ADOPTION OF QAS AND IMPACT FROM NORMS IN EXPORT CHAINS: MYCOTOXIN MANAGEMENT FOR MERCOSUR WHEAT ACTORS.

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1.- Introduction and goal:

International regulations regarding food quality and safety (FQS) on produced, processed, marketed, imported and/or consumed agro-food products are becoming stricter, more detailed and more widely applied over time. Much has been written about the impacts of international regulations on the food sector and the consumers within the EC (Raynaud, Sauvée, and Valceschini, 2002; Codron, Giraud-Héraud, and Soler, 2005; Fulponi, 2006, among others). At a more macro-economic level, another body of literature has been focusing on the impact of standards and regulations on export earnings of producer countries (Unnevehr, 2000; Otsuki *et al*, 2001). Much less evidence exists on the impacts of such regulations on the structure and organization of exporting countries' food sector, especially in the case of developing countries dominated by medium and small-scale family farming (Farina and Reardon, 2000; Henson and Mitullah, 2004; Jaffee and Henson, 2004).

Regarding FQS problems, mycotoxin contamination is among the top priority issues of cereal and other field crops. Mycotoxins produce toxic byproducts that have been defined as "…fungal metabolites which, when ingested, inhaled or absorbs through the skin, cause lowered performance, sickness or death in man or animals. Mycotoxins can be carcinogenic, mutagenic and immunosuppressive…" (Dohlman, 2003). According to the same author, mycotoxin contamination affect lives in more than one quarter of global food and feed production, with serious outbreaks known in several countries like it USA, Canada, Russia among others.

Recent project data (EC INCO-Dev project (MYCOTOX, 2003-05)) shows evidence that Argentina and Uruguay have had serious *fusarium* induced mycotoxin contamination events in wheat production (MYCOTOX WP4 project report). An inventory of mycotoxin occurrences in Brazil, showing to large variety of toxins and affected crops/products, was conducted by Brabet et al.(2003).

A Codex Committee on Food Additives and Contaminants (CCFAC) report in 2002, recommended that Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) be used to establish formal hazard analysis and critical control point (HACCP) food safety systems to identify, monitor, and control mycotoxin risks all along the food production chain. The HACCP system is widely used in the food industry to prevent food safety hazards and to ensure product quality. Yet little economic research has been conducted to assess the entire supply chain, or what the possible impacts these systems may have on producers, processors, consumers and industry.

The existence and magnitude of externalities in a market that contains mycotoxin contaminations products may result in the need for government and industry intervention to address these issues. The decision whether or not to intervene depends on the nature and magnitude of the externalities and the costs associated with intervention (Gray et al. 2000).

The objective of this paper is to assess the possible impacts from introducing new food safety norms, in order to provide recommendations for national policy makers to formulate the appropriate tools to promote the adoption of cost-effective QAS (i.e. HACCP) in national wheat chains.

The question to be addressed prior to that of impact is, why and how do chain actors adopt a QAS along the national wheat supply chain linked to export markets. Explaining this adoption, invites the following questions: (i) what are the direct and indirect costs and benefits along the supply chain by implementing an HACCP system , and (ii) what are the mechanisms – mandatory regulations or incentives/subsidies for a successful adoption.

2.- Background

In developed countries, institutions have evolved to reduce transaction costs, the absence or under-development of these institutions significantly increases transaction costs, impeding investment and hampering long-term economic growth and competitiveness. In spite of the process of globalization, the economic culture still has national components, which are the dominant values of each society, and is related to the concept of "institutions". According to North (1993) institutions are the playing rules in a society and they are constituted by formal (laws, rules, etc.) and informal (norms of conduct, codes of Behavior, conventions) conditions and by its powers of compulsion.

The externalities associated with mycotoxins wheat/products crops consist of human health externalities, marketing/segregation externalities, production cost externalities and information cost externalities (Hobbs, 2003):

(a) Human health externalities could arise in the event that foods containing mycotox contaminations had negative health impacts to consumers; depending on the market the producer may or may not pay for or receive compensation for these costs and/or benefits. (b) Marketing/segregation externalities are associated with the costs involved with distinguishing between Mycotoxin contaminated and non-Mycotoxin contaminated product; the existence of contaminated products may force non-contaminated producers to segregate their product to distinguish it from lesser-valued contaminated products.
(c) Production cost externalities are associated with the potential that non-contaminated products may have increased production costs due to the implementation of GAP´s/GMP or other practices. (d) Information cost externalities arise if consumers must incur costs to obtain and process new information (Gray et al. 2000).

