Policies for QAS implementation in export chains: mycotoxin management for Mercosur wheat actors

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Abstract

Wheat related products contaminated with mycotoxins, generate human health externalities, marketing/segregation, production cost and information cost externalities. The implementation of a cereal Quality Assurance Systems (QAS) is an issue of importance in agro-supply export chains. Most countries do recognize that placing standards on the level of mycotoxins entering the food chain, is prudent, but diverging perceptions of how to balance economic costs and health benefits have become a source of trade friction between countries. This paper provides preliminary recommendations for national policy makers to formulate the appropriate tools to promote the adoption of cost-effective QAS.

The first results allow us to conclude that in order to implement a Hazard Analysis and Critical Control Points (HACCP) system along a supply chain, "external" intervention is needed. However, the public intervention should be analyzed carefully since inappropriate incentives may cause an increase in transaction costs making the supply chain less efficient. Today national market signals are not strong enough to assure that the enforcement of government incentives can be efficient. There exists a need to strengthen cooperation between institutions and different chain actors, educational training with reliable information directed to producers, agronomists, bakeries and end-users, and education in good mycotoxins management practices and regulatory frameworks.

Keywords: HACCP, quality assurance system, governance, mycotoxins

1. Introduction and goal

Wheat related products contaminated with mycotoxins generate human health externalities marketing/segregation, production cost and information cost externalities (Hobbs, 2003). Human health externalities could arise in the event of foods containing mycotoxin contaminations having negative health impacts on consumers. Marketing/segregation externalities are associated with the costs involved with distinguishing between mycotoxin contaminated and non-mycotoxin contaminated products. The existence of contaminated products may force non-contaminated product producers to segregate their product to distinguish it from lesser-valued contaminated products. This would be considered an externality as the costs associated with segregating are paid by the non-contaminated products. Production cost externalities are associated with the potential that non-contaminated products may have increased production costs due to the implementation of Good Agricultural Practices (GAP) or other agricultural practices in order to reduce mycotoxin incidence. While it is difficult to generalise about costs, an example may be useful. It has been estimated that national process-based GAPs increased costs for Chilean maize farms by 17% (Ramirez y Caro, 2003).

Information cost externalities arise if consumers must incur costs to obtain and process new information (Gray et al. 2000). If consumers are uncertain about the adverse effects of wheat crops, and are unable to visually distinguish between contaminated and non-contaminated products, there may also be costs associated with the need to generate and communicate the information with public and private resources (Gosnell, 2001). The existence and magnitude of externalities in a market that contains products contaminated by mycotoxins 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 the intervention (Gray et al. 2000).

The implementation of cereal QAS is an issue of importance in agro-supply export chains. Most countries do recognize that placing standards on the level of mycotoxins entering the food chain is prudent, but diverging perceptions of how to balance economic costs and health benefits have become a source of trade friction between countries. HACCP and other schemes could serve as effective trade barriers to the extent that they become standard business practice.

A Codex Committee on Food Additives and Contaminants (CCFAC) report (Codex Alimentarius Commission, 2002), recommended that GAP and Good Manufacturing Practices (GMP) be used to establish formal HACCP food safety systems to identify, monitor, and control mycotoxin risks, 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 how cost effective HACCP may be for improving food safety or how it may affect food markets, consumers, and industry. Moreover, the literature recognizes different aspects that may affect the willingness to adopt HACCP systems (Ziggers, 2000; Nettles and Bukenya, 2004; Herath and Henson, 2005). However, not many of the articles have focused on the different aspects that may affect the implementation of HACCP and QAS along the supply chain.

Given the above, the objective of this paper is to provide recommendations for national policy makers to formulate appropriate tools to promote the adoption of cost-effective QAS (i.e. HACCP) in national wheat chains, in order to penetrate international markets with appropriate quality standards. The challenging question is, how to implement an HACCP as a QAS along the national wheat supply chains linked to export markets: (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. This study goes further than most HACCP literature, in that the analysis targets the full wheat supply chain, and its actors, rather than a single-level industry.

