International
Food & Agricultural Trade
Policy Council

IPC Technology
Issue Brief

December 26, 2004

The Potential Impacts of the Biosafety Protocol on Agricultural Commodity Trade

Prepared for the International Food & Agricultural Trade Policy Council

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Second Printing

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Foreword

At its recent plenary meeting, the International Food & Agricultural Trade Policy Council (IPC) discussed the issues surrounding the implementation of the Biosafety Protocol (BSP). During that discussion, IPC Members expressed grave concerns that the potential implications for the agricultural trade system, in particular for importing and developing countries, were not well documented or understood by those making the decisions on the BSP. IPC members were also concerned that policy makers do not know who will bear the costs of implementation, what the unintended consequences might be, or whether the implementation options being considered were necessary to achieve the objectives of the BSP.

This paper, based on analysis by Professor N. Kalaitzandonakes and with input from the IPC, identifies potential issues that will arise as these implementation decisions are made, and outlines the likely effects on farmers, consumers, and traders in developed and developing countries. Before the parties to the BSP take further decisions on implementation, the IPC believes that the costs and implications for the global agricultural system, for food importers, and for farmers must be understood. The IPC plans to continue its analytical work to quantify the costs and implications of potential BSP implementation decisions on developed and developing country importers.

About the IPC

The International Food & Agricultural Trade Policy Council (IPC) convenes high-ranking government officials, farm leaders, agribusiness executives and agricultural trade experts from around the world and throughout the food chain to build consensus on practical solutions to food and agricultural trade problems.

An independent group of leaders in food and agriculture from industrialized, developing and least developed countries, the IPC's thirty-six members are chosen to ensure the Council's credible and impartial approach. Members are influential leaders with extensive experience in farming, agribusiness, government and academia.

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Executive Summary

In September 2003 the BSP entered into force. In the coming months, the signatories will be making key decisions about implementing the Protocol, which could significantly affect global agricultural production, consumption and trade; induce structural changes; and ultimately, affect social welfare.

For Living Modified Organisms destined for food, feed, or processing (LMO-FFPs), the key implementation issues to be decided in 2005 include:

- What kind of information should be required with export documentation?
- How will "Adventitious Presence" (AP) be defined?
- Will AP considerations be for LMO crops only or for all (including non-LMO) crops?
- What thresholds should be established for AP?
- How will approved versus unapproved events be treated?
- What kind of documentation will be required of exporters?
- What kind of testing will be done and where will it occur?

Because the BSP is a mandatory, global system governing the exports and imports of all LMOs traded internationally, its impact will be felt throughout global agriculture. Prior experience suggests that even seemingly small differences in organism testing requirements and thresholds can result in enormous shifts in the scope and impacts of LMO regulations. The potential impacts of various options for implementing the BSP provisions must be evaluated so that the Protocol can be implemented in the most effective and least costly manner. The following questions need to be addressed.

- What portion of global crop production and trade could be affected by the BSP?
- What are the potential impacts on the costs and structure of production and trade?
- How will the costs of implementing the BSP be distributed across the agrifood chain?
- How will those costs affect exporters (developed and developing countries)?
- What are the costs to importers (developed and developing countries)?
- What are the impacts on farmers (large, developed country farmers and small, subsistence farmers)?
- What are the potential consequences in the supply chain arising from the BSP (vertical integration, bias toward larger farmers, risk aversion by exporters to certain markets)?
- How might such impacts evolve over time?

Potential Scope of BSP

Global Consumption and Production Dominated by Few Crops

Feed crops such as maize and soybeans, constitute a large portion of global agriculture and represent a significant share of the cultivated land around the world. Four crops – wheat, rice, maize, and soybeans – account for approximately 50% of the world's arable land, while another four – barley, sorghum, cotton and canola – account for an additional 15%. Due to rising demand for animal protein (because of population growth and rising incomes), demand for and production of these crops is expected to climb in the next thirty years.

Global Trade Dominated by Few Crops

The same crops that dominate land use and agricultural production around the world represent the bulk of global agricultural commodity trade. Almost 300 million metric tons of wheat, maize, soybeans, and rice are traded globally every year. However, trade represents only a fraction of total crop production – typically less than 15%. Despite its small share, agricultural trade plays a critical role in balancing global demand and supply.

Global Trade Characterized by Few Exporters and Many Importers

Just as there are a few key crops in global production, there are also only a few key exporters in global trade. The United States and Argentina dominate maize exports. Australia, Canada and the United States dominate wheat exports, followed by Argentina and the European Union. The United States, Argentina and Brazil dominate global soybean production and trade.

Indeed, with the exception of rice, seven countries with large agricultural sectors – namely, Argentina, Australia, Brazil, Canada, China, the EU and the US – supply 60-90% of all exports in all key crops. While developed countries are the largest importers in terms of volume, the vast majority of the importers are developing countries.

LMO Adoption Concentrated in Few Key Crops in Key Exporting Countries

Most LMO adoption has occurred in these few key crops and in these few major exporting countries. With the exception of Europe, all of the major producing and exporting nations have commercially introduced one or more LMOs in their production system. Where commercialization of LMOs has been allowed, adoption has occurred at an unprecedented pace.

The introduction of LMOs has transformed global production of soybeans, maize, cotton and canola. While LMOs have not yet been commercialized in rice and wheat production, China has announced introduction of LMO rice in 2006. LMO wheat varieties are also in the pipeline. Since the adoption and use of LMOs is concentrated in precisely the key crops and in the key countries that dominate global production and trade, the BSP covers a large portion of today's agricultural commodity trade. Moreover, it is clear that its scope will expand as LMOs are introduced in other widely traded agricultural commodities in the future.

Complex Global Marketing Chain

The potential impacts of the BSP emanate from the changes it imposes on the global marketing chain for agricultural crop commodities. In any given year, the harvest from millions of small and large farms dispersed over vast terrain must be collected during a short period of time and moved to storage from where it will gradually be dispersed to animal feeding and processing facilities throughout the year. An expansive global marketing chain ensures that crops are moved from surplus to deficit areas, that crops are stored when they are plentiful and drawn down when needed, and that crops of varying quality are put to their optimal uses.

Although these functions of the global marketing chain are conceptually simple, the execution is not. Even well-functioning crop marketing chains must contend with many uncertainties that complicate their operations. Local production and consumption volatility lead to significant investment risks for physical assets. Crops change hands many times in any given year and in every transaction the buyer must confront price risk while owning the crop. Uncertainty in freight prices, interest rates, and in exchange rates further add to the price risk confronted by operators in the crop marketing chain. Even the most developed marketing chain will have difficulties managing the implementation of the BSP, and will incur costs. The less sophisticated marketing chains will have more difficulty complying with precise BSP provisions.

Analysis of Potential Implementation Decisions

The operational details currently under discussion by the parties to the BSP will determine its impact on production, consumption and trade of LMOs for feed, food or processing. Using case studies it is possible to evaluate the potential costs of various identification and testing protocols.

Exporting LMOs: The Costs of Identifying LMOs

In the absence of substantial efforts to source and identity preserve non-LMOs under strict protocols, export vessels originating from countries with meaningful LMO production should generally be expected to contain LMOs. The exact level of LMOs and the share of individual LMO events will vary drastically across vessels depending on the production in the regions where crops are originated. Importantly, commercial production of an LMO event does not automatically imply that it is present in a particular export cargo.

Accordingly, without testing each cargo for its overall LMO content and for the share of each LMO event, exporters may be unable to indicate that their cargoes definitively "contain" certain events simply on the basis that they have been commercialized in a given country. In an LMO producing country and in the absence of extensive testing, exporters may only be able to reliably indicate that a cargo "may contain" LMOs.

Exporters could develop "may contain" identification and documentation procedures with modest changes in current operations. If exporters must specifically identify (or quantify) the LMO content of export cargoes, they would have to extensively test each and every cargo and could be forced to change their operations to avoid costly delays.

Case Study: Identifying LMOs in a US Maize Cargo

The United States is a major producer and exporter of maize as well as a leading user of LMOs. The farm level adoption of the various LMO maize traits is not evenly distributed across the US geography. Adoption is generally driven by farm-level economic benefits that tend to vary across farms and geographic regions due to differences in pest and weed pressures. All maize LMOs that are approved for commercialization in the United States are considered equivalent to conventional maize. Accordingly, no effort is generally made to separate LMO and non-LMO maize during harvest.

An extensive infrastructure moves maize from the key producing regions to the few large export elevators that are located in coastal areas. Most maize exports originate in surplus producing states in the Midwest and most flow out of the country through the Gulf of Mexico. Ocean vessels carry an average of 25,000 metric tons of maize in each journey and many exceed 50,000 metric tons of cargo. Depending on their point of departure, these vessels contain large amounts of maize of different varieties from various regional elevators in multiple locations.

With the geographically dispersed use of LMOs, the continual commingling and aggregation of maize from various farms to trucks to storage bins in the local and river elevator, to river barges, and then onto export vessels, what might be the expected LMO content and share of LMO events in any given vessel cargo?

As an example, take an ocean vessel with a maize cargo destined for Japan carrying 58,000 metric tons of maize agglomerated from smaller cargos carried by 52 river barges: The barges were sourced from 16 different locations in 6 states – Iowa, Illinois, Indiana, Missouri, Minnesota, and Louisiana. The contribution of each barge to the vessel averaged 1100 metric tons, but varied widely from 50 to 2000 metric tons.

In all the states where the barges were sourced, there was significant production of LMOs. In the absence of substantial efforts to source and identity-preserve non-LMO maize under strict protocols, the vessel certainly contained LMOs. However, the exact level of LMOs and share of individual events could vary drastically across vessels depending on the LMO production in regions where their cargoes originated. Importantly, commercial production of an LMO event does not automatically mean it will be found in a particular export cargo (See page 16).

In the absence of testing each cargo for LMO content and for the share each LMO event, exporters may be unable to indicate that cargos definitively “contain” certain events simply on the basis that such LMOs are commercially produced in a given country. Hence, in an LMO producing country and in the absence of extensive testing, the most accurate reporting exporters might be able to do could be to indicate that a cargo “may contain LMOs.”

Case Study: The Cost of Testing for LMOs

Laboratory costs increase with the number of samples that must be tested; the type of assessment required (i.e. qualitative, quantitative); the number of events that must be measured; and the number of crops that must be evaluated. Using customs data from the two main exporting countries – the United States and Argentina – and book prices for relevant tests, it is possible to assess the appropriate number of export cargoes that might require testing and the projected cost under alternative sampling and testing procedures that might be dictated by alternative labeling requirements.

If the BSP were to require 1) a qualitative assessment of whether the cargo contains LMOs; 2) an identification of specific LMO events contained in the cargo; and 3) the measurement of the amount of each LMO event in the cargo, laboratory-testing costs for all US and Argentine maize exports could range from $936,000 to $4,356,000, with the highest costs incurred if quantification of traits is required.

If the BSP requires more stringent sampling procedures, then a larger number of samples might be tested individually for each event. Under such potential sampling procedures, laboratory-testing costs would explode, ranging from $18 to $87 million for maize cargoes from these two countries (See page 18).

Beyond these laboratory costs, additional compliance costs in testing export cargoes for LMO content exist but are more difficult to calculate. These include handling and overhead charges incurred by exporters for maintaining an inventory of samples and managing the interface and test reporting with labs, sampling authorities, regulators and their customers.

Other compliance costs are less direct and obvious but could still be significant. BSP labeling reduces the inherent fungibility of commodity grain and the flexibility of its marketing chain. Some of the gains from efficiencies and scale economies achieved in today's commodity chains could therefore be lost. It is difficult to estimate the magnitude of these costs.

Importing LMOs: Potential Uncertainties and Costs

A central implementation issue of the BSP is whether the importer will confirm the presence of LMOs through laboratory testing. If so, the exact LMO content must be identified and measured. The vessel would need to be sampled and tested in similar ways as at its point of departure, doubling the testing costs incurred in the marketing chain. Even more than the testing and other compliance costs, however, are the uncertainties created through such practices. Since LMO testing is a statistical process, even with identical testing protocols, repeated sampling of the very same cargo would likely produce different results.

Moreover, trade in LMOs that have been granted regulatory approval in a producing country but not in an importing country has proved challenging for the crop marketing chain. Since only 19 countries in the world have an established regulatory process that has approved any LMOs, building the capacity to effectively regulate and approve LMOs across all importing countries could prove challenging, at least in the short run.

If re-testing is required or if vessels must be diverted to other locations, the potential holdup costs from such circumstances would be astronomical. Depending on the size of cargo and the import location; reloading costs and demurrage charges from re-directing a vessel to an alternative destination; as well as quality deterioration and other costs could add up to millions of dollars per held-up vessel. The uncertainty of the approval status of various LMO events in countries that lack an ongoing regulatory process amplify such holdup risks and costs. The higher the uncertainty of a destination, the higher the transaction costs importers in that destination would have to pay (See pages 19-20).

Importing Non-LMOs: Potential Costs and Risks

Importers who want to avoid LMOs can contract for non-LMO cargoes. Procuring non-LMOs implies operational changes in the crop marketing chain. Strict identity preservation (IP) must be used throughout the chain to prevent presence of LMOs and secure the required purity in sourced cargoes. IP procedures in non-LMO systems, therefore, imply additional costs. Direct IP costs result from:

- **Increased need for market coordination and control:** IP systems require increased search and coordination efforts resulting in substantial transaction costs, including salaries and wages for sourcing and management, information systems, third party certification fees, etc.

- **Changes in operations:** As firms adapt their operations, they incur extra payable capital, labor and material costs. For farmers, payable costs may result from extra labor for equipment cleaning during planting, harvest and storage; increased field isolation to prevent pollen flow from other adjacent fields; as well as increased delivery transport costs. Testing can also lead to significant incremental material costs.

- **Risks and liabilities:** IP often involves risks and liabilities beyond those confronted in commodity markets. Such risks and costs might involve testing risks or risks associated with unplanned disruptions in the supply chain and ensuing sourcing risks, etc. When insurable, such risks and liabilities translate directly into payable costs in the form of premiums.

Indirect IP costs stem from underutilization of production, storage, transportation, and processing assets. Lost profits represent additional indirect costs to IP systems. Foregone storage margins and carrying spreads, and foregone profits from adoption of LMOs, are examples of indirect costs.

