined that they were resistant to glyphosate. Results were reported to USDA and a series of interventions ensued.

As background, Monsanto had field tested Roundup Ready wheat in 16 states from 1998 to 2005. The last tests in Oregon were in 2001. The fields where the sample was found had not been a prior field testing site. To date, USDA has not found evidence that the trait had entered the commercial stream and USDA-APHIS was still unsure how the plants got into the field. In response, both Japan and South Korea temporarily suspended new wheat purchases, and others considered similar actions. It is important that Japan had 2+ months of stocks which facilitated the implicit embargo. Purchases were cancelled and after finding they could not find like qualities elsewhere they recommenced tenders when stocks were at 30 days supply. South Korea's millers evaluated French and EU imports. Though they did make some purchases from elsewhere and considered the more costly Australian wheat, South Korea resumed purchases after an intensive testing program was initiated.

Though what happened was unfortunate and still not resolved, there were some important lessons learned from the process. First, the fact that the GM trait in question had previously been determined to be safe by the FDA was critical. Second, USDA continued its letterhead informational item for export sales indicating *"There is no commercially grown GM wheat grown in the US…"* Finally, an important strategic communication initiative was adopted and the major message was used that it was a single field, from a single farm, of a trait that was deemed safe.

Chinese Rejection of GM Corn Shipments

Concurrent behind the scenes of the above development is the rejection of US cargoes containing GM traits by China. Specifically, the variety was known as Agrisure Viptera developed by Syngenta which is insect resistant with the MIR162 GMO strains. It had been approved in the United States and 15 countries including the EU and had been under review by China since 2010. "The company has applied for safety certification for import for use in processing many times, and after an (earlier) evaluation by our country's biosafety committee, we considered their testing data and related materials to be incomplete and that problems still existed," citing a Chinese authority.

This is an example of a variety being released prior to gaining approval in all import countries (allegedly with on-going discussion with National Corn Growers Association and grain traders in anticipation of commercial release versus international approvals).

Sometimes with known late approvers (like the EU) there may be an understanding about the expectation of LLP until the final approval is granted (and product that is likely to carry the new GM trait, based on growing region, will be "channeled" to other ports).

LLP Status and Issues Regarding Wheat

Low-level presence (LLP) is defined as the presence of small amounts of GM traits that are approved in the exporting country but unapproved in the importing country, contained within shipments of approved varieties. The development of GM traits and differences in licensing and approval procedures and timelines in different countries has resulted in traits being developed and released in exporting countries which have not been licensed in importing countries. This asynchronous approval system across countries can result in unapproved traits being comingled at low levels with traits approved in both exporting and importing countries. This can result in short term trade disruptions whose severity varies according to the limits of tolerance applied and can be more severe when zero tolerance policies are employed.

Adams (2012) references Kalaitzandonakes who lists traits approved by selected exporters and importers showing the extent of the dichotomy of approvals. As the pace of release of new traits increases, the differences in traits approved by countries will only increase, further increasing the chances of LLP occurring in trade flows. Gruere (2009) developed a welfare model of asynchronous approval to analyze different policies. These alternative policies included total ban of GM, 0 % LLP, tolerance levels applied to LLP, and total pass through of LLP comingled shipments. Results are shown in Table 1. Gruere (2009) evaluated the probability of

Table 1 Summary of main effects of regulatory options

Option	Probability of rejection	Price effect	Risk effect	Cost effect	Conclusions
GM Ban	1	High	0	Very high	Valid only if any perceived risk exceeds total costs
0 % LLP	~1	High until approval	Larger variance	Very high	Valid if high perceived risk and no trust in export
τ % LLP	Moderate	Moderate	Larger variance and mean	Moderate to high	Best solution from trade's perspective
All Pass	0	0	Much larger variance and mean	None	Valid if prices matter more than anything else

Source Gruere (2009)

rejection, price, risk, and cost effects of each strategy and concluded where each type of policy would be adopted. He found a total GM ban would have very high price and cost effects and would only be valid if perceived risks exceed total costs. The 0 % LLP would likely arise when perceived risks were high and there was no trust in the export market. The best solution from the trade's perspective would be tolerance levels applied to LLP. All Pass systems would be valid where price matters most.

Issues

Since the development and release of genetically modified traits, there have been limited cases of inadvertent comingling, including LLP. These have included different crops and different trait events and have resulted in trade disputes and disruptions. One of the more recent is the finding of the Roundup Ready trait in a volunteer wheat field which was responded to with stoppages of specific imports from US sources. Kalaitzandonakes (2011) classifies these types of comingling into four main categories (1) biotech events approved for some uses but not others, (2) biotech events approved for all uses in one country but not others, (3) experimental events unexpectedly found in commercial food/feed supply chain, and (4) biotech events that were reviewed and were granted time limited approvals which have expired. As the pace of biotechnology trait approvals increases in exporting countries, many importing countries do not have procedures for biosafety evaluation or procedures may be based on other means such as decrees, etc. Further, some importing countries do not have the resources to evaluate biosafety, suggesting that importing countries may consider joining with other countries or groups of countries to perform biosafety evaluations. As a result, as the pace of trait releases increases, the potential for asynchronous approvals increases.