Following Gosnell (2001), regarding strategies for the wheat/flour market, these could include: a) allowing the market mechanism to work, b) government and industry intervention to regulation, and c) segregation of non-contaminatios production. The first would be to allow the market mechanism to determine the fate of mycotoxin contaminated product in the market. The problem with using the market to determine the desirability of these products is that it may ignore the presence of externalities.

The second strategy involves government or industry intervention to regulate the existence of contaminated crops. To address all potential negative externalities may require that the production of contaminated crops be restricted to a certain level, or banned completely. Restricting production to a certain level, or completely banning contaminated wheat would require changes to the current registration policies.

The segregation of non-contaminated products, could be either voluntary (with the existence of premiums) or compulsory. If compulsory segregation is imposed on wheat production, a number of negative externalities may be eliminated. The voluntary product segregation

would eliminate the same externalities as compulsory product segregation, however, there is presumably a much higher risk of contamination in this system, in which case the reduced-demand externality may once again arise. A voluntary segregation system will only exist if there is a premium for the product and thus an incentive to keep it separate from contaminated product (Gosnell, 2001).

Crop segregation systems require close management of all links in the supply chain where potential contamination could occur. For example, a report prepared by the FAO, 2003 (TCP/URU/2801), outlines HACCP Plans for Uruguayan wheat chain, with the critical points where monitoring and enforcement are required to ensure mycotoxin contamination is prevented.

3.- Methods and data:

The economic framework of the research is based on Ziggers' (2000) argument, that, food safety increases transaction costs because searching for information, negotiating and monitoring the transaction will have an additional component. In other words, it increases uncertainty and asset specificity of the transaction. QAS, as an HACCP system, constitutes an institution that reduces these additional transaction costs, generating a more coordinated and efficient supply chain. Hence, the study's use of transaction costs and the analysis of the governance structures.

The main objective of the transaction costs theory consists of analyzing which of the distinct existing alternatives to organize exchanges has the best adaptation to the characteristics of each transaction, in the sense of minimizing the risks and, mainly the costs that these carry with themselves. According to Williamson (1996), the enterprises and the economic system as a whole tend to be organized so that the costs of performing transactions be minimized.

The transaction costs originate from attempts to compensate the opportunism, the limited rationality and the need to design safeguards, and they result according to the efficiency with which a determined "execution structure" ("governance") channels transactions in function of the frequency, uncertainty and specificity that characterizes each transaction. The question presented consists of selecting the type of organizations -or structures of "governance"- that do minimize the associated costs to the execution of a specific transaction. In this paper we use a research framework with Transaction Cost Economics (TCE) analysis in the agri-food supply chain (Figure 1). The impact of the institutional environment must be taken into account. Williamson (1991) shows that the rules in the institutional environment will influence the choice of governance structures in modifying the level of transaction costs.

The Bilateral Governance Structures in the supply chains have the following relevant transactions:

- transaction between farmers and their input suppliers,
- transaction between farmers and the first transformation step (Mill),
- transaction between the first and the second transformation steps (Bakeries),
- transaction between wholesalers or the last transformation step and the retailers (traditional retailers and supermarket/hypermarket chains).

The empirical work is based on small national wheat supply (sub)chains in Argentine, Uruguay and Chile, including a qualitative/quantitative assessment of : (1) identifications of additional benefit and costs derived form the implementation of an HACCP adapted to export

markets at each level of the chain, using a Commodity Flow Diagram (CFD), and specific CCP indicators, and (2) governance structure of the supply chain, adding the impact on transaction cost from HACCCP implementation.