2. Background

The decision to adopt HACCP has different dimensions and constraints. On one side, there are incentives provided by the market for the adoption of such systems. However, there are costs associated to HACCP implementation and other factors that prevent its adoption. Market incentives usually come in the form of price premiums and/or market access. According to Klein (1996), a necessary condition for a producer to voluntarily maintain a high quality and safety of a product, is the existence of a price premium or "quasi-rent". Studies show that consumers value food safety and that they are willing to pay a higher price for this attribute. For example, Ott (1990) reported a 5 to 10% premium for fresh produce free of pesticides. Huang et al. (1999) reported a higher premium, 16%, for the same product and

attribute. In a study that elicited willingness to pay for information about food safety for beef in Finland, Latvala and Kola (2000) reported that 59% of the sample population is willing to pay a premium for having more information at the purchasing moment. Willingness to pay for more information in the way of certified products has also been a research topic. Rozan et al (2004) analyzed the impact in the consumer willingness to pay for non-certified products, when a certified product enters the market. The conclusion was that the willingness to pay decreases showing that consumers are really concerned about food safety. Some authors recognize that food safety can also be seen as a marketing opportunity, for which the implementation of a HACCP system, provides a distinction recognized by the consumer, allowing the firm to increase sales and market share (Hinson and Whitley, 2003).

On the other side, the costs of HACCP implementation include fixed costs such as, the costs of designing and implementing control points, training and new equipment, and variable costs that are often minor and include labor and materials. HACCP costs will vary with the plant scale, affecting the industry structure (Unnevehr, 1997). Hooker et al. (2002) evaluated the importance of scale in HACCP implementation and concluded that there is evidence of economics of scale. In this sense, we can argue that scale could be a barrier for HACCP adoption.

Assuming that agents at any level of the chain are profit maximisers, the decision to implement safety measures and specifically a HACCP system will depend on its net benefits. However, despite de net benefits, a HACCP system implementation may have an important set of restrictions for its adoption. Galan et al. (2002) classifies the obstacles to adopt such systems in: organizational, informational, technical and financial. This means that quality and safety assurance systems need reorganization of activities, traceability and data recording, specific technical skills and economic resources. Herath and Henson (2005) argue that the reasons that explain unwillingness to implement HACCP are complicated and even when the net benefits are positive and substantial, other barriers to adopt the technology may exist. In general, non-adoption has been associated with two main factors. The first one is a net cost, derived from a market that does not pay for the benefit. The second factor is a net benefit that is not perceived by the enterprise, and who therefore decides not to adopt. Why doesn't the firm perceive the benefits? In some cases this is because the benefits are intangible, in other cases this is because they do not keep records that reflect the associated costs and benefits. According to a survey study performed by Herath and Henson (2005) in the Ontario food processing industry, 50 % of the respondents considered the implementation of HACCP systems difficult or very difficult. In the same study, the main barrier to adopt HACCP can be associated with questionable appropriateness of HACCP, meaning that firms do not believe that HACCP is the best solution to food safety, or that they perceived a high uncertainty regarding its applicability and standards in the future. The second barrier was the scale of changes, regarding organization and management that need to be performed before implementing HACCP. Financial constraints have a low priority among barriers. These results reveal that the main focus in promoting HACCP or any other protective measure should emphasis impact on the organizations and informational dimension of the enterprise to be successful. Galan et al. (2002) found that the main restrictions to implement a management system are technical and organizational, and in particular, in terms of information management.

As recognized by most of the authors, the most important restrictions for the adoption of HACCP are organizational. Food safety will probably require new forms of vertical coordination to minimize the probability of contamination in food (Hobbs and Kerr, 1992),

which implies that actors will need to adjust their relationship to new forms, before successfully implementing HACCP throughout the supply chain. Ziggers (chapter book, 2000) recognizes that transaction costs can be affected by food safety in different ways. There are legal standards to meet that require to manage more information, to trace the product. Transaction costs include supplier identification, contract negotiation and contract verification and enforcement, which will increase as regulation increases. As one moves up the food chain, transaction costs resulting from food safety, may increase. Therefore a key issue in encouraging the adoption of QAS along the supply chain, is an appropriate distribution of the costs and benefits along the chain.

The factors and examples listed above, give relative transaction costs and organizational forms of the chain an important place in QAS adoption success. Besides, it is important to generate ways to promote partnerships among the chain actors to achieve safety objectives. According to Ziggers and Trienekens (1999), developing partnerships are aimed at improving efficiency and effectiveness of the supply chain, therefore, this may be an approach to study how to implement safety measures in the export wheat supply chains under analysis.

HACCP supply chain partnerships can be put in a transaction perspective, as a regulatory system in order to establish an efficient and reliable flow of transactions among interdependent chain actors. The organizational structure and the derived transaction costs are not purely a matter of asset specificity, transaction frequency and uncertainty (Williamson, 1979), but are impacted by forces which affect relations within chain partnerships. In the same manner, the knowledge possessed by partners (asymmetric information), bounded rationality, opportunist behavior, are also affected by uncertainty and complexity of the local institutional supply chain environment. Therefore, understanding how actors within partnerships interact with each other is necessary for exposing the technical and economic consequences of product development and differentiation. Furthermore, due to the significant difference in scale between successive farm and non farm stages, it must be noted that closer vertical coordination is needed in food supply chains (Hobbs, 2001 and Ziggers et al, 1999).