The IP costs in non-LMO markets are not fixed. They vary significantly from one part of the chain to another and across commodities. They also vary substantially with logistics and available infrastructure. The impacts of some key drivers are well understood and more or less predictable:

- **Purity Standards and AP Tolerances:** The rigor with which IP procedures are designed and implemented depends mostly on the desired level of purity. For non-LMO systems with low thresholds, strict measures designed to prevent adventitious presence of LMOs must be put in place. Beyond certain levels, as thresholds diminish, IP costs increase exponentially.

- **Scale of IP Systems:** Unlike commodity systems, IP non-LMO systems do not enjoy scale economies. Indeed, if the demand for non-LMOs grows quickly, driving these markets beyond their current "niche" status, IP costs could escalate in the short term, as unsuitable assets would be increasingly employed, raising the average cost of IP systems.

- **Scale of LMO Production:** With increasing numbers of LMO events and acreage, adventitious presence of LMOs in non-LMO lots would tend to increase. Under such conditions, firms all along the IP marketing chain must implement more rigid IP processes to meet purity thresholds and incur rising IP costs.

To estimate these IP costs, it is useful to examine the extra costs (above commodity) paid by buyers for non-LMO cargoes at points of import in two main non-LMO markets: the European Union and Japan. Despite their limited market share, non-LMO maize and soybean markets cost consumers in Japan and the EU an additional $100 million per year. These costs would rise with increasing adoption of LMOs; increasing number of LMO events; increasing number of LMO crops; and lower AP thresholds (See page 22).

The Distribution of Costs: Impact on Importers

Markets for commodities, feed ingredients, animal products, and various processed foods are vertically and horizontally linked within any given country but also with markets in other countries. The degree of vertical integration and market power also complicates insights on expected outcomes. Nevertheless, some useful initial observations can be made. The compliance costs associated with the implementation of the BSP – much like with IP costs in non-LMO segments – will likely become "costs of selling" in export markets and will be paid by the buyers.

Most of the top-importing countries have signed and ratified the BSP and could end up paying compliance costs in proportion to their import shares. However, small developing countries will likely incur disproportionately higher costs. Per vessel compliance costs are more or less fixed; therefore lower volumes will result in higher per unit costs.

Conclusions

It should be clear that the broad scope of the BSP will influence the level and distribution of the compliance costs borne by the global food system. In particular:

- **Compliance costs will be significant and will be spread across the global food system.** While it is difficult to anticipate the exact ways such compliance costs will be distributed, it is reasonable to expect that the majority of compliance costs will be borne by consumers in importing countries.

- **Compliance costs will increase with lower thresholds** (e.g. costs increase exponentially as thresholds become lower).

- **Compliance costs are unevenly distributed across the supply chain.** Large commodity importers would likely bear a substantial share of the compliance costs. Importers with low volumes and inefficient infrastructure will likely bear disproportionately higher unit costs.

- **Compliance costs are unevenly distributed across commodities.** The potential impacts from supply responses across commodities are complex and difficult to anticipate. While supply increases in non-LMO crops might be expected, land constraints; processing infrastructure; and consumption patterns can mute such potential supply responses.

- **Compliance costs will be unequally distributed among various importers and also among different exporters,** depending both on their size in the marketplace, but also on the relative sophistication of their agricultural infrastructure.

The scope of the BSP will influence the amount of incremental risks borne by various actors in the system. Specifically:

- **Test-based enforcement creates incremental risks.** Adoption of testing standards decreases but does not eliminate incremental risks because of sampling variance and testing errors. Even the same test performed on the same cargo will yield different results.

- **Incremental risks are difficult to estimate and hence cannot be easily priced and insured.**

- **Incremental risks expand disproportionately when AP thresholds become lower.**

- **The uncertainty of the approval status of events in countries that lack an ongoing regulatory process amplify incremental risks.**

- **Incremental risks and compliance costs resulting from BSP implementation are not static;** they will increase with changing market conditions including:

  - Increasing adoption of LMO crops (this is very likely, based on trend)
  - Increasing number of LMO events/traits (this is very likely, also based on trend)
  - Increasing number of LMO crops
  - Improvements in testing technology (very likely)

Incremental risks and compliance costs resulting from the BSP will change the incentive structure in the supply chain. Some potential consequences include:

- **Changes in the composition of trade away from raw commodities to more highly processed products** (i.e., not LMOs) such as soybean meal and soybean oil: Countries with processing facilities located near major production areas would benefit from such potential impacts while those with processing capacity that is dependent on imported commodities would lose.

- **Increased vertical integration throughout the marketing chain:** In the presence of increased uncertainty that cannot be easily mitigated or insured, risk-averse exporters might opt to control their cargoes from planting all the way to the point of export. This structural change could benefit larger, more integrated farmers, and make life more difficult for smaller farmers.

The scope of these concerns and the potential for real, significant costs to be imposed on food importers calls for the various implementation options being considered under the Protocol to be assessed and understood so that the objectives of the BSP can be met in the most efficient and least costly manner possible.

This analysis covers only a small number of the issues arising from BSP implementation, and draws from case studies of how developed country agricultural systems might respond. Given their weaker physical and regulatory infrastructure, it is likely that these costs will be even higher for developing countries, which represent a large share of global food importers. **The IPC strongly urges parties to the BSP to assess the likely impacts of these issues – in particular for developing country importers, who may bear the brunt of higher food costs – before finalizing implementation details.**

The information in this paper was presented to IPC members and discussed at the Council's Plenary Meeting in October 2004. Statements made in this paper should not be attributed to any individual IPC member.

The Potential Impacts of the Biosafety Protocol on Agricultural Commodity Trade

I. Introduction

On September 11, 2003 a new international agreement affecting the transboundary movement of agricultural commodities **–** the Biosafety Protocol (BSP) **–** entered into force. In the coming months, the signatories to the BSP will be making key decisions about implementing the Protocol, which could significantly affect global agricultural production, consumption and trade, induce structural changes and ultimately affect social welfare**.**

The key implementation decisions to be made in 2005 include:

- What kind of identification should be required for Living Modified Organisms (LMOs) destined for food, feed or processing?
- How will "Adventitious Presence" (AP) be defined?
- Will AP cover LMO crops only or all (including non-LMO) crops?
- How will approved versus unapproved events be treated?
- What thresholds should be established for AP?
- What kind of documentation will be required of exporters?
- What kind of testing will be done and where will it occur?
- How will the Protocol be enforced?

Because the BSP is a mandatory, global system governing the export and import of all LMOs traded internationally, its impact will be pervasive throughout global agriculture, with the exception of trade between non-parties to the protocol. Prior experience suggests that even seemingly small differences in documentation requirements and thresholds can result in enormous shifts in the scope and impacts of LMO regulations. It is important that the potential impacts of various options under consideration be evaluated so that the Protocol can be implemented in the most effective and least costly manner. The following questions need to be addressed:

- What portion of global crop production and trade could be affected by the BSP?
- What are the potential impacts on the costs and structure of production and trade?
- How will the costs of implementing the BSP be distributed across the agricultural chain?
- How will those costs affect exporters (developed versus developing countries)?
- What are the costs to importers (developed versus developing countries)?
- What are the impacts on farmers (large, developed country farmers versus small, subsistence farmers)?
- What are the potential consequences in the supply chain arising from the BSP (vertical integration, bias toward larger farmers, risk aversion by exporters to certain markets)?
- How might such impacts evolve over time?

II. The evolution of the biosafety protocol

The BSP originated in 1992 as part of the Convention of Biological Diversity (CBD) The objectives of the CBD are to conserve biodiversity, to ensure its sustainable use, and to guarantee that the benefits of biodiversity are equitable (Mackenzie et al.). The CBD contains specific provisions on "living modified organisms"[1] (LMOs) produced through biotechnology. Indeed, since its inception, the CBD emphasized the need for a protocol to set out conditions for the safe transfer, handling, and use of LMOs that could adversely affect the conservation and sustainable use of biological diversity. In 1994, at the first CBD Conference, the parties to the Convention authorized a series of meetings to consider the "need and modalities" for such a protocol.

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[1] The term "living modified organisms" is similar to the term "genetically modified organisms" or GMOs used in the European Union and elsewhere. The major difference between LMOs and GMOs is that LMOs are capable of reproducing, whereas GMOs may not, if already processed or refined. This is a critical distinction since the BSP applies only to the LMOs and not to processed modified commodities.

In those meetings over the course of several years, considerable disagreement emerged on the content of the protocol. A draft for consideration was finally produced in February 1999 at a meeting held in Cartagena, Colombia. Though the parties could not reach agreement on the draft during that meeting, subsequent deliberations produced a compromise draft and the Protocol was adopted on January 29, 2000 in Montreal, Canada. The BSP then entered into force in September 2003. As of 20 December 2004, 111 countries have ratified the protocol.

The BSP creates rights and obligations for the parties to the Protocol on the transboundary movements of LMOs. Exporting countries that ship biotech seeds and other LMOs intended for introduction in the environment must inform importing countries of their intent through Advanced Informed Agreements (AIAs) and must provide documentation during the material transfer that identifies the LMO. Transboundary shipments of LMOs intended for food, feed, or processing (FFP) do not require AIAs. Instead of country-by-country notification, exporting countries must communicate regulatory approvals of LMOs through a web-based database – the Biosafety Clearing House. Exporters must provide documentation indicating that the exported LMOs are not intended for introduction into the environment.

Having received information through an AIA or the Biosafety Clearing House, importing countries can place conditions or refuse imports of LMOS if they believe there is insufficient scientific evidence regarding the potential impact of the LMOs on their biodiversity. Indeed, the BSP, in-line with the CBD, has advocated the use of the "precautionary principle" (de Greef). In this context, the BSP allows restrictions on the trade of LMOs in the presence of perceived risks, however small (ibid).

Despite the introduction of such rights and obligations, the presence of the BSP has, so far, hardly been felt in international trade. Indeed, other than Mexico's decision to enter into a Trilateral Agreement with Canada and the United States to define documentation requirements under Article 18.2(a) and the European Union's regulatory reform, it is unclear that there has been any serious attempt by the parties to enforce the Protocol. This is, in part, because the parties have not yet made decisions on how to implement it in practice. For instance, in the case of LMO-FFPs, details on how to operationalize the documentation requirements in the BSP remain under consideration. Such operational details include the form of the documentation that will be required, the content of the accompanying information that should be included, a working definition for "adventitious presence" (AP) of LMOs, and specific AP thresholds below which identification is not required. Similarly, details on enforcement practices are absent. Therefore, the full impact of the BSP on global agricultural trade is uncertain.

It is important to recognize that despite its environmental origin, the BSP is a mandatory global system that applies to all LMOs traded internationally. Its operational details must therefore be evaluated in this context. Prior experience suggests that even small differences in documentation requirements and AP thresholds can result in enormous shifts in the scope and impacts of LMO regulations (Kalaitzandonakes, 2004, Kalaitzandonakes and Magnier, NERA). It is therefore important to assess the potential impacts of BSP provisions currently under consideration in global commodity trade.

III. The Potential Impacts of BSP on LMO-FFPs

Since the vast majority of genetically modified crops are produced and traded for food, feed, or processing, the potential impacts of the BSP on LMO-FFPs is of particular interest. Article 18 of the BSP addresses the handling, transport, packaging and identification of LMOs. On the documentation requirements of LMO-FFPs, article 18.2(A) dictates that

> Each party shall take measures to require that documentation accompanying living modified organisms that are intended for direct use as food or feed, or for processing, clearly identifies that they "may contain" living modified organisms and are not intended for intentional introduction into the environment, as well as a contact point for further information. ***The Conference of the Parties, serving as the meeting of the Parties to this Protocol shall take a decision on the detail requirements for this purpose, including specification of their identity and any unique identification, no later than two years after the date of entry into force of this Protocol*** (emphasis added).

Many of the "detailed requirements" mentioned in Article 18.2 (A), which will ultimately determine the scope of BSP must be decided in the near future. These requirements can be grouped into three relevant sets.

The first set includes decisions on allowances for accidental commingling or admixtures of LMOs in export cargos. These decisions, in turn, determine what is an LMO and when identification might be necessary. Some of the key questions that need to be answered include:

- At what purity threshold will identification not be necessary? That is, what might be an allowable level for “adventitious presence” (AP) of LMOs in any given export cargo?
- Will BSP rules apply to crops for which LMOs have been commercialized (e.g. maize and soybeans) or will they also apply to other crops for which LMOs are not yet commercially available, (e.g., wheat or rice) but where trace amounts of LMOs from other crops might be accidentally present in any export cargo?

A second set covers the content of the information provided by exporters and how such information should be collected. The following questions need to be answered:

- Will a “may contain” indication be sufficient or will more detailed identification – or quantification – of all the LMOs in a cargo be needed?
- Should BSP rules involve issuance of separate documents or could relevant information be provided through existing documentation, such as commercial invoices?
- How should exporters acquire relevant information on the LMO content of an export cargo before they can report it?

Finally, the third set of issues involves decisions on how the importer receives and, in turn, uses the information provided by the exporter. A key question is:

- Will the importer need to independently confirm the information provided by the exporter? If so, how and what might be allowable responses?

These decisions will operationalize the BSP and determine its scope. The potential impacts of BSP can be determined by the changes in the global marketing chain needed to implement its provisions and the associated benefits and costs. In this context, the current functions of the global crop marketing chain provide a baseline for any examination of the impacts of the BSP.

IV. Global Crop Production and Trade and the Scope of BSP

To examine the potential scope of the BSP, it is necessary to place the use of LMOs within the context of the global production and trade of crops directed to food, feed, or processing. In doing so, it readily becomes apparent that the BSP already pertains to a large segment of global agricultural production and trade, and could influence the vast majority of it in the very near future.

Global Production

Over the last four decades, global production of crops produced for food, feed, and industrial uses has continued to grow rapidly in response to increasing food demand. Key drivers for increased food consumption have been population growth and economic development.