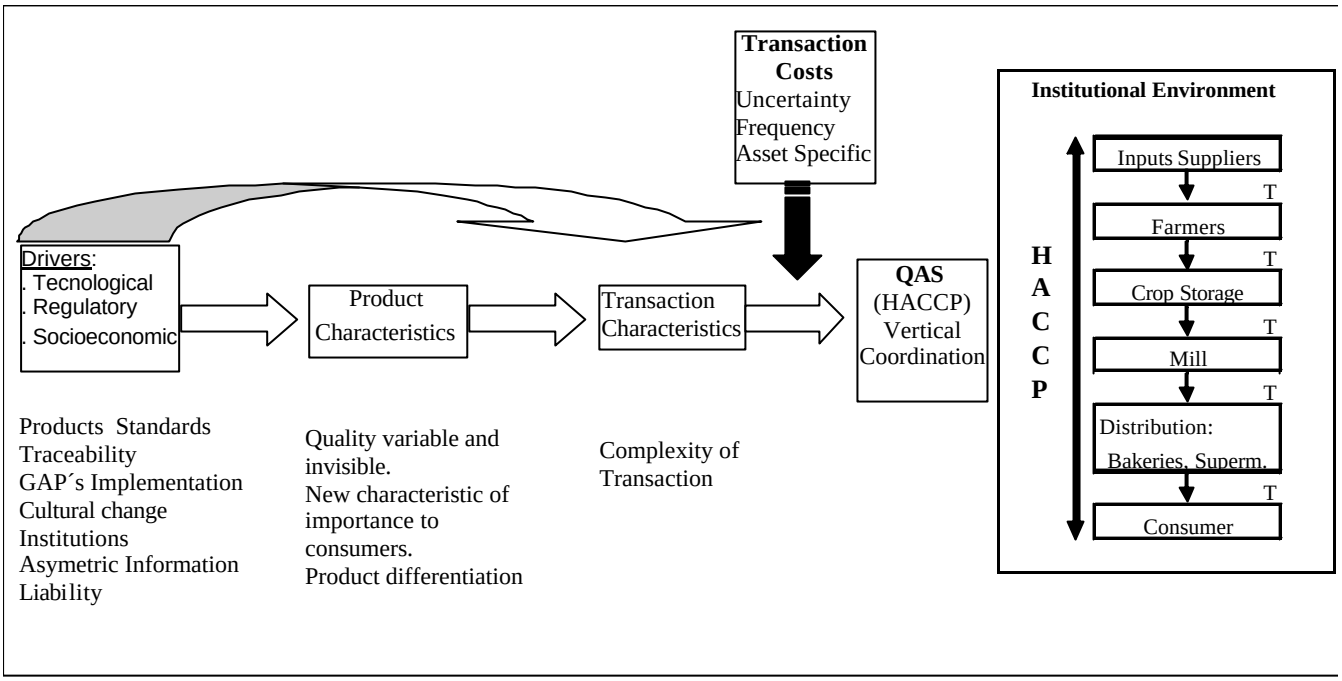

Figure1: Research framework Scheme. (Adapted from Hobbs and Young, 2000)

Secondary data was used to generate a sub-supply chain characterization. In each country, a case study was identified to gather primary data for: (a) a first quantitative assessment of farmers, traders/storage, mills, bakeries and transport (to construct a CFD), and (b) a second qualitative survey with all relevant chain actors i.e. input suppliers, farmers, storage, traders, transporters, millers, distributors, including detailed questions on key elements of transaction costs regarding governance structures. The sample used to perform the study in the 3 countries of interest, is presented in Table 1.

Table 1: Sample used for actor interviews, by country

	Argentina	Uruguay	Chile
Wheat farmers	20	34	13
Storage owners	3		
Mill	1	1	1
Transporters	3		
Bakery / factory	8	4	5

4.- Results and Discussion

The case studies' results reflect different degrees of integration and governance structures that allow us to identify costs and benefits from implementing QAS. A spot market governance structure generates high financial burdens in implementing QAS such as HACCP. On the other hand, the structure of HACCP costs/benefits seem to be quite diverse depending on firm, and actor level in the supply chain and the large costs of developing and implementing a plan are not scale neutral and will be lower on a per unit basis for larger food

enterprises (farmer, mill, etc). Price and market signals are strong drivers to quality achievement, rather than enforcement mechanisms that are hard to control.

Although with slight differences, a common CFD for the three countries, is constructed, in which we identify the main critical control points (CCP) for mycotoxin contamination problems (Figure 2). The main mycotoxin contamination problem in Uruguay and Argentina is *fusarium* based. CCP´s are selected in order to achieve that the main product is safe in contamination terms.