This paper uses a similar transaction costs based approach to analyze the incentives to promote HACCP adoption throughout the wheat export supply chains of Southern Cone countries. We focus on the benefits and costs of HACCP systems, but also on coordination between the different actors and the transaction costs of maintaining HACCP systems. This information serves to give directions regarding policy incentives and instruments that may encourage its adoption.

3. Methods and data

To establish quality assurance in agrifood supply chains it is important to consider the specific characteristics of raw materials and production systems. Specific production/product characteristics, like a "free mycotoxin" final product, are an important issue for closer vertical coordination, due to variable and/or invisible quality. This includes variability of quality and quantity of supplies of farm-based inputs due to biological variation, seasonality, random factors connected with weather, diseases or other biological hazards in successive stages of the cereal chain. All of this stands for an integrated HACCP chain approach of a QAS at all the stages of cereal supply chains ("supply chain partnership").

In this paper we attempt to integrate the HACCP concept with a Transaction Cost Economics (TCE) analysis in the agro-food supply chain (Figure 1). These approaches are often applied

separately, however their insight may be complementary and applied together, may enhance the vertical coordination approach. The empirical work is based on small national wheat supply (sub)chains in Argentina, Uruguay and Chile. Argentina and Uruguay share the same basic mycotoxin contamination problems in wheat. Production systems are basically the same, making the wheat production susceptible to the same hazards and the internal market structure is almost identical, with a large predominance of spot market use, poor vertical integration between farmers and millers, and scarce use of contracts to ensure quality. The Chilean case is different, since the mill selected as the case study, presents a high degree of coordination with farmers and the mill.

There is no market data available to estimate costs – benefits and transaction costs of implementing HACCP measures, therefore, a qualitative assessment was performed. The information collected for the study is the following: (1) identification 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) adapted from FAO (2003), and (2) governance structure of the supply chain, adding the expected impact on transaction cost derived from the implementation of HACCP. Each supply chain constitutes a case study to understand the expected associated costs and benefits of HACCP.

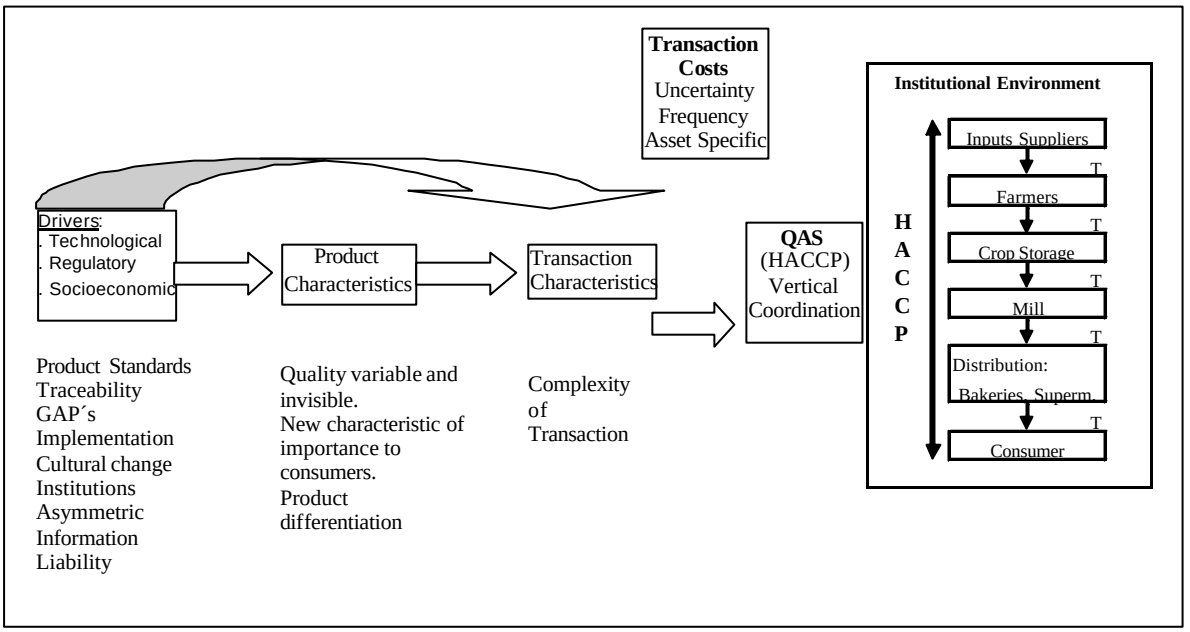

Figure 1: Research framework Scheme. (Adapted from Hobbs and Young, 2000)

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 structure at each level of the chain. As evidenced below, the Argentinean and the Uruguayan case are very similar, hence this allows to split up the studies needed to consider the whole supply chain based on where the critical information is available. This also explains the division of tasks among countries. The estimation of the incremental cost of implementing HACCP was obtained through interviews with key players at the producer level and the mill. The sample used to perform the study is presented in Table 1.