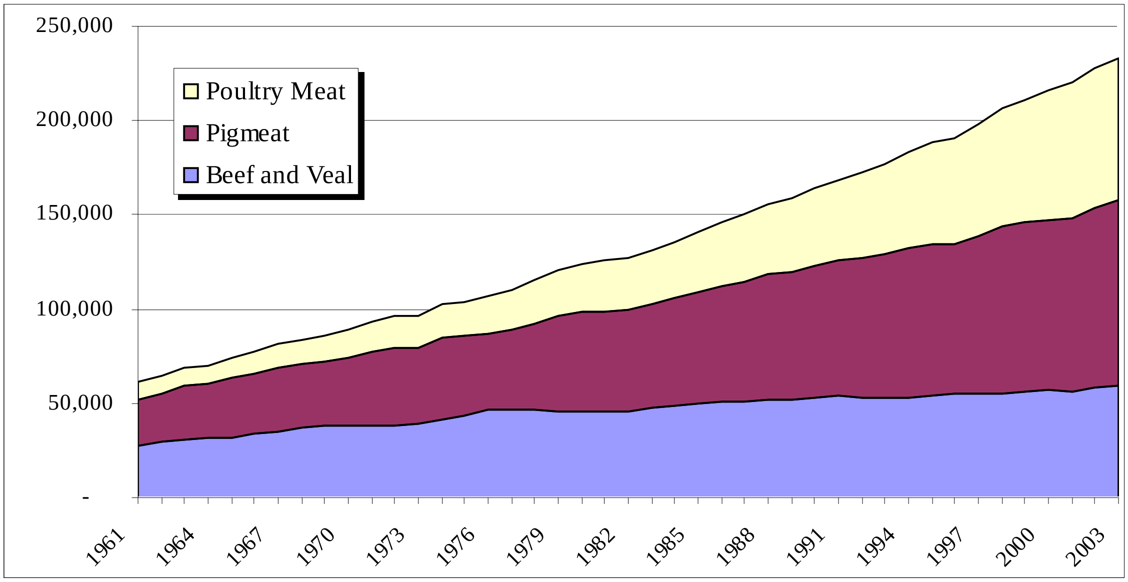
Not only has the world’s population been growing at a fast pace but so too have incomes and wealth. These changes have led to diets with increased caloric intake and higher consumption of animal protein and vegetable oils (Figures 1 & 2). The changes have been more pronounced in Asian countries like India and China, but growth has occurred in other regions as well.

Increased meat consumption has translated into even higher demand for grains and oilseeds. Consequently, feed demand dominates the utilization of many key crops. For example 73 percent of the global maize production is directly fed to livestock. The remainder is processed for food and industrial uses, with many of the byproducts utilized in livestock feed.

Feed crops such as maize, soybeans, and sorghum therefore constitute a large portion of global agriculture and have a significant share of the cultivated land around the world. Indeed, four crops alone – wheat, rice, maize, and soybeans – account for approximately 50 percent of the world’s arable land, while another four – barley, sorghum, cotton and canola – account for an additional 15 percent of planted acreage (FAOSTAT, 2004).

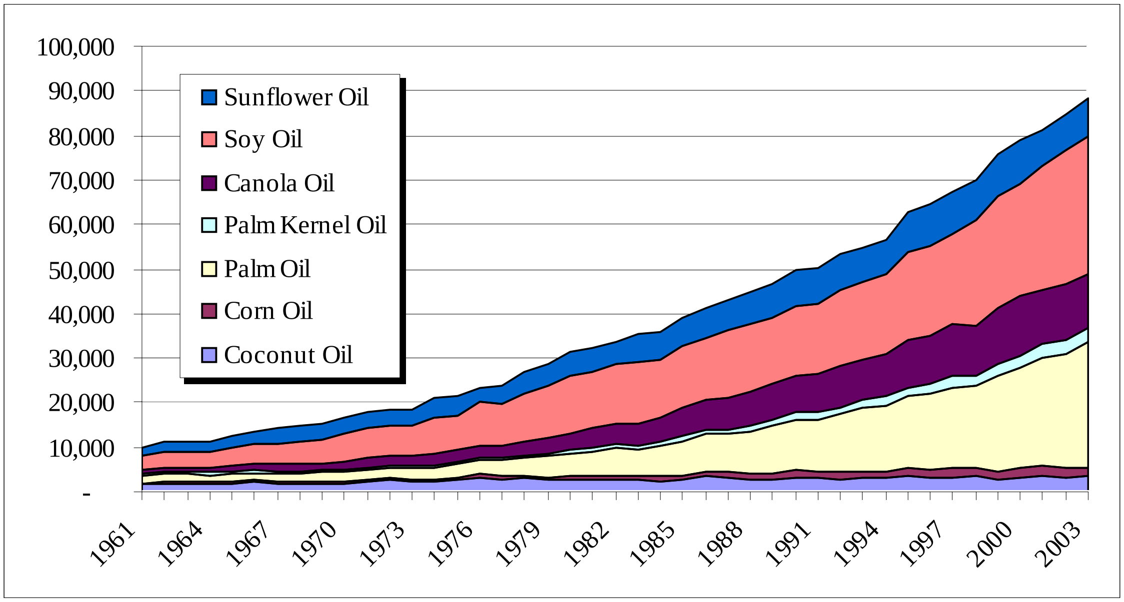
To meet increasing demand, production of these key crops has continued to expand in recent decades (Figure 3). Much of the growth in production has come from productivity gains, as the total amount of land in crop production has remained relatively stable (Figure 4).

Figure 1 **Global Meat Production/Consumption (1000 MT)**



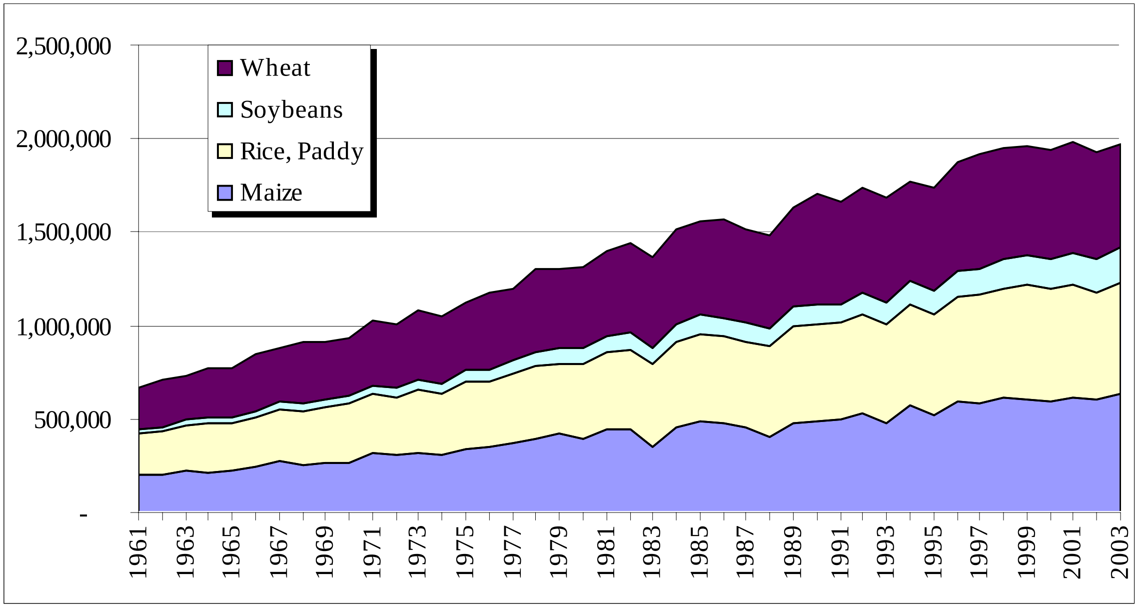
Source: FAOSTAT

Figure 2 **Oil Production/Consumption (1000 MT)**



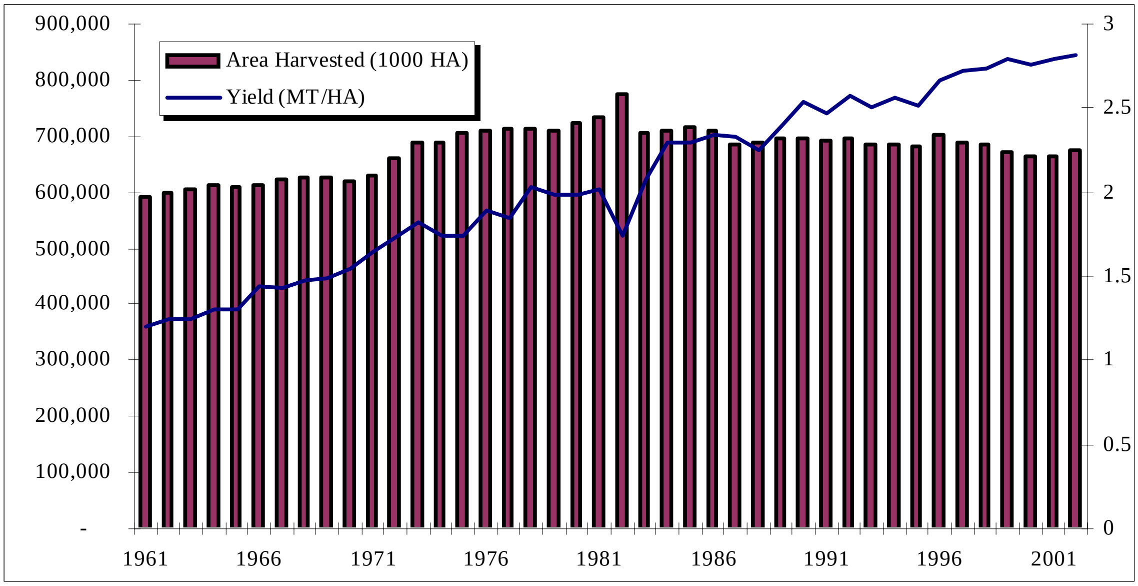
Source: FAOSTAT

Figure 3 Global Production of Key Crops (1000 MT)



Source: FAOSTAT

Figure 4 World Grain Area and Yields

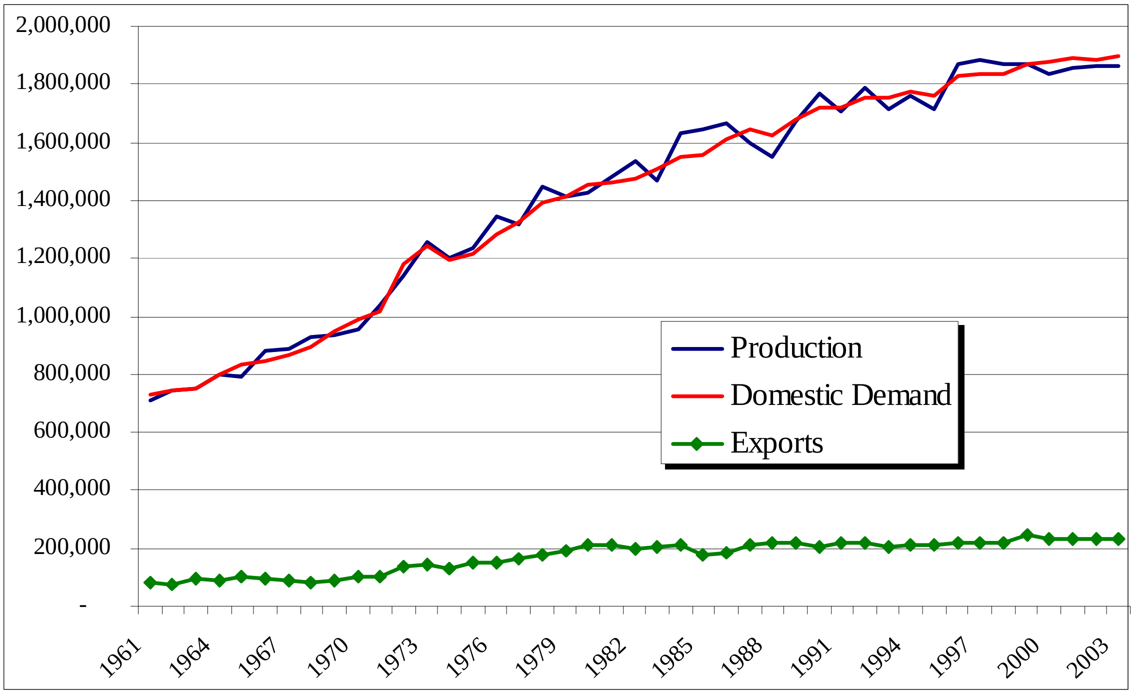


Source: FAOSTAT

Global Trade

Not surprisingly, the same crops that dominate production also represent the bulk of global agricultural commodity trade. Almost 300 million metric tons of wheat, maize, soybeans, and rice are traded globally every year across a large number of countries. However, trade in these agricultural commodities represents only a fraction of total crop production – typically less than 15 percent (Figure 5).

Figure 5 Global Grain Production, Consumption, and Trade 1960-2003

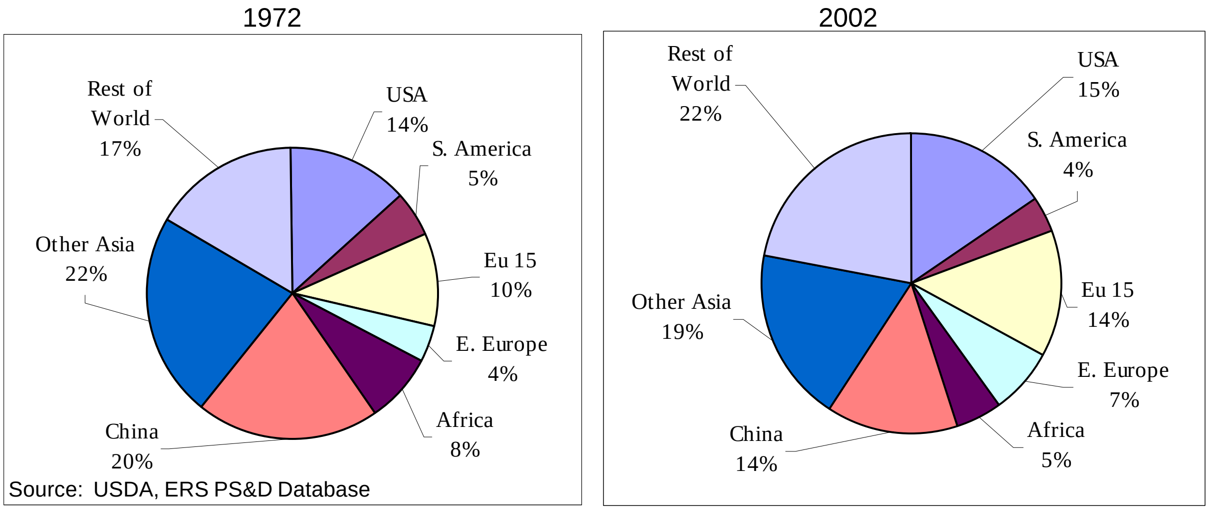


Source: USDA ERS, PS&D Database

Despite its overall small share, however, trade in agricultural commodities plays a critical role in equilibrating demand and supply conditions across the globe, keeping a vast food system working, for the most part, uninterrupted. Crop markets are inherently unstable with significant production and quality fluctuations from region to region and from one year to another, principally, due to variations in weather and pest infestations. In this context, grain and oilseed trade moves products from surplus to deficit regions, mitigating the risks caused by the volatility of local markets.