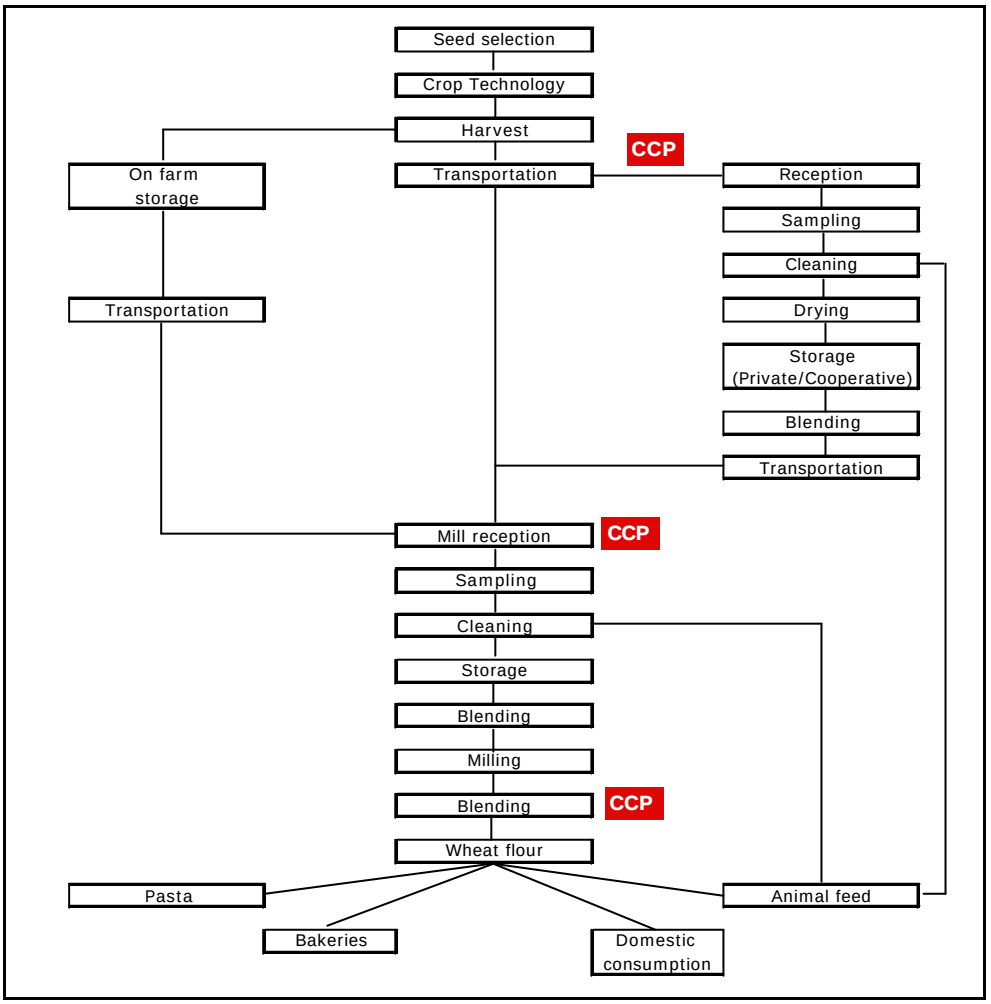

Figure 2: Commodity Flow Diagram

To consider the harvest as a critical control point, an instrument of prediction of the state of the crop is required, that is representative of the prospective levels of contamination. Without a good prediction or a representative fact, it would be impossible to consider this point like a CCP, because there is not a rapid analysis method available. In our case the main CCP is the point of reception of the cereal at the mill or in the private storage facility.

For each case study, the possible financial, informational and organizational incentives and restrictions along the supply chain, were analyzed, to implement QAS as HACCP system, as well as the associated transaction costs. Regarding the incentives and restrictions, Table 2 and 3 summarize the most important elements for each case study.

Table 2: Financial Incentives and restrictions to implement HACCP along the wheat supply chain