Table 1: Sample used for actor interviews, by country (Source: internal project data)

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

4. Results and discussion

4.1 Supply chain characterization

The wheat supply chain in Argentina and Uruguay presents a governance structure close to a spot market, in which contracts do not exists, and previous coordination is present only in the Chilean selected chain. There are some important differences among the countries that create different scenarios for our study. For example, Argentina is one of the world's largest wheat producers reaching an output of more than 15 million tons a year. As a large producer, it is also an important player in the international wheat trade. Two thirds of production is exported. On the other hand, Uruguay dedicates its production almost entirely to satisfy the internal market, and occasionally sells wheat in the international market, mainly to Brazil. Its production is around 350 thousands tons a year. Finally, Chile is deficient in wheat, importing around a 30% of its requirements. Its production is around 1.8 million tons a year.

The case studies selected in each country are presented in table 2. The central entry point of the chain involved is the first processor (mill) and the study focus is then extended to producers, traders and second processors involved in this particular chain. As showed in table 2 each case has its own characteristics.

Only one third of Argentina's wheat production is destined to the mill which represents 3.5 - 4 million tons of flour. 10% of this volume is exported, almost exclusively to neighbor countries (Brazil, Bolivia, Paraguay and Chile concentrate 80% of the destination). The quality standards in those markets, as well as in the internal markets, are low. In Argentina there is an official standard for traded grain that includes quality standards. Argentina uses the local spot market as a price reference (derived from the existence of a futures market). As expected, the premium/discount policy of the milling industry is basically a concept determined by the millers according to their best interest. This does not encourage a long term policy system sending clear signals to the farmers in terms of the quality of wheat they need. In addition, the Argentinean mill can purchase wheat based on a very large supply, hence it is a price setter. Another important characteristic has to do with the structure of the production systems, in which specialization in a single commodity, is very rare. Farmers often have several activities that share the soil resource and the allocation of this resource largely depends on the expected returns. It is also a good risk management strategy, by diversifying the productive and income risk. The most common system includes wheat, maize, soybeans and sunflower as agricultural crops mixed with livestock production. This structure of production makes it difficult for a farmer to focus on a single QAS strategy for a single product (wheat) mainly due to cost considerations (economies of scale and different opportunity costs among products).

Table 2. Case studies supply chain description (Source: internal project data)

	Argentina	Uruguay	Chile
Case Study	Medium size wheat mill - La Pampa Province	Wheat mill cooperative	Wheat Mill – X Region
Ccapacity	24.000 ton a year	50.000 ton a year.	35.000 ton a year
Relative importance	It's a medium size mill (Ranked 65 over 120 mill in the country)	It belongs to the largest Uruguayan milling group	It is the biggest mill in the south of Chile. However, its relative importance in the national market is low.
Suppliers (farmers)	Only 50% of the wheat processed a year is bought directly from the producer. The other 50% is provided by local Coops & brokers. It´s important to mentions that the mill demand only cover less than 10% of the area wheat production.	Wheat supplied by farmers accounts generally for 75% of the total wheat and 25% comes from the cooperative sector / private traders.	95% of the wheat is provided by producer, manly large producers. It is important to mention that in general, mills in Chile import part of their requirements, but this mill uses only national wheat.
Product market	60% of the final product is destined to bakeries and 40% to a pasta factory owned by mill. A final byproduct is destined to a animal food factory owned by mill	80% of the final product goes for internal market mainly to small bakers and domestic consumption. Export and industrial clients are minimal on the total market share.	50% of the production is derived to supermarkets, 10% to food salmon industry and the remained production to local stores and bakeries.
Quality concept	There is no a dear concept of quality across the chain. For the producer it is related to protein content (as the official standard), the mill request gluten, and the bakery measures baking quality in the final product.	The mill quality is resumed in clean and dry wheat. No integration whatsoever on industrial quality parameters to induce the farmer to certain wheat type or class. Price premium criteria vary year by year depending on the average harvest quality.	The mill buy certain varieties of grain and test for different quality characteristics such as protein, gluten index and sedimentation. Farmers produce the variety of wheat that the mill will buy. Quality is related to mostly to gluten content and sedimentation.
Coordination and integration	The coordination of the chain is low; lack of production contracts between farmers and millers, poor price risk management tools (in spite of the existence of a futures and options market) and poor management of the productive risk due to the lack of massive insurance contracting indicates the frame under which wheat production is done. Institutional and commercial confidence is extremely low, indicating that the relation between the farmer and the mill is non-cooperative.	Very poor coordination between farmers and the Mill. The leading purchase strategy is to buy wheat at harvest as much as possible using extensively the sport market. Usage of contracts is poor among parties specially on what has to do with quality signals and price premiums.	There exist coordination between producer and the mill, however no contracts exist. An important group of producers are related to the mill in a specific program that promotes technology use to improve quality of the grain. The mill can trace 90% of its input need. The relationship between the mill and the retailers is as spot market.
Experience with fusarium and/or mycotoxins	Farmers and storagers have had evidence of fusarium in the past, however they do not know about the presence of mycotoxin because they have not tested for it. In general, there is a lack of information about mycotoxin norm and regulations.	During the years 2001/02 Uruguay experienced a serious fusarium infection on the wheat crop, that caused a serious decline un average yield and also mycotoxin contamination problems in both wheat and wheat flour.	In Chile, although climate conditions and cultural practices favor a low presence of fusarium. There have been evidence of the fungus in the field. No experience related to mycotoxins exists. No test are applied either.