Trade is also essential when local demand outpaces production growth. For instance, over the last forty years imports of grains and oilseeds have outstripped imports by developed countries (Figure 6) as developing country incomes have risen. Trade has been instrumental in bridging the gap between domestic production and consumption (Table 1).

Figure 6 Changes in Grain Consumption by Region – 1972 to 2002


1972

2002

Source: USDA, ERS PS&D Database

Table 1 Global Vegetable Oil Imports by Region, 1970-2002 (in 1000 MT)

	1970	1980	1990	2000	2002
Developed Countries	2,474	4,418	7,507	12,106	12,188
Less Developed	1,686	6,459	12,638	22,777	23,765
North America	537	860	1,659	2,495	2,547
Europe	2,065	4,056	6,428	10,087	10,354
Africa	447	1,317	2,233	3,399	3,474
Asia and Oceania	749	3,195	6,725	14,387	14,582

Source: FAOSTAT

Table 2 Maize Trade Flows: Primary Exporters and Importers
(2000-2 average —in MT)

Exporter / Importer	Argentina	Brazil	China	Hungary	Romania	USA	Total
Japan	325,700		286,350			14,113,967	14,726,017
S. Korea	1,038,300	2,837,150	2,240,891				6,116,341
Egypt	572,600	345,936				4,870,106	5,788,642
Mexico		868				5,336,977	5,337,845
China	18,700		65,410			4,792,506	4,876,616
Canada	17,600					3,528,320	3,545,920
Malaysia	284,700		1,702,983			23,198	2,010,881
Colombia	98,300	287				1,756,757	1,855,344
Algeria	258,300			15,907	10,044	1,371,956	1,656,207
Saudi Arabia	458,000					918,314	1,376,314
Spain	881,300			471,169	2,341	4,733	1,359,543
Chile	1,103,300	171,022		14		33,904	1,308,240
Turkey	400			295,341	82,225	817,739	1,195,705
Dominican Republic						990,081	990,081
Peru	694,000	320				283,969	978,289
Syrian	97,200				1,703	782,477	881,380
Indonesia			620,790			257,595	878,385
Israel	49,200				1,324	781,177	831,701
Morocco	155,200			6,807	12,807	626,339	801,153
Tunisia	86,700			2,045	5,910	699,329	793,984
Venezuela,	2,600					684,387	686,987
Iran	545,200			56,559		62,999	664,758
United Arab Emirates	240,600					402,409	643,009
Guatemala						595,172	595,172
South Africa	236,500					324,530	561,030
Costa Rica						456,364	456,364
Russia			10,240	278,828	40	102,287	391,395
Jordan	338,000					39,022	377,022
Portugal	345,400			18		114	345,532
N. Korea			344,730				344,730
El Salvador						344,090	344,090
Cyprus	24,900	93,711		123,840	1,883	96,782	341,116

Source FAOSTAT

Just as there are a few key crops in global production, there are also a few key exporters in global trade. For instance, Argentina, Brazil and the United States dominate soybean exports while the United States and Argentina dominate maize exports (Table 2). Australia, Canada, and the United States supply the bulk of wheat exports while Argentina and the EU also contribute significant amounts (Table 3).

Indeed, with the exception of rice, 60-90 percent of exports in all key crops are supplied by a handful of countries that have expansive agricultural sectors and are major exporters – namely, Argentina, Australia, Brazil, Canada, China, the European Union and the United States (Table 4). Some of these countries also have large domestic markets where much of their production is utilized (e.g. Brazil, China, the EU, and the United States). Indeed, China's domestic market has expanded quickly in recent years and has become a significant net importer. Others, like Australia, Argentina and Canada export the bulk of their production (Table 5).

Table 3 Wheat Trade Flows: Primary Exporters & Importers

(2000-02 average —in MT)

Exporter Importer	Argentina	USA	Australia	Canada	EU-15
Brazil	6,519,500	199,198		6,300	972
Egypt	108,900	3,546,903	1,680,069	159,000	761,700
Japan		2,996,267	1,195,509	1,443,958	2,872
Indonesia	201,300	186,804	2,105,279	625,000	114,059
Algeria	131,600	217,022	25,652	813,000	1,931,056
Mexico		2,192,039		882,100	
Iraq	346,500		2,245,095		
Korea		1,210,435	952,818	294,200	278
Nigeria	86,500	1,882,487		279,500	167,728
Philippines		1,418,002	83,126	738,500	4,862
Italy	74,900	1,075,802	451,213	537,200	
China	13,500	1,149,735	99,474	758,603	
Morocco	49,300	152,079	129,500	628,500	1,059,000
Yemen		592,100	450,113	7,300	427,689
Peru	469,300	564,066		352,000	
Colombia	42,200	537,082		600,800	139
Malaysia		167,127	681,725	187,900	
Cuba		153,675		58,600	797,657
Thailand		363,432	285,930	202,800	6,251
Sudan	25,600	17,400	450,462	195,800	101,924
Tunisia	201,700	45,154		319,300	159,200
Sri Lanka	80,400	431,883	209,167		
Israel		608,387	18,436		60,190
Jordan	202,700	456,506		11,800	3,611
Spain	21,000	397,974		189,000	
United Arab Emirates	43,600	67,253	226,417	205,300	25,972
Bangladesh		214,248	132,855	153,000	55,000
Guatemala		155,065		353,900	
South Africa	329,600	18,568	97,755	11,000	44,356

Source: FAOSTAT

Table 4 Country Shares of Global Exports for Selected Grains & Oilseeds

(2000-02 average)

	Cottonseed	Maize	Canola	Rice	Soybeans	Wheat
European Union (15)						8.0%
Argentina	1.0%	12.5%		1.1%	12.1%	8.4%
Australia	40.6%		16.7%	1.7%		12.9%
Brazil					28.4%	
Canada			38.4%		1.0%	12.7%
China		10.8%		7.5%		
USA	21.0%	58.5%	3.1%	10.8%	50.5%	21.3%
TOTAL	69.1%	81.8%	64.8%	22.2%	92.0%	63.3%

Source: FAOSTAT

Table 5 Exports as a Percent of Total Production
(2000-02 average)

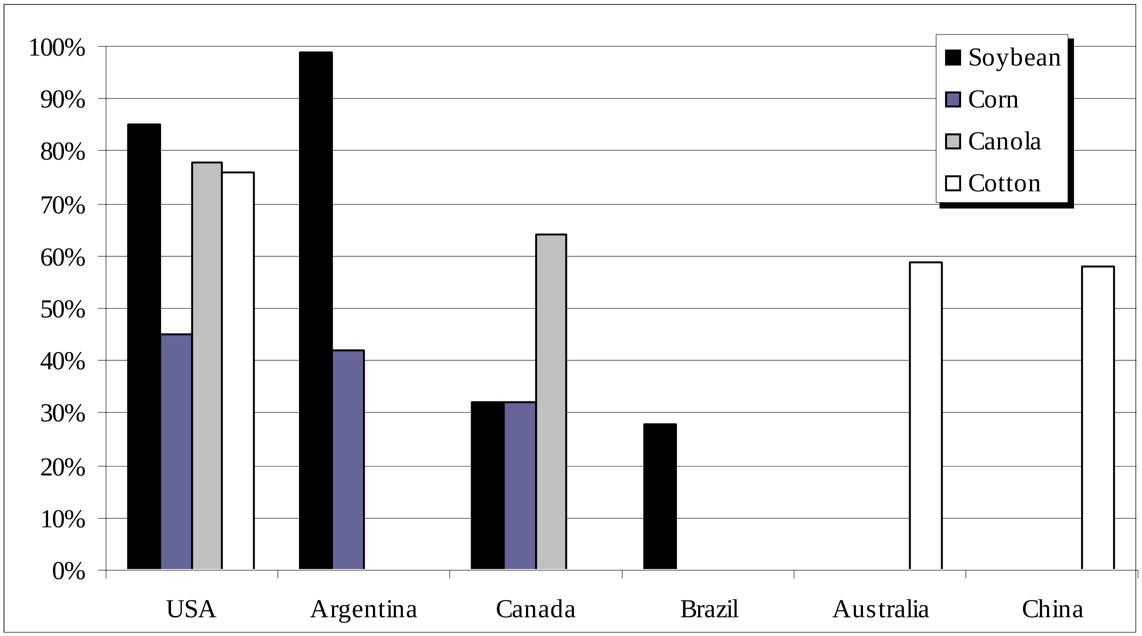
	Cottonseed	Maize	Canola	Rice	Soybeans	Wheat
World	2%	13%	24%	5%	31%	20%
European Union (15)						10%
Argentina	4%	67%	24%	38%	24%	72%
Australia	41%		84%	31%	11%	87%
Brazil					40%	
Canada			69%		29%	81%
China		7%		1%	2%	1%
USA	3%	20%	32%	30%	37%	51%

Source: FAOSTAT

Biotechnology Innovation and Adoption

Against this global crop production and trade context, much of the adoption of LMOs has taken place in these key crops and in these key exporting countries (Figure 7). Excluding Europe, all of the major crop producing and exporting nations have commercially introduced one or more LMOs into their production system. And, in those countries where commercialization of LMOs has been allowed, adoption has occurred at an unprecedented pace, often covering more than 80 percent of the available acreage in just a few years (ISAAA, 2004).

Figure 7 Adoption of LMOs in various Crops and Major Exporting Countries



Source: USDA NASS, AAFC, and ISAAA

These patterns of LMO adoption are the outcome of strong economic forces. Market potential drove the early focus of biotechnology research and development on LMO traits toward large acreage crops such as maize, soybeans, cotton, canola, wheat, and rice. Identifying, inserting, and validating any genetic modification, as well as guiding a modified crop through the regulatory process, is a lengthy process that typically takes 7-10 years. Research and development and regulatory costs are similar across crops and traits. Innovators must therefore incur these fixed costs whether the technology could be adopted on one or a million acres. The profits, on the other hand, are directly proportional to the number of acres on which the technology is adopted. As a result of these economic forces, biotechnology companies have developed LMO traits that offer the largest potential value among the most widely planted field crops, namely feed-grains and fiber crops.

Once LMOs are commercialized, farmers quickly adopt them because of strong economic incentives at the farm level. Adopters generally enjoy substantial benefits from increased yields, lower risks, reduced use of chemical pesticides, as well as increased savings in management, labor and capital equipment costs. There are also gains from reduced tillage and other synergistic production practices (Kalaitzandonakes, 2003).

Incentives for adoption and use of LMOs have been stronger in export-minded countries with agricultural sectors that compete in global markets (Anderson and Jackson). Producers in these countries continuously look for more efficient technologies and improved farming systems in order to maintain their cost competitiveness. Countries with protected and inward looking agricultural sectors have diminished incentives to use LMOs as they could add to domestic production surpluses and to government subsidy spending (ibid).

Under these conditions, the observed patterns of adoption and use of LMOs are not surprising and will continue in the future. Use of LMOs has already transformed the production systems of major field crops such as soybeans, maize, cotton and canola. And while LMOs have not yet been commercially introduced in rice and wheat production, many are already in the pipeline. For instance, China has already field-tested and is expected to be the first to commercialize LMO rice in 2006 (Huang).

Since the adoption and use of LMOs is concentrated in key crops and in countries that dominate global production and trade, it is clear that the BSP will pertain to a large portion of today's agricultural commodity trade. Its scope will only expand as LMOs are introduced and adopted in other widely traded agricultural commodities in the near future.

The Global Crop Marketing Chain

The potential impacts of the BSP will be determined by the changes in the global marketing chain that will be necessary to implement its provisions. In this context, it is crucial to understand the current functions of the global marketing chain.

Every year, the harvest from millions of small and large crop farms that are spatially dispersed over vast terrains must be collected during a short period of time, and moved to storage where it will be gradually dispersed to animal feeding and processing facilities throughout the coming year. An expansive global marketing chain transmits timely and accurate information between consumers and producers so supply and demand adjust spatially (moving crops from surplus to deficit areas); temporally (storing crops when they are plenty and drawing from stocks when they are needed); and qualitatively (moving crops of varying quality to their optimal uses).

Although this key function of the global marketing chain is conceptually simple, its execution is not – especially in the face of continually changing market conditions. Indeed, marketing chains in many countries and regions are not effective or well functioning. For instance, marketing chains in many countries suffer chronic under-investment in storage, transport and other assets. Others have misplaced physical assets with poor market access and ineffective information channels. Systematically, such marketing chains experience large postharvest losses from spoilage, rodent and pest infestations. In some countries ineffective marketing chains have often created the need for large imports even in the presence of local bumper crops.

Crop marketing chains contend with many uncertainties that complicate their operations. The volatility of local production and consumption from one year to another leads to significant changes in the utilization rates of physical assets (e.g. storage silos, transport, processing plants) thereby raising the investment risk for such assets. Price risks are also significant. As they are traded, crops change hands many times in any given year, and in every transaction the buyer assumes price risk.

For instance, country elevators that purchase grain from local farmers in the fall and store it through the winter anticipate that prices in the spring, when they will sell their grain, will be at least as high as the prices they paid, plus a margin for storage costs and quality deterioration. Indeed, grain prices typically rise through the marketing season reflecting the costs of storage. But this is not true in all years or all locations. Uncertainties in freight prices, interest rates, and in exchange rates of international currencies further add to the overall risk confronted by operators in crop marketing chains. Counterparty risks are also significant as transactions are mostly impersonal, occurring among parties in distant locations, often in different countries.