	Argentina	Uruguay	Chile	Summary
Price premium	At this time, there is not a "Price premium" in any actors of the supply chain; price premium is one of the strongest disincentives to adopts QAS.	No price premiums for farmers using QAS on mycotoxins. Price is adjusted based on spot market conditions and industrial quality of every harvest.	The market that is paying a price premium for safety is the salmon industry, which needs traceability of inputs. However, this industry buys most of their needs as grain and not directly to the mill. Bakeries and supermarkets do not pay quality and the price is the strongest attribute to compete.	No evident price premium. It´s a strong incentive.
Access to market	The adoptions of QAS could allow the access to external markets in developed countries. The internal market and the bordering countries markets have low requirements of quality referred to mycotoxins.	Mycotoxin levels do not represent a major access problem for farmers. Cases of initially rejected wheat based on quality problems were later purchased by the industry were reported. Poor government control on wheat flows based on quality.	The implementation of QAS allow the mill to access the salmon industry as a wheat buyer.	Allow for accessing specific markets. Is an incentive in specific cases.
Product differentiation	In the country they are developing in isolated form some business of "wheat (bread) of quality." The market, through the commercial standard and the allowances for protein, doesn't reach by itself to generate the necessary incentives to provide such product.	Almost non existent due to structural difficulties on the storage sector. Yet, some selection by the negative is made by millers (do not accept certain varieties based on poor industrial quality. Lack of a proper price policy by the industry makes it very difficult to build a market based on quality differentiation.	The mill industry produces today different types of flour (in average 25 different kind) that have different purposes and uses different grain specifications and additives. This differentiation has different prices. However, most of the production is still of one type of flour.	Allow for accessing specific markets. Is an incentive for specific cases.
Classifications & segregations	Its important the incremental cost due to the low grain rotation flow; although in the last years have been developed a new storage technology ("Silo bag") such interesting to help segregation to farms and storages.	Segregation based on quality is difficult because of structural deficiencies on the national storage system. Silo bag is becoming a useful tool for farmers but some quality concerns remain at the industry in the massive usage of this technology.	Segregation and classification implies a cost. The mill under study uses different silos for different varieties of grain and protein content that mixes for the different types of flour it needs.	The incremental cost is a disincentive.
Production costs	Increase variable production costs (labor) and fixed production costs (informatics' equipment, annual certification and long time to implement norms)	Increased production costs of implementing a QAS with uncertain expected results. Certification is not considered an option since there is no market for specialized farmers or products.	Productions cost will increase. This incremental cost is a disincentive for HACCP. However, farmers surveyed and the mill did not give this topic a great importance.	Not an important disincentive.
Additional Investment	Hardware & software Equipment	Certification / auditing costs are high for a single activity	-	Not an important disincentive

Table 3: Organizational Incentives and restrictions to implement HACCP along the wheat supply chain

	Argentina	Uruguay	Chile	Summary
Reorganization of activities (GAP´s implementations)	It's still a very incipient practice in grain. It has economies of scale and due to a mixed farm production need a full farm GAP´s implementations. There are not GAP grain programs	Although well publicized GAP are not of common usage among farmers on mycotoxin contamination problems. Poor information flows leads to a very weak conscience of the scope of the problem.	GAP are getting more important for the agricultural export sector. For example, the fruit and wine industry, etc. For crops that are sold to the internal practice, there are less incentives to implement them. However, there are farmers that are familiar with the practice because they have other crops in rotation that are subject to GAP, therefore implementing it to wheat would not be very costly.	GAP´s need a promotion plan to be adopted in cereals
Training (know haw, Cultural change)	Human capital limitations it's a very important issue. Need much time in training & learning being doing. There is not information about contamination levels.	Wide public campaigns on control measures were made. Farmers are aware of the technical possibilities but are reluctant to take drastic measures to control de disease that causes contamination (crop rotation, conventional tillage)	The government is giving incentives to the different actors of the chain to adopt better management skills and quality systems. In this, the training is subsidized.	It's an important restriction to adopt
Traceability	It's necessary to implement a traceability system for grain for this institutional environment.	No plans to implement traceability on the wheat sector. Lack of official controls on wheat flows makes it extremely necessary.	The mill under study is implementing traceability in order to accomplish the salmon industry requirements.	It needs a promotion plan to be adopted in cereals
Data recording	Specific software management. But this software could be used to farm management applications. It's costly in term of opportunity costs.	Very poor data recording at farmers level. Some costs information is available as a general management tool.	Data recording is still an important issue. Data need to be specific and producers are not use to this. However, many of the mill supplier have crops that need GAP and data recording, generating some know how that can be applied to wheat.	It's an important disincentive
TRANSACTION COSTS				
Asymmetric information	There is a lack of information and concern related to mycotoxin contamination among actors in the wheat chain	As in Argentina there is a lack of information.	There is also lack of information; however, in Chile mycotoxin contamination have not been documented.	It's an important disincentive
Uncertainty	Low institutional confidence and lack of trust among parties.	Poor institutional confidence among parties and very poor cooperation on quality issues. Absence of domestic regulations permits the co existence of a black market that offers a channel for contaminated wheat.	The market in general provide low institutional confidence generating high uncertainty to implement QAS models; however, in this case study producers trust in the mill and this relationship promote the adoption of quality measures.	It's a strong restriction for adoption

Actor incentives to adopt QAS can be divided into economic incentives, regulatory/legal incentives and human capital incentives. The disincentives include economic disincentives, institutional infrastructure constraints and human capital constraints.

Economic incentives also operate on the cost side of the profit (net revenue) equation. For example improving agricultural practices that reduce storage costs, reduce wastage or result in more efficient use of labour or other farm inputs can reduce average costs.