Stephens (2011) indicates that zero thresholds are often defined as detectable at the 0.01 % level which is equivalent to 1 seed in 10,000 seeds. This level of measurement is so fine that dust particles included in a sample have resulted in positive detection. He cites recent examples where dust in soybean shipments to the EU indicated inclusion of 3 corn traits not approved there, stopping EU soybean trade for an extended time period. Thus he argues that the advances in LLP detection have effectively made zero threshold policies impossible to achieve in any industry.

LLP Initiatives

In 2008, the Codex Alimentarius Task Force on Foods Derived from Biotechnology adopted international guidelines for food safety assessment in the case of asynchronous approval and Low Level Presence. The Codex Annex specifically covers assessment guidelines for food/feed safety in the presence of LLP.

OECD working groups have been working on parallel efforts to the Codex Annex focused on environmental assessment of risks for LLP in seeds (Kalaitzandonakes 2011). Specific countries are also developing LLP initiatives. Existing policies in some countries, however, tend to make LLP incidents resulting from asynchronous approvals more, rather than less, likely. For example, China's biosafety regulations require full regulatory approval in the host country prior to the start of China's import regulatory process. This process takes 2–3 years which results in significant time lags in commercialization, and/or the prospect for asynchronous approvals, leading to the problems manifested in the current corn market (Huang and Yang 2011).

Canadian Policy

Canada assesses risk and employs measures designed to return to compliance. Canada employs border alerts and testing of flows which continue until events are approved for use in Canada. Canada currently does not differentiate between LLP and events that have never been approved. Stephens (2011) argues that current policy has been effective to date on a regulatory basis, but may not be adequate as the pace of release of events increases and is not effective from a trade perspective.

Stephens (2011) discusses several recommendations for improved LLP Policy including redefining zero tolerance to 0.1 % plus 0.2 % for uncertainty (for total of 0.3 % requirement for detection) to preclude identification through dust particles alone. Then employ options (1) synchronize approvals among major trading partners, (2) mutual risk assessments, (3) international risk assessment, and (4) proactive LLP assessment.

Canada is in the process of revising their LLP policy framework. A proposed policy framework was disseminated for comment from November 2012 to January 2013 (Agriculture and Agrifood Canada 2012). The policy framework will be refined and a final framework will be presented to the Canadian government. Refinements focus on the tolerance level, where those would be set based on the event and by crop.

Summary and Implications

One of the next major frontiers in development of genetically modified crops is in wheat. All of the major biotechnology companies have expanded with new initiatives in wheat and varying forms of partnerships. Due to these initiatives and competitive pressures, it is very likely by the early 2020s there will be several new traits moving forward in the deregulatory system, probably competing with traits from other companies and countries. Hence, the pressures to expedite commercialization and therefore regulatory approval will likely be immense.

Several characteristics are important for GM wheat. First, it is a large acreage crop which is grown in many countries and imported by many more countries than either corn, soybeans or canola. Second, wheat is viewed as a food grain and hence development of GM wheat may be more subject to regulations and consumer acceptance. Third, our studies (Wilson et al. 2008a), albeit dated, suggested about 35 % of the market would require some level of segregation to facilitate trade. This is much greater than in other crops.

Segregation is already common in wheat. Segregation occurs with respect to color, grade, and class, in addition to informational factors such as protein level and dockage; increasingly more common are measures of fusarium content, variety, stability, and other measures of end-use performance. Hence, segregation with respect to GM content should work relatively smoothly. Prerequisites to efficient segregation are variety declaration, testing procedures, and contract terms.

The evolution of GM wheat will put pressure on the system of segregation and on LLP in regulatory systems across exporting countries developing new traits and importing countries which may or may not have approvals. Already, there have been concerns about GM wheat that has been found in production, despite the fact that field trials ceased many years ago. Though systems do exist that can induce segregation, at a cost, the issues of LLP are more regulatory and ultimately impact commercial relationships. This is problematic for all crops going through deregulation as well as GM wheat. Indeed, a recent wheat industry official indicated “There are going to have to be tolerances in place once GM wheat is introduced to the market so that’s the first place to start … we need to work on getting those in place so there’s no regulatory problem when these things occur.” (Sosland 2013, p. 34)

The structure of the trait development industry is such that there will be immense pressure for commercializing traits. More likely that will result in Asynchronous approvals, hence making issues related to LLP very important. LLP policies and the Codex Alimentarius Annex are mechanisms to handle LLP when there are differences in approval of traits between importing and exporting countries. While some countries are developing LLP policies, others may not have the capabilities to assess approvals or may have approval mechanisms that instead foster asynchronous approvals. The pace of trait development and asynchrony of approvals between exporting and importing countries will compound any issues that might arise.

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