Complex institutions have developed to facilitate information flows between buyers and sellers and minimize risks in the marketing chain. For instance, public and private agencies have emerged (e.g. USDA, International Grains Council) to produce and disseminate market information and statistics and reduce risks from limited or inadequate market knowledge. Similarly, broadly accepted standardized trading terms (e.g. the Grain and Feed Trade Association, the North American Export Grain Association, and the Canadian Wheat Board) as well as arbitration procedures have been developed to manage counterparty risks.

Futures markets also diversify price risks. Buyers and sellers in the marketing chain can trade promises of future commodity deliveries in futures markets. Through hedging – making equal and opposite transactions on the cash and futures markets – farmers, elevator managers, traders, processors and others can protect themselves against adverse price movements while they hold grain inventories. Freight and exchange rate risks can be similarly hedged.

To facilitate the exchange of appropriate signals between buyers and sellers in distant markets and reduce transactions costs, grades and standards have been developed for key grains and oilseeds. Grades and standards provide information that enables buyers to determine end-product yield and quality as well as storability, without visual inspection. Public and private agencies (e.g. the USFederal Grain Inspection Service) provide inspection services and ensure that grain standards are upheld. In this way, a large number of transactions can be consummated at limited transactions costs.

Grain and oilseeds grades and standards also facilitate improvements in the efficiency of crop marketing chains. Grains and oilseeds from numerous farms are mixed and blended to meet specific grades throughout the supply chain and over time resulting in perfectly fungible and divisible product streams. This fungibility has facilitated the efficient use of discrete storage and transport assets and has yielded significant scale economies.[2] Since grains and oilseeds are bulky and relatively expensive to transport and store, efficiencies and scale economies throughout the grain marketing chain have helped control costs and expand trade.

V. Calculating the Costs of Implementing the BSP for LMO-FFPs

Identifying Cargoes at the Point of Export

The impact of the BSP on the global marketing chain will be determined by the nature of the LMO identification that will be required. These decisions have yet to be made. Positions supported by various stakeholders include:

- Simply indicating that a cargo “may contain” LMOs;
- Identifying the specific LMOs in the cargo; and
- Identifying the specific LMOs in the cargo and quantifying their amounts.

As described above, under typical conditions crops change hands multiple times as they travel through the marketing chain, commingled time and again in storage and transport to improve quality characteristics and maximize the use of physical assets. The exporter is the last in a long series of entrepreneurs that take ownership of the crops along their journey within a given country and any given season. The question then is: what changes in typical operations might be needed so exporters have appropriate information to effectively describe a cargo according to BSP provisions?

Necessary operational changes will depend on what must be labeled and how. For instance, a “may contain” statement could be substantiated by exporters through knowledge of what LMOs are in production and of the cargo’s origin. More specific requirements where the LMOs in a cargo must be specifically identified or quantified would need to be supported by extensive testing. The operational challenges are best clarified with a specific case study below.

Case Study: Identifying LMOs in a Maize Cargo

The United States is a major producer and exporter of maize as well as a leading user of LMOs. Since the commercial release of the first biotech maize traits in the mid-1990s, the adoption of biotechnology in US maize production has continued to grow at a rapid pace, reaching 45 percent of all the maize acreage in 2004 (Figure 8).

Commercial maize LMOs involve two main phenotypic properties: herbicide tolerance and pest resistance. Pest resistance accounts for the majority of the adoption – over 80 percent of total LMO maize seed sales – in the form of single or stacked traits. The approved LMO events include a number of commercial products each conferring a unique mode of action. Table 6 reports the maize LMO events that have been approved by regulators for commercial introduction in the United States. Of those, BT 11, GA21, MON 810, MON 863, NK 603 and TC1507 are commercially cultivated in the United States.

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[2] For instance, transporting a ton of cargo by barge is almost 15 times cheaper than transporting it by truck. Similarly, the cost of storing a bushel of grain varies by as much as five times, between some small and large elevators. Such economies of scale exist throughout the grain marketing chain and can only be captured through a flexible commodity system of fungible commodities.

Figure 8 US Adoption of Maize LMOs – 1996-2004

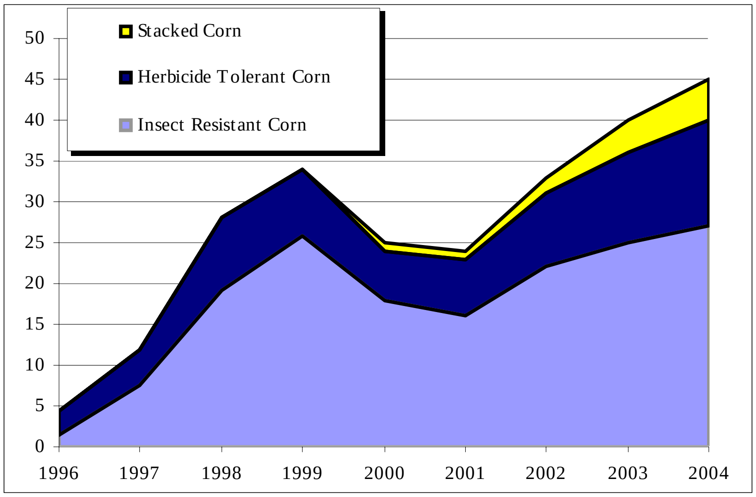


Table 6 Maize LMOs Approved for Commercialization in the United States

Event	Company	Gene	Phenotype
176	Syngenta Seeds, Inc.	CryIA(b) - Donor: Bt kurstaki Phosphinothricin acetyl transferase	IR - European Corn Borer resistant
676, 678, 680	Pioneer Hi-Bred	DNA adenine methylase - Donor: E. coli Phosphinothricin acetyl transferase - Donor: Strep. viridochromogenes	AP - Male sterile HT - Phosphinothricin tolerant
B16 (DLL25)	Dekalb Genetics	Phosphinothricin acetyl transferase - Donor: Strep. hygroscopicus	HT - Phosphinothricin tolerant
BT11 (X4334CBR, X4734CBR)	Syngenta Seeds, Inc.	CryIA(b) - Donor: Btk Phosphinothricin acetyl transferase	IR - Lepidopteran resistant
CBH-351	Aventis CropScience	Cry9C - Donor: Bt tolworthi Phosphinothricin acetyl transferase - Donor: Strep. hygroscopicus	HT - Phosphinothricin tolerant IR - Lepidopteran resistant
DBT418	Dekalb Genetics	CryIA(c) - Donor: Bt kurstaki Phosphinothricin acetyl transferase	IR - European Corn Borer resistant
GA21	Monsanto	EPSPS - Donor: Corn	HT - Glyphosate tolerant
MON80100	Monsanto	CryIA(b) – Donor: Bt kurstaki EPSPS	IR - European Corn Borer resistant
MON802	Monsanto	CryIA(b) - Donor: Bt kurstaki EPSPS - Donor: Agrobacterium Glyphosate oxidoreductase - Donor: Achromobacter NptII*	HT - Glyphosate tolerant IR - European Corn Borer resistant
MON809	Pioneer Hi-Bred	CryIA(b) - Donor: Bt kurstaki EPSPS* Glyphosate oxidoreductase*	IR - Lepidopteran resistant
MON810	Monsanto	CryIA(c) - Donor: Bt kurstaki Phosphinothricin acetyl transferase*	IR - European Corn Borer resistant
MON863	Monsanto	Cry3Bb1 - Donor: Bt kumamotoensis NptII*	IR - Coleopteran resistant
MS3	Bayer CropScience (Aventis CropScience(AgrEvo))	Barnase - Donor: Bacillus amyloliquefaciens Phosphinothricin acetyl transferase - Donor: Strep. hygroscopicus	AP - Male sterile HT - Phosphinothricin tolerant
MS6	Bayer CropScience (Aventis CropScience(AgrEvo))	Barnase - Donor: Bacillus amyloliqufaciens Phosphinothricin acetyl transferase*	AP - Male sterile
NK603	Monsanto	EPSPS - Donor: Agrobacterium	HT - Glyphosate tolerant
T14, T25	Bayer CropScience (Aventis CropScience(AgrEvo))	Phosphinothricin acetyl transferase - Donor: Strep. viridochromogenes	HT - Phosphinothricin tolerant
TC1507	Mycogen (c/o Dow AgroSciences); Pioneer (c/o Dupont)	Cry1F - Donor: Bta Phosphinothricin acetyl transferase - Donor: Strep. viridochromogenes	HT - Phosphinothricin tolerant IR - Lepidopteran resistant

Source: USDA APHIS

The farm-level adoption of the various LMO maize traits is not evenly distributed across the United States (Figures 9 and 10). Adoption is generally driven by farm-level economic benefits that vary across farms and geographic regions due to differences in pest and weed pressures (Kalaitzandonakes, 2003). For example, pressures from the European corn borer and corn rootworm differ dramatically across the Corn Belt from year to year and affect the use of insect resistant (IR) maize.

Figure 9 Adoption of Insect Resistant Maize in the United States, 2003

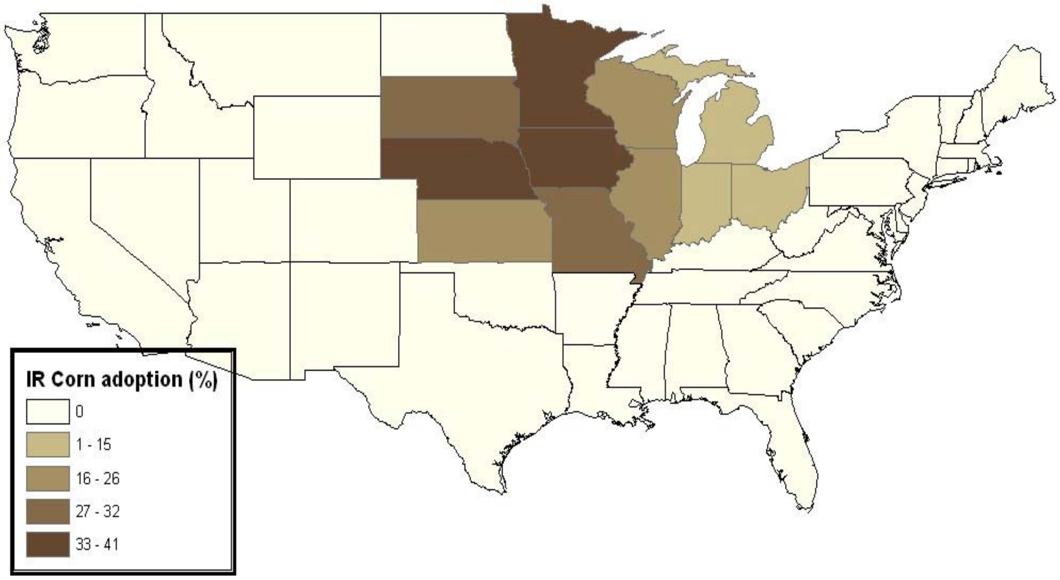
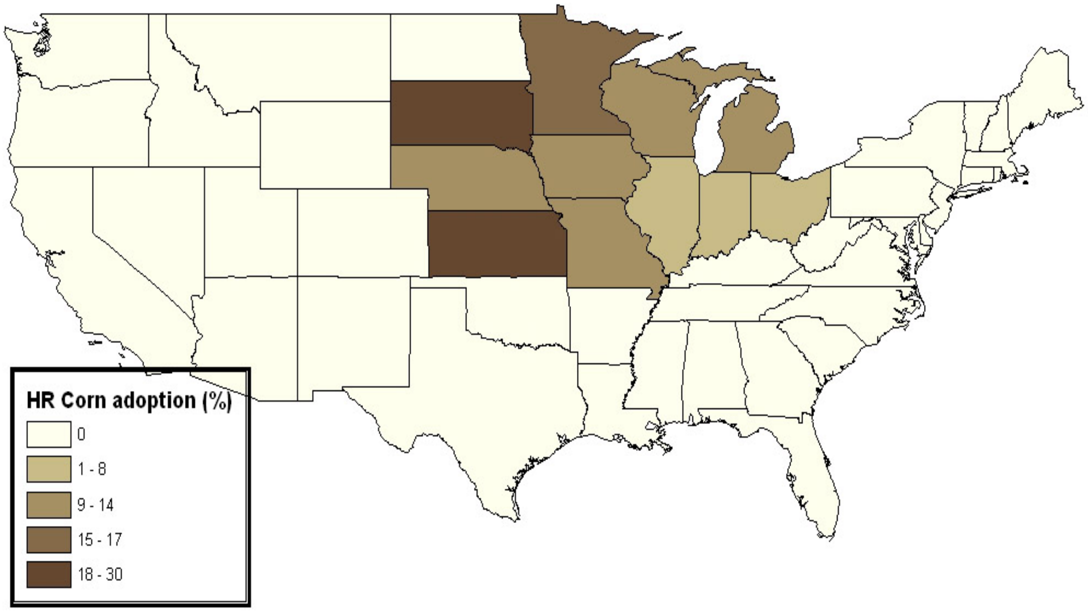


Figure 10 Adoption of Herbicide Resistant Maize in the United States, 2003

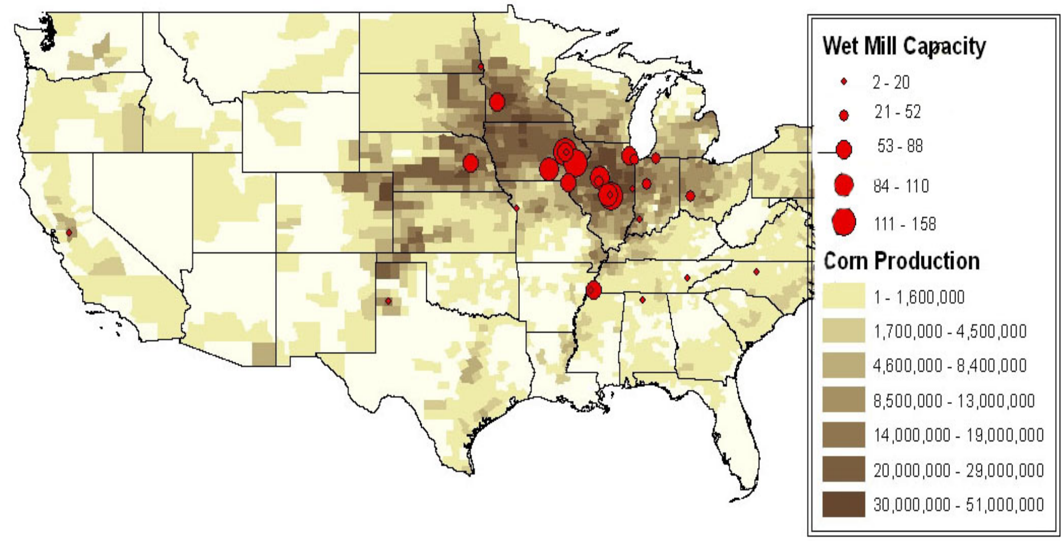


Local maize markets also influence producers' planting decisions. Production areas close to waterways targeting export markets are affected by international market preferences. Similarly, production areas close to dry and wet mills are influenced by the manufacturers' effective demand for specific maize varieties and traits.