Policies to correct market failure seek to internalise the external costs by transferring the burden of social costs back to the farms. Taxes, subsidies and regulations are the common means by which policymakers change the incentive structure with respect to spill-over effects (externalities). Regulatory intervention to correct a problem is only desirable if the benefits of intervention outweigh the costs. The lack of infrastructure to implement or enforce policies, then regulatory intervention to promote QAS may not be a viable strategy.

The disincentives or constraints include economic disincentives, institutional infrastructure constraints and human capital constraints. The most obvious economic disincentive is cost.

Increased variable costs include higher labour requirements or labour training to improve harvesting techniques, increased record-keeping requirements, discontinuing the use of cheaper inputs in favour of inputs that are harder to obtain and/or more costly but that are more environmentally friendly, etc. Decreased yields can result from less intensive use of agricultural chemicals or the use of soil and water conservation techniques. Reductions in yield increase average costs of production, assuming that other input costs remain unchanged. New capital investments increase fixed costs and can include required improvements in harvesting and storage equipment, energy and waste management or investments to improve farm worker safety. While it is difficult to generalise about costs, some examples are useful, i.e. it has been estimated that national process-based GAPs increased costs for Chilean maize farms by 17% (RIMISP 2003).

Farmer adoption of QAS is sometimes constrained by human capital limitations, i.e. limits on the farmer's ability to apply the prescribed production and management protocols and maintain the appropriate level of documentation. The EUREPGAP system, for example, requires documentation that would allow traceability of farm products (e.g. records of sales), records of chemical and fertiliser inputs, etc. These records are transaction-cost reducing mechanisms that facilitate trade over time and distance. Record keeping is also a part of good management practice that allows a farm enterprise to review its status and plan future production decisions.

Record and documentation requirements can also be costly in terms of the opportunity cost of a farmer's time – i.e. the time spent preparing and maintaining records could more usefully be spent on other activities. This can become a problem where multiple GAP systems are emerging and farmers are faced with duplicative record-keeping tasks for different commodities or to qualify for different GAP schemes. Most of on-farm food safety systems are commodity-specific, so that a mixed farm producing wheat, beef, soybean and sunflower products (such us Argentine cases) could be faced with keeping several separate sets of records pertaining to on-farm practices that affect food safety, in addition to audits for each commodity. Multiple commodity audits are under consideration to reduce the burden for farmers.

Where 'market failures' exist other actors become involved in establishing QAS; there may be a role for producer industry associations or retailer associations. Public sector agencies can play a role in assisting the establishment of QAS in clear cases of market failure due to externalities (spill-over) or information asymmetry (where quality attributes are hidden).

5.- Conclusions

The preliminary results allow us to conclude that in order to implement a HACCP system along a supply chain, "external" intervention is needed. Mandatory regulations will not always be the easiest way to generate a quality management system. Moreover, public incentives to generate a higher integration along the supply chain could be a cheaper and effective way to generate a change in the governance structure that allow for a efficient adoption of HACCP.

Impacts from quality norms on export chain actors include more vertical integration, more internal and third-party certification schemes, relatively stronger competitiveness for adopters, and better controlled safety foods for final consumers. Information and how it is delivered between successive firms in a vertically related "value chain" is a key factor in determining corporate structure.

Obviously, in primary agricultural production, physical processes are an important component of the impacts from norms in export chain, however, information is also playing an important role.
Producers need to be extremely proactive, in their individual business and in prompting their producer organizations to undertake new roles to invest in the skills and equipment needed to compete in more highly specialize products.

Market failure due to information asymmetry may impede the formation of closely coordinates supply chain; government policy could reduce or eliminate information asymmetry, e.g., in the provisions of information about quality, accreditation of quality assurance schemes, etc. But there should be a third party who provides an independent and objective assessment of the quality attributes (including intangible attributes as in mycotoxin cases) of the products to reduce information costs for producers and processors.

Also technical advances may reduce measurement costs by enabling firms and/or governments representatives to measure quality attributes more accurately. There is a need for education and advice to producers and processors: alternatively this role could be performed by the government or the industry/producers associations

This paper has only touched upon some of the the principal issues related to adoption of QAS systems in supply chains. And taking the discussion one step further, it has made some preliminary assessments about impacts from QAS norms on the actors and their organization. Furthermore, this paper has put forward some recommendations for national policy makers. Due to the nature of the research results, significant additional and much more robust research is needed to validate these preliminary findings.

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