In Uruguay the wheat production is manly focused on the internal market, with occasional exports of wheat and wheat flour mainly to the Mercosur region. As an important difference with the Argentinean case, in Uruguay there does not exist a domestic mandatory quality standard for wheat. However, since in 2001-02, Uruguay had serious mycotoxin contamination problems caused by a massive *fusarium* infection, Uruguayan authorities issued a domestic standard specifically for mycotoxin contamination of wheat flour. This rule

was based on a risk assessment by public health officials based on the domestic consumption of wheat. However, since the control point was the contamination level of wheat flour and not on the wheat, large parts of the Uruguayan population were exposed to high toxin levels. Due to the current structure of the internal market in which co exists formal with informal milling and bakery, the enforcement of a quality standard in mycotoxin contamination levels was proven difficult.

Uruguay lacks a well structured marketing system, and quality signalization through price on wheat leads to a very poor adoption of QAS in wheat. This is largely due to the traditional adverse relationship between farmers and millers which in turn has lead to a very poor coordination among them to tackle the quality problem in wheat from a food safety perspective. As in Argentina, contracting is almost non existent and often based on informal rules, based on the best interest of the milling industry.

Chile is not self sufficient in wheat, and needs to import about 15% of the industry requirements, which has caused that most of the mills are concentrated in the central part of Chile close to harbor facilities and, while the wheat production area is located in the south of the country. The governance structure of the chain is historically that of a spot market, where no coordination exists. However, in recent years this situation has changed. For example, the noodle industry is getting a better coordination with producers tending to a more integrated chain.

The specific supply chain selected in Chile is located in the south and has an important distinction, which is that there exists a coordination between producers and the mill that is atypical for this industrial sector. The mill and producers have had a relationship for years and most the of the suppliers are located close to the mill. 20 years ago, the mill under study adopted the strategy of developing a permanent relationship with the producers to improve the quality and homogeneity of the grain. This relationship evolved into a formal group of producers that receive extension and recommendations. The cost of this program is shared by the producers, the mill and the government. Their objective as a group is to incorporate good agricultural practices measures. Because the mill sells some of the production to the food salmon industry, which production goes to the export salmon industry, they need to implement traceability in their process. Although, there is a strong coordination, no contract exists.

As was evidenced, each country presents a different case for the study, which will provide important pieces of information, that help to understand the barriers to adopt GAP and HACCP systems.

4.2. Mycotoxin contamination and CCP for the wheat supply chain.

Incorporating country differences, a common CFD for the three countries was constructed in which we state the main critical control points (CCP) for mycotoxin contamination problems (Figure 2). Since the main contamination problem in Uruguay and Argentina is fusarium causing the mycotoxins, CCP´s are selected in order to achieve that the main product is non-contaminated. The mill can blend both high quality and low quality wheat and wheat flour in order to achieve acceptable mycotoxin levels. Therefore these operations are considered a control point. Since fusarium develops toxins while the wheat is in the field, proper seed selection and crop technology (crop rotation, spraying fungicides, proper harvest ventilation) may reduce the incidence of contaminated wheat. This means applying GAP.