Against this context, in 2003 the use of maize LMOs was higher in the Western Corn Belt where adoption levels reached 80 percent (South Dakota). In contrast, the Eastern Corn Belt had much lower adoption levels with Indiana and Ohio, on average, below 20 percent.

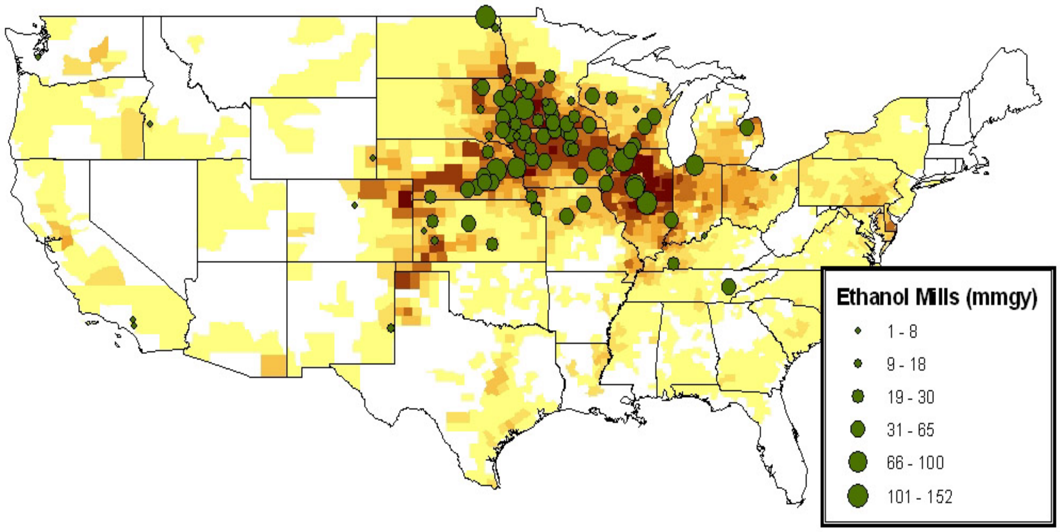
All maize LMOs that are approved for commercialization in the United States are considered by regulation equivalent to conventional maize. Accordingly, no effort is generally made to separate LMO and non-LMO maize during harvest. Over half of the United States maize production is fed to livestock on the farm it is produced or on other nearby farms. Another 25 percent travels to the closest wet or dry milling facilities, located in the center of maize producing areas to improve sourcing and minimize transport costs. Such facilities process maize into ethanol, starches, syrups and a variety of other industrial products and feed byproducts (Figures 11 and 12).

Figure 11 Location and Capacity of the United States Maize Wet Milling Industry, 2003



Finally, some 20 percent of US maize production is exported to international markets. An extensive infrastructure facilitates the movement of maize from the key producing regions in the Midwest to the few large export elevators that are located in coastal areas. These are some of the largest elevators in operation and have appropriate equipment to load ocean vessels destined for overseas markets. The flows of maize from the various producing regions in the United States to the points of export are not uniform. Most maize exports originate in surplus producing states in the Midwest but flow out of the country from a small number of export points (Figure 13). Indeed, exports from the Gulf of Mexico account for almost 80 percent of all US maize exports. [3]

Figure 12 Location and Capacity of US Maize Dry Milling Industry, 2003



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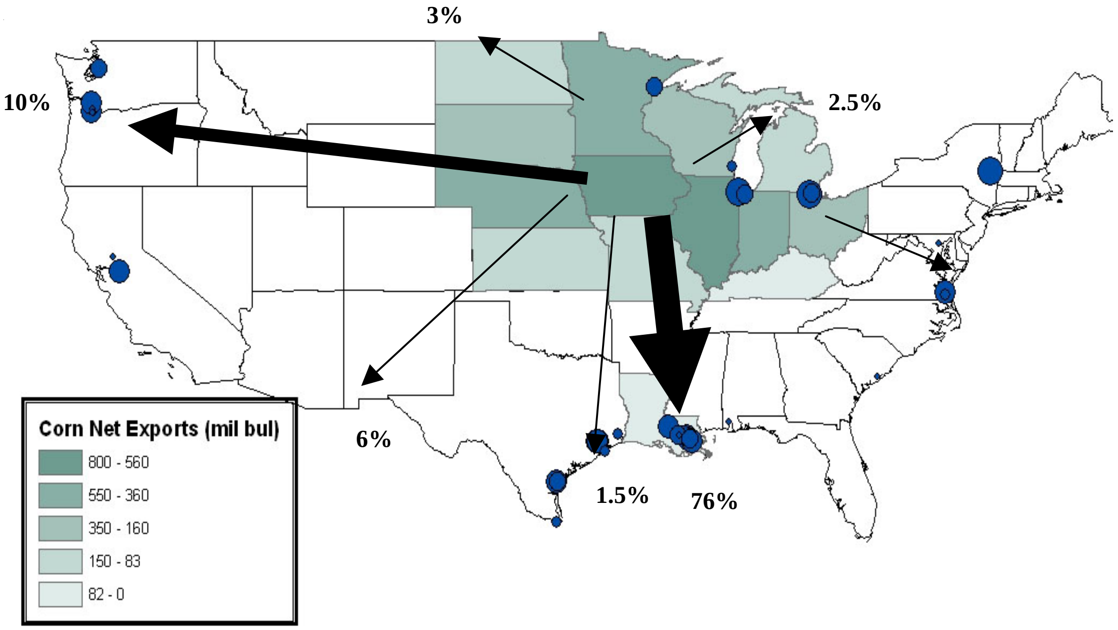
[3] Using detailed data on the location and size of livestock herds that are fed with corn in each county, information on the location and capacity of maize processing plants, as well as data on export volumes and standard and transport costs and routes, we can approximate the volumes of maize used locally, those exported, as well as the flows directed to all key points of export (Figure 13).

Ocean vessels carry an average of 25,000 metric tons of maize in each journey and many exceed 50,000 metric tons of cargo. Depending on their point of departure, they source large amounts of maize from various regional elevators in multiple locations that have available supplies and can minimize transport costs. The typical journey involves maize traveling on barges along the river all the way to the large silos of the export elevator and ultimately into a vessel.

Figure 13 Maize Export Flows from Maize Producing States to Points of Export



Given the geographically dispersed use of LMOs, the continual commingling and aggregation of maize from the various farms, to the trucks, to the storage bins in the local and river elevator, to the river barges, and then onto the export vessel, what might be the expected LMO content of any given vessel cargo? And what might be the share of each LMO maize event?

Using actual data from representative export vessels and county-level adoption data for individual LMO maize events, it is possible to calculate the expected LMO content of the cargo in the vessels. The results of one such calculation are illustrated below. [4]

Figure 14 Barge Origination for a Maize Cargo

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[4] Information on the origins of barges sourced to supply representative export vessels were provided by grain trading firms for the purpose of this research. The conclusions from analyses of other vessels were qualitatively similar to those presented here.

Consider an ocean vessel with a maize cargo destined for Japan. This vessel carried a total of 58,000 metric tons of maize that was agglomerated from smaller cargos carried by 52 river barges. The barges were sourced from 16 different locations in 6 states –Iowa, Illinois, Indiana, Missouri, Minnesota, and Louisiana (Figure 14). The contribution of each barge to the vessel averaged 1100 metric tons, but varied widely from 50 to 2000 metric tons.

In all the states where the barges were sourced, there was significant production of LMOs. In the absence of substantial efforts to source and identity-preserve non-LMO maize under strict protocols, the vessel likely contained LMOs. Of course, the exact LMO content would depend on the production profile of the areas surrounding the river elevators where the barges were sourced.[5]

Assuming that all the maize loaded on each barge was sourced within 100 miles of the elevator location, and using county level adoption of various LMO maize events, the expected share of LMO events in the barges and ultimately in the vessel can be estimated (Table 7). While this is certainly only an approximation to the actual LMO content of the vessel it is revealing in certain ways.

Table 7 Expected Shares of Commercial LMO Events in Vessel

(Percentage of vessel cargo)

GA21/NK603	MON 810	MON 863 X MON 810	MON 863	MON 810 X NK 603	MON 863 X NK 603 X MON 810	MON 863 X NK 603	TC 1507	BT11
9.92%	18.41%	0.22%	4.95%	3.32%	0.10%	0.34%	9.90%	2.21%

Specifically, the results indicate that in the absence of identity preservation or segregation, vessels originating from countries with meaningful LMO production should be expected to contain LMOs. The exact level of LMOs and share of individual events, however, could vary drastically across vessels depending on the production profile of the regions where their cargoes originate. Importantly, the results indicate that commercial production of an LMO event does not automatically warrant its presence in a particular export cargo. For instance, while the stacked trait MON 863 X NK 603 has meaningful adoption levels in the United States, only trace amounts were expected in the cargo of the vessel.

Accordingly, without testing each cargo for LMO content and for the share each LMO event, exporters would be unable to indicate that cargos definitively "contain" certain events simply on the basis that such LMOs are commercially produced in a given country. Hence, in an LMO producing country and in the absence of extensive testing, the most accurate reporting exporters might be able to do could be to indicate that a cargo "may contain LMOs."

Operational Changes and Potential Compliance Costs at the Point of Export

If exporters must verify specific events or the share of those events in a given cargo, what operational changes in the crop marketing chain might be required to implement detailed BSP documentation provisions? The changes in the operations of the exporters would be proportional to the detail required by the mandated BSP labels. Exporters could specify that a cargo "may contain" LMOs with modest changes in the operations. If exporters had to specifically identify or quantify the LMO content of export cargoes, they would have to extensively test each one separately.

Case Study: The Cost of Testing for LMOs

Anticipating the operational changes that might be required and estimating the compliance costs for testing and identifying export cargoes according to BSP guidelines involves complex analysis beyond the scope of this study. Some initial insights, however, can be derived through straightforward calculations. To proceed, one must first answer a number of practical questions, including:

- How should one appropriately sample an export cargo so that the test results are representative of its content?
- Should one test only for commercial LMO events or all deregulated ones?

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[5] Typically some 90 percent of the grains and oilseeds handled by river elevators in the US are sourced from surrounding areas. The rest might be sourced from other distant locations. These shares, of course, can vary from one year to another depending on the local harvest.

- Should one test for LMOs in the exported crop only or as well for LMOs in other crops that are likely present in trace amounts in most export cargoes?
- Should one simply assess the presence of LMOs in a cargo, assess the presence of specific LMO events, or quantify their individual share?

Laboratory costs increase with the number of samples that must be tested; the type of assessment required by the BSP (i.e. qualitative, quantitative); the number of events that must be tested; and the number of crops that must be evaluated. Some of the compliance costs are easier to estimate than others. For instance, the costs associated with testing for LMOs in export cargoes under different BSP implementation scenarios can be estimated by calculating a per cargo testing charge and the total number of cargoes that would require such testing. Clearly, the number of cargoes exported from different countries varies from year to year and so average forecasts must suffice. Furthermore, practical data limitations allow only approximating the number of export cargoes that would require testing. Nevertheless, such approximations can be revealing.

For instance, consider the testing costs that might be incurred for identifying LMOs in maize export cargoes. Assuming that:

- Only maize LMO events that are currently in production are evaluated;
- Stacked LMO traits are not separately tested for[6]; and
- Bagged and containerized cargoes are assumed to be identity-preserved and do not require testing.

Using customs data from the two main maize exporting countries – the United States and Argentina – it is possible to approximate the number of export cargoes that might require testing.[7] Using book prices for relevant tests from various testing laboratories to calculate laboratory charges, it is possible to calculate aggregate annual laboratory costs for six scenarios derived from two alternative sampling approaches and three testing procedures dictated by alternative labeling requirements.

In the first three scenarios, a single composite sample is used to evaluate the content of a vessel under three alternative test options: (a) qualitative assessment of whether the cargo contains LMOs; (b) identification of specific LMO events contained in the cargo; and (c) measurement of the amount of each LMO event in the cargo. With an average cargo size of 25,000 metric tons of maize, vessels are sampled multiple times in set intervals as the grain flows into the cargo hold. A representative sub-sample of approximately 2.3 kg is sent to a laboratory for testing. From that, 10 grams of homogenized ground maize are tested for LMO content. Under this sampling approach, the laboratory testing costs for maize exports ranges from $936,000 to $4,356,000 annually in Argentina and the United States, with the highest costs incurred if quantification of traits is required (Table 8).

The relevance of the test results derived, of course, depends on whether the tested sample is representative. Using 2.3 kg (or 10 grams that are actually tested) to accurately represent the content of a 25,000 metric ton cargo might be difficult.

To address these considerations, the European Commission recently produced a draft of recommended practices for sampling and testing LMOs in bulk commodities to provide guidance for EU member states when conducting official tests. These testing plans were developed to address stratification/pockets of LMOs in shipments and to test the level of LMOs in a "lot" (e.g. vessel, ship hold, container, etc). The draft plan requires collecting a large number of samples to be tested individually for each event. The recommended practices suggest that for lots exceeding 500 metric tons, 100 separate primary 0.5 kg samples should be taken at regular time intervals as grain moves through the grain trade system, following broadly accepted sampling standards (e.g. ISO 13690, ISO 6664, and GAFTA Rule 124 Annex B). From those, a minimum of 20 samples are to be separately tested and a composite test score to be produced to represent the content of the lot. Under such potential sampling procedures, laboratory-testing costs explode. Even with the minimum recommended 20 tests per cargo, laboratory-testing costs for maize exports range from $18 to $87 million annually for the United States and Argentina (Table 8).

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[6] Stacked events represented an estimated 18 percent of US LMO maize acres in 2004. Their popularity is expected to increase further in the future. Testing for stacked events implies complications that are most significant when the share of such events needs to be quantified. Currently, this can be achieved only by testing individual kernels/seeds in the cargo—escalating complexity and testing costs beyond those considered here.

[7] Data for cargoes exported through ocean vessels are considered here. Exports through other means of transport (e.g. rail) are not included.

Table 8 Estimated Annual LMO Testing Costs of Maize Export Cargoes (in US dollars)

Samples Tested	Cargoes Tested	"Contains LMOs"	"Identifies LMOs"	Quantifies LMOs
1 sample/cargo	3,575	$936,650	$2,342,900	$4,356,900
20 samples/cargo		$18,733,000	$46,858,000	$87,138,000

Author's calculations

Beyond these laboratory costs, there are additional compliance costs in testing export cargoes for LMO content that are more difficult to calculate. These include handling and overhead charges incurred by exporters for maintaining an inventory of samples and managing the interface and test reporting with labs, sampling authorities, regulators and their customers. These compliance costs increase as the number of samples tested increases.[8]

Other changes are less direct and obvious. The associated costs might be more difficult to estimate but could still be significant. Ultimately, BSP requirements reduce the inherent fungibility of commodity grain and the flexibility of its marketing chain. Some of the gains from efficiencies and scale economies achieved could therefore be lost. It is difficult to estimate how large such implicit compliance costs could be.

The estimated costs for testing maize cargoes indicates the magnitude of compliance costs that could be incurred in implementing the BSP provisions across all commodities and countries involved in LMO trade, and illustrates the large differences in compliance costs driven by seemingly small shifts in implementation details. Full accounting of the BSP compliance costs must, of course, tally expenditures for testing all crops that have LMOs (e.g. maize, canola, soybeans) and, potentially, crops that do not (e.g. wheat and rice) but could include traces of LMOs through "adventitious presence" of other LMO crops (e.g. maize and soybeans). Full accounting should also incorporate future increases in compliance costs that will come from: increasing adoption of LMO crops; an increasing number of LMO events/traits; an increasing number of LMO crops; and an increasing number of countries that will become LMO producers.

It is important to point out that very few developing countries have facilities capable of testing for LMOs. In order to perform the required tests, samples would have to be sent to a laboratory abroad. Not only would this add to the direct costs of testing, it would add to the demurrage costs while a cargo awaited test results.

Operational Changes and Compliance Costs at Point of Import

A central implementation issue is how importers will receive and verify the information provided through BSP documentation. Will confirmation of the documentation be needed, and if so will it be done through laboratory testing? If exact LMO content must be identified and measured, the loaded vessel will likely be probed and sampled in ways that are different from the sampling procedures used at the point of export.[9]

Such practices would more than double the laboratory testing costs incurred by the marketing chain. It typically takes 5-7 days to receive laboratory test results for any given vessel suggesting costly delays at the point of import. On average, each additional day at the port adds $25,000-$30,000 to the freight costs of a 50,000 metric ton vessel. Depending on the number of samples and the number of events tested, it might be economical to expedite testing. Testing can be expedited to 1-2 day turnaround time, but at increased laboratory costs, up to three times the normal charges. Hence under most scenarios, laboratory-testing costs would more than double the costs presented in Table 8.

Even more troublesome than the explicit testing costs, however, are the implicit uncertainties associated with testing. Indeed, it is not clear which authorities will be responsible for implementing the BSP at the point of import. It is also unclear how an importing country might respond if the test results at origin differ with the test results at the final destination. And, it is highly likely that these test results will differ.

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[8] For instance, with thousands of export vessels transporting corn every year, taking 20 separate 1 kgr samples for each vessel would amount to a very large number of samples that must be properly archived, stored and maintained for quality. The number of test results that must be handled also increases in parallel.

[9] It is unlikely that a vessel would be unloaded at the point of import before the testing was completed, if such testing was in fact required. Current practices would dictate that a 12 ft probe be used to sample the static grain.

Since LMO testing is a statistical process, repeated sampling and testing of the very same cargo would regularly produce different results. There are several sources of variance in test results, including: differences in the testing and sampling methods and protocols as well as uncertainty or error rates in tests. Clearly differences in testing methods and protocols across various labs are significant sources of variance. No standardization in LMO testing methods is expected in the near future and hence such source of variance will not diminish.

Conflicting test results, however, could occur even if identical lab protocols are used, unless the same sample is tested. Depending on the concentration and distribution of a trait within a particular lot and how it was sampled, it could be difficult, if not impossible, to duplicate any set of test results.

Finally, every assay should be measured to confirm the level of relative uncertainty (for quantitative assays) or assay error rate for generating false positive and/or false negative results (qualitative assays). Irrespectively, some relative uncertainty or error is present in every assay.

Depending on the sampling procedures and the testing protocols used, some divergence of the test results at origin and destination should be expected. Could such divergence result in delays or rejections of cargoes at destination?

The potential holdup costs from such circumstances could escalate rapidly. Depending on the size of cargo and port of import, demurrage charges from delayed unloading of a cargo or from re-directing a vessel to an alternative destination, quality deterioration and other costs could add up to millions of dollars per held-up vessel. To put such holdup costs in perspective, it is useful to look at a case study of demurrage charges that resulted from redirecting a vessel from its original destination to an alternative one.

Case Study: Demurrage Costs

Consider a 56,000 metric ton vessel loaded with maize traveling towards its original destination port Tarragona, Spain. After arrival, and for reasons that are not relevant to the study, the vessel did not discharge its cargo. After one-day delay, it is redirected to Brake, Germany and ultimately redelivered to Cape Finisterre (Figure 15).

Port delays and additional travel time added a total of 7.73 days to the time the vessel was hired. Accounting for added fuel and port charges, demurrage costs for an additional week's delivery time amounted to over $460,000 (Table 9).

This case study illustrates how quickly costs add up for cargoes that are held-up at or redirected away from their original discharge destination. Test-driven compliance to BSP would create uncertainties that are impossible to eliminate and difficult to manage. Holdup costs associated with such uncertainties could prove very substantial.

Figure 15 Redirected Vessel: Original Port and Deviation

Intended discharge port: Tarragona –
Deviated to: Brake - Re-Delivery: Cape Finisterre

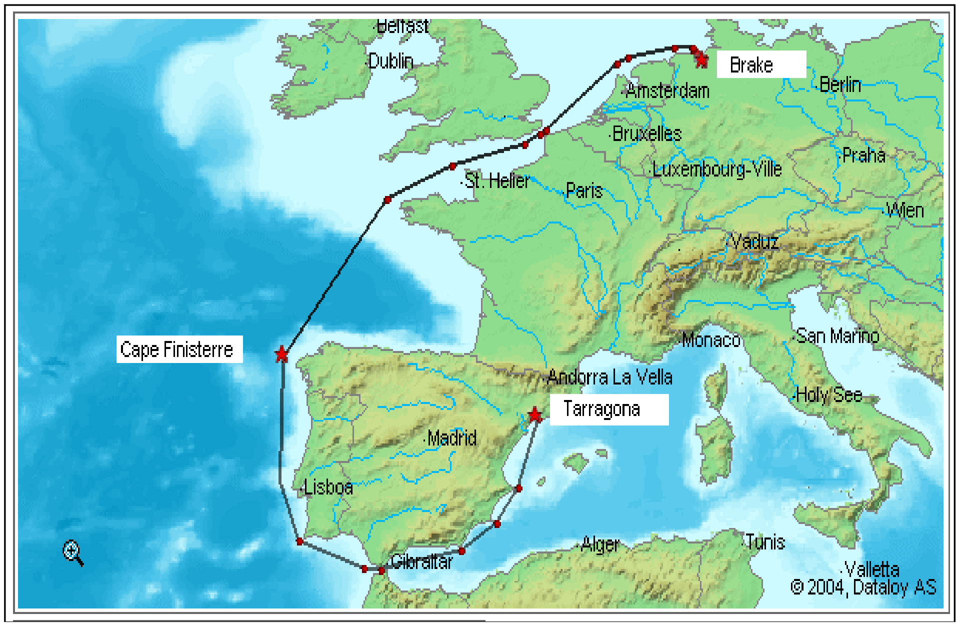

Table 9 Demurrage Costs for Redirection of Vessel

Travel/Distances		Tarragona-Brake		Brake-Cape Finisterre
Distance – NM		2,100		1,032
Average speed – KN		13.00		13.00
Duration – DAYS		6.73		3.31
Additional waiting time – DAYS		1.00		0
Hire payment voyage Tarragona-Brake				
	7.73 days @	USD 30,000.00 per day[10]		231923
Bunker consumption Tarragona-Brake (fuel for engines & generators)				
Intermediate Fuel Oil	7.73 days @	37 MT/day @	USD 200.00/mt	57202
Marine Diesel Oil	7.73 days @	3 MT/day @	USD 500.00/mt	11596
				68798
Port disbursements Tarragona, vessel one day berthed, in and out				37000
Hire payment voyage Brake-Cape Finisterre				
	3.31 days @	USD 30,000.00 per day		99231
Bunker consumption Brake-Cape Finisterre (fuel for engines & generators)				
Intermediate Fuel Oil	3.31 days @	37 MT/day @	USD 200.00/mt	24477
Marine Diesel Oil	3.31 days @	3 MT/day @	USD 500.00/mt	4962
				29438
TOTAL DEMURRAGE COSTS				USD 466,390

The Costs of Avoiding LMOs: Sourcing non-LMOs

At present, importers who want to avoid LMOs can contract for non-LMO cargoes. Procuring non-LMOs implies operational changes in the crop marketing chain. Strict identity preservation (IP) must be used throughout the chain to prevent presence of LMOs and secure the required purity in sourced cargoes. IP procedures in non-LMO systems therefore imply additional costs, which are normally paid by the purchaser. Some relevant questions for importing countries then are: How large are IP costs in non-LMO markets? What are their key drivers? How sensitive are non-LMO IP costs to these drivers?

Why do non-LMOs Cost More?

IP non-LMO systems involve more coordination and planning than commodity-based systems. In most cases, changes must begin at the time a cargo is procured by an importer. While under current practices an importer's order can be fulfilled within 3-6 months, non-LMO cargos require procurement 12-18 months ahead of delivery. Exporters must reach, either directly or through intermediaries, all the way back to individual farms to contract acres for non-LMO production well ahead of the production season. And depending on the BSP standards in the country in question, coordination all the way back to the seed stock could be necessary.

Additional changes in the functions of the marketing chain are also necessary, as the production of the contracted acres must be protected from commingling with LMOs in the field, during harvest and transport, in storage, in the rail cart or barge, and all the way to the export vessel. Hence, operations at each and every part of the marketing chain are changed, with significant incremental costs. Recent research has begun to examine the size and dimensions of IP costs.

Both direct and indirect IP costs are incurred in non-LMO systems and must be tallied. (Kalaitzandonakes et al.). Direct IP costs are payable costs and generally result from:

> Coordination and control: IP non-LMO systems require more market coordination resulting in higher transaction costs. Such costs typically include salaries and wages for sourcing and management personnel, specialized information systems, third party certification fees, and so on.
>
> Re-engineering of operations: As firms adapt their production and marketing operations for IP, they often incur extra capital, labor and material costs. For instance, farmers incur higher costs from extra labor for equipment

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[10] Using 2004 hire daily rates –almost $50,000 per day—and fuel costs, the demurrage costs of the case study presented here would be almost 50 percent higher than those incurred just one year earlier.

cleaning during planting, harvest and storage as well as increased field isolation to prevent pollen flow from adjacent fields. Elevators incur extra labor costs for facility clean outs, and higher testing costs (Lin et al.). In fact, similar re-engineering costs are incurred throughout the chain.

Risks and liabilities: IP often involves risks and liabilities beyond those confronted in commodity markets (e.g. Alexander et al.). The most significant risks come from potential system failures at each stage. When insurable, such risks and liabilities translate into payable costs in the form of premiums.

Indirect IP costs are mostly implicit costs that result from loss of flexibility; inefficiencies due to underutilization of production, storage, transportation and processing assets; and lost profits (e.g. foregone storage margins and carrying spreads and potential loss of technology benefits from use of LMOs).

Drivers of IP Costs in non-LMO Markets

IP costs in non-LMO markets are not fixed. They vary significantly from one part of the chain to the other (Borchgrave et al.) and across commodities.[11] They also vary substantially with logistics and the infrastructure at hand. Because of such heterogeneity and limited experience with such systems, it is difficult to characterize the structure of IP costs in non-LMO markets. Nevertheless, the impacts of some key drivers are well understood and the direction of those impacts is reasonably predictable.

Purity Standards and AP Tolerances: The rigor with which IP procedures are designed and implemented depends mostly on the desired level of purity. For non-LMO systems with low thresholds, strict measures designed to prevent adventitious presence of LMOs must be put in place. Beyond certain levels, as thresholds diminish, IP costs increase exponentially (Kalaitzandonakes and Magnier, Huygen, et al.).

Scale of IP Systems: Unlike commodities, IP non-LMO systems do not generally enjoy scale economies. Indeed, if the aggregate demand for non-LMOs was to grow quickly and drive these markets beyond their current “niche” status, IP costs could escalate, as unsuitable assets would be increasingly employed in IP systems. Farmers, elevators and other contracted participants in non-LMO marketing chains are currently selected for skills and attributes (e.g. availability of on-farm storage, location with little penetration of LMO production) that minimize IP costs. Under significant scale expansion, less suitable, or more “average” assets, would be utilized, thereby raising the average cost of IP (Kalaitzandonakes et al.).

Scale of LMO Production: With increasing LMO acreage, adventitious presence of LMOs in non-LMO lots would tend to increase. Under such conditions, firms all along the IP marketing chain must implement more rigid IP processes to meet purity thresholds and incur rising IP costs.

How High are non-LMO IP Costs?

Most studies on IP costs have concentrated on a specific part in the marketing chain (e.g. seed – Kalaitzandonakes and Magnier; agricultural production – Bullock et al.; elevator— Maltsbarger and Kalaitzandonakes, Herman et al.). There are only few studies that provide estimates on how IP costs accumulate through the whole chain and their levels at the point of import. The evidence is rather limited and covers a wide range. Borchgrave et al. reported that IP costs for non-LMO soybean marketing chains with 1 percent AP tolerance levels average $22.5/metric ton at the point of import. Similarly, the Canada Grains Council put average IP costs for non-LMO bulk shipments with 5 percent AP tolerance levels at $8/metric ton and those with 2 percent AP tolerance at $25/metric ton.

For some confirmation of these IP costs, it is useful to examine the extra costs (beyond those paid for the commodity) borne by buyers for non-LMO cargoes at points of import in the main non-LMO markets: the European Union and Japan.[12] Using export data and information from various industry sources, it is possible to approximate the range of incremental costs paid by buyers at the point of import, given the size of these non-LMO markets.

The Japanese non-LMO maize market ranges between 3.5-4.5 million metric tons in any given year. Most non-LMO maize originates in the United States and is identity-preserved from the farm throughout the supply chain and all the way to the end user – largely the Japanese wet milling industry. Japan also has an active non-LMO soybean market that draws IP soybeans mostly from the United States for food uses. The estimated volume of the non-LMO soybean

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[11] Commodities differ in their production systems, marketing chains, and end uses. Because of idiosyncrasies, non-LMO IP costs can vary substantially across commodities. For instance, while outcrossing control requires expensive measures in the production of cross-pollinating canola and corn, it is a minor issue for self-pollinating soybeans.

[12] The incremental costs or “premiums” paid by buyers for non-LMOs at the point of import can vary from year to year with demand and supply conditions and may be quite different from IP costs. Nevertheless, since IP non-LMO markets are competitive and rather stable in size, IP costs and “premiums” paid by buyers will tend to converge in the long run.

market in Japan varies from 1-1.5 million metric tons in any given year. Both markets have been rather stable and have not experienced significant growth in the last 3-4 years.

The only other meaningful non-LMO market is found in the European Union where non-LMO soybeans have been sourced mostly from Brazil. The non-LMO soybean market in the EU ranges between 1.2-1.6 million metric tons.[13]

The incremental costs paid by importers in the EU and Japan for non-LMO soybeans are rather similar. In 2004, the incremental costs for soybeans in the EU were typically $20-25/metric ton while they were slightly higher in Japan averaging $22-27/metric ton. The incremental costs paid by Japanese non-LMO maize buyers averaged $10/metric ton at the point of import. These incremental costs seem to confirm the range of costs that accumulate up to the point of imports in non-LMO chains.

On average, the incremental costs paid by non-LMO maize buyers in Japan have been stable in the last few years reflecting the adequate supply conditions in the United States. Indeed, in 2004 less than 50 percent of the US maize acreage was LMO, suggesting adequate supplies of non-LMO maize. On the other hand, the incremental costs paid by non-LMO soybean buyers in both the European Union and Japan have been edging higher. It is unlikely that such increases are due to supply constraints, as the total non-LMO soybean market absorbs less than 2 percent of the total soybean production in the United States and less than 3.5 percent the soybean production in Brazil. It is more likely, that such increases reflect higher IP costs that come with increasing adoption of LMOs in both countries.

Finally, the aggregate costs of the non-LMO markets are of interest. Despite their limited share, non-LMO maize and soybean markets in Japan and the EU cost approximately $100 million per year to the domestic consumers, beyond the actual cost of the commodities themselves. These costs would of course increase with increasing adoption of LMOs; increasing number of LMO events (more costly to IP and test for); increasing number of LMO crops; and lower AP thresholds.[14]

The Challenge of “Unapproved Events”

An issue worthy of separate consideration concerns “unapproved events” – LMOs that have been granted regulatory approval in a producing country but not in an importing country. Unapproved events have already proved challenging for the crop marketing chain. Despite efforts to align commercialization and production of LMOs with regulatory approvals in major import markets, there have been a few cases where unapproved events had to be kept away of specific markets. The record in such cases is rather mixed with the most known disruption in trade coming from US exports of (unapproved) StarLink maize to Japan in early 2001. Indeed, deliveries of the unapproved event occurred despite significant efforts to test and segregate small amounts of such event out of the US maize marketing chain (Lin, et al.).

In these cases, the BSP creates an interesting tension. On the one hand, it empowers importing countries to regulate any environmental and human health risks that might apply to LMOs within their own domestic conditions, facilitated by AIA and other relevant procedures. On the other hand, the BSP also obligates the importing countries to a timely decision carried out “in a scientifically sound manner” (Article 15). Since only 19 countries in the world have established regulatory processes that have approved any LMOs, building the capacity to effectively regulate and approve LMOs across all importing countries could prove challenging, at least in the short run.

If implementation of the BSP resulted in increased exchange of scientific information, regulatory transparency, and improved coordination and speed in the global regulatory infrastructure, unapproved events would prove to be a non-issue. If however, implementation resulted in a highly segmented system with differential lists of unapproved events across various countries, the impacts would be pervasive. The existing global crop marketing chain cannot serve such a highly segmented global market and it is unlikely that it can develop relevant capabilities in the foreseeable future. Major exporters would most likely avoid import markets with long lists of unapproved events – in all likelihood those with the weakest regulatory infrastructures – leading to diminishing quality and higher costs of grain and oilseed imports.

VI. Who Pays?

Markets for commodities, feed ingredients, animal products, and various processed foods are vertically and horizontally linked within any given country but also with markets in other countries. Local institutions, policies, technologies and other idiosyncratic factors make the links among markets more complex and unpredictable. The degree of vertical

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[13] There are small amounts of non-LMO corn and soybeans that are traded under IP protocols to countries such as South Korea, Australia, New Zealand, China and others. However, such amounts are generally very small.

[14] Current AP thresholds for non-LMO markets are 5 percent in Japan and 0.9 percent in the EU.

integration and market power also complicates insights on expected market outcomes. Under these conditions, fully anticipating the trade and welfare impacts from BSP compliance costs on selected market segments is complicated. It is similarly difficult to fully evaluate the allocation of compliance costs of the BSP in the absence of a formal trade model.

Nevertheless, some useful initial observations can be made. As noted earlier, most key exporters of grains and oilseeds are LMO users. In their domestic markets, LMOs are equivalent by regulation to conventional crops and their use implies no incremental handling costs. In export markets, LMO cargoes would incur compliance costs associated with the BSP but these costs would be similar across all exporting countries. Under these conditions, the compliance costs associated with the implementation of the BSP, much like with IP costs in non-LMO segments, will become "costs of selling" in export markets, meaning that importers will pay the price.

It is therefore interesting to examine the spatial allocation of key grain and oilseed imports. Countries with large import volumes – especially those that are signatories and have ratified the BSP – will likely incur a large share of the compliance costs. As Table 10 indicates, the top grain and oilseed importers are developed and large developing countries with Japan, South Korea, China, and Mexico leading the group. Most of the largest importing countries have signed and ratified the BSP and would end up paying compliance costs that are proportional to their import shares. Among the top commodity importers, China and South Korea have signed, but have not yet ratified the BSP. Japan and Mexico are full members and hence they could end up shouldering a large share of the compliance costs.

On a per unit basis, however, small developing countries will likely incur disproportionately higher costs. As Table 11 illustrates, the average cargo size shipped from the United States to such destinations is typically significantly smaller than that of cargoes sent to many developed countries and large developing countries.[15] Since the per vessel compliance costs are more or less fixed, smaller cargoes destined for developing country markets will result in higher per unit costs.

VII. Summary and Conclusions

It should be clear from the foregoing analysis that the broad scope of the BSP would influence the level and distribution of the compliance costs borne by the global food system. In particular:

- Compliance costs will be significant and will be spread across the global food system. While it is difficult to anticipate how such compliance costs will be distributed, it is reasonable to expect that the majority of compliance costs will be borne by the importing countries.
- Compliance costs will increase with strict identification and documentation standards (e.g. they increase exponentially as the requirements become more demanding or as the AP thresholds become lower).
- Compliance costs are unevenly distributed across the supply chain. Large commodity importers will likely bear a substantial share of the compliance costs. Importers with low volumes and inefficient infrastructure will likely bear disproportionately higher unit costs.
- Compliance costs will be unevenly distributed across commodities. The potential impacts from supply responses across commodities are complex and difficult to anticipate. While supply increases in non-LMO crops might be expected, land constraints, processing infrastructure, and consumption patterns can mute such potential supply responses.
- Compliance costs will be unequally distributed among various importers and also among different exporters, depending both on their size in the marketplace, but also on the relative sophistication of their agricultural infrastructure.

The scope of BSP will also influence the amount of incremental risks borne by various actors in the system. Specifically:

- Test-driven enforcement creates incremental risks. Adoption of testing standards decreases but does not eliminate incremental risks, because of sampling variance and testing errors.
- Incremental risks are difficult to estimate and hence cannot be easily priced and insured.

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[15] Exports from other major exporters (Brazil and Canada) and other crops (e.g. wheat) were examined and showed similarly small average cargo sizes being shipped to small developing countries. Hence the data presented in table 11 are representative.

Table 10 Top Crop Importing Countries & BSP Membership

(In metric tons)

Importing Country	Maize	Soybeans	Wheat	Total	Signed BSP?	Ratified BSP?
Japan	16321093	4935444	5692039	26948576		Y
China	5148023	15115128	1734458	21997608	Y	
Korea, Republic of	8797167	1415089	3745042	13957298	Y	
Mexico	5843470	4431094	3262794	13537357		Y
Spain	3119884	3290183	5105067	11515134		Y
Netherlands	1984993	5918696	3490411	11394100		Y
Egypt	4758902	335994	4993845	10088740		Y
Italy	685158	1110760	7621149	9417067		Y
Brazil	484809	947394	6794286	8226488		Y
Iran, Islamic Rep of	1510498	425563	5280467	7216527		Y
Algeria	1778302	5	5268020	7046326		Y
Germany	796847	4459907	1180591	6437345		Y
Indonesia	1094930	1250836	3512129	5857895	Y	Y
Belgium	610703	1574064	3374756	5559523		Y
Morocco	1024066	287022	3346943	4658030	Y	
Malaysia	2191313	667793	1653052	4512158		Y
Canada	3632053	752393	67407	4451852	Y	
Portugal	1175828	1090797	1608660	3875285		Y
United Kingdom	1506567	930416	1289610	3726593		Y
Colombia	1934334	530589	1253906	3718828		Y
Philippines	225488	290057	2995483	3511028	Y	
Israel	950094	652582	1429153	3031829		
Tunisia	847592	9	1635013	2482613		Y
Peru	893455	68449	1411632	2373536		Y
United States of America	255179	110823	2007191	2373193		
Nigeria	24311	1	2294020	2318331		Y
Bangladesh	223857	0	2014391	2238248		Y
Turkey	857570	466875	722297	2046741		Y
Venezuela, Bolivia Rep of	638602	89783	1211889	1940274		Y
Greece	547785	355274	1033072	1936130		Y
Tanzania, United Rep of	54626	1445891	385937	1886453		Y
Yemen	258423	52094	1461585	1772101		
France	263993	992649	505701	1762343		Y
Chile	1147443	124942	265006	1537391	Y	
United Arab Emirates	470794	15148	891558	1377499		
Dominican Republic	1034120	120	338038	1372277		
Saudi Arabia	1124235	1181	1335	1126751		
South Africa	576473	23513	467908	1067894		Y
Korea, Dem People's Rep	467211	46900	550000	1064111		Y
World	84955692	57064364	116105862	258125917		

Source FAO

Table 11 Average Cargo Sizes of US Exports by Destination
(In metric tons)

Maize		Soybeans	
TOP 10	Average cargo		Average Size of Cargo
EGYPT	49338	THAILAND	51920
CHINA	48925	CHINA	51483
S. KOREA	44973	SPAIN	49391
INDONESIA	44404	BELGIUM	41344
TURKEY	40430	S KOREA	40189
SYRIA	34183	INDONESIA	39532
JAPAN	31955	PORTUGAL	37577
MOROCCO	28135	NETHERLANDS	36253
LEBANON	26908	MALAYSIA	28183
S ARABIA	25468	MOROCCO	24828
BOTTOM 10			
EL SALVADOR	9700	PHILIPPINES	12268
CHILE	9596	CUBA	12216
HONDURA	8615	TRINIDAD	7826
MOZAMBIQUE	6657	COSTA RICA	6893
TRINIDAD	5995	COLOMBIA	6143
JAMAICA	5933	NIGERIA	4686
NICARAGUA	4774	JAMAICA	3124
BARBADOES	4530	GUATEMALA	3080
GHANA	4492	BARBADOS	2822
SURINAM	1975	NICARAGUA	1810

Author's calculations from 2003 export data

Incremental risks and compliance costs resulting from BSP implementation are not static; they will increase with changing market conditions including:

- Increasing adoption of LMO crops (this is very likely, based on trend)
- Increasing number of LMO events/traits (this is very likely, also based on trend)
- Increasing number of LMO crops (as mentioned earlier China plans to commercialize LMO wheat and rice in the next few years)
- Improvements in testing technology (very likely)

Incremental risks and compliance costs associated with the BSP will change the incentive structure in the supply chain. Some potential consequences include:

- Changes in the composition of trade away from raw commodities to more highly processed products (i.e. not LMOs), such as soybean meal and soybean oil. Countries with processing facilities located near major production areas would benefit from such potential impacts while others with processing capacity that is dependent on imported commodities would lose.
- Increased vertical integration throughout the marketing chain. In the presence of increased uncertainty that cannot be easily mitigated or insured, risk-averse exporters might opt to control their cargoes from planting all the way to the point of export.

The scope of these concerns and the potential for real and significant costs to be imposed on food importers argues that the various implementation options being considered under the Protocol need to be assessed and understood before implementation decisions are taken so that the objectives of the BSP can be met in the most efficient and least costly manner possible.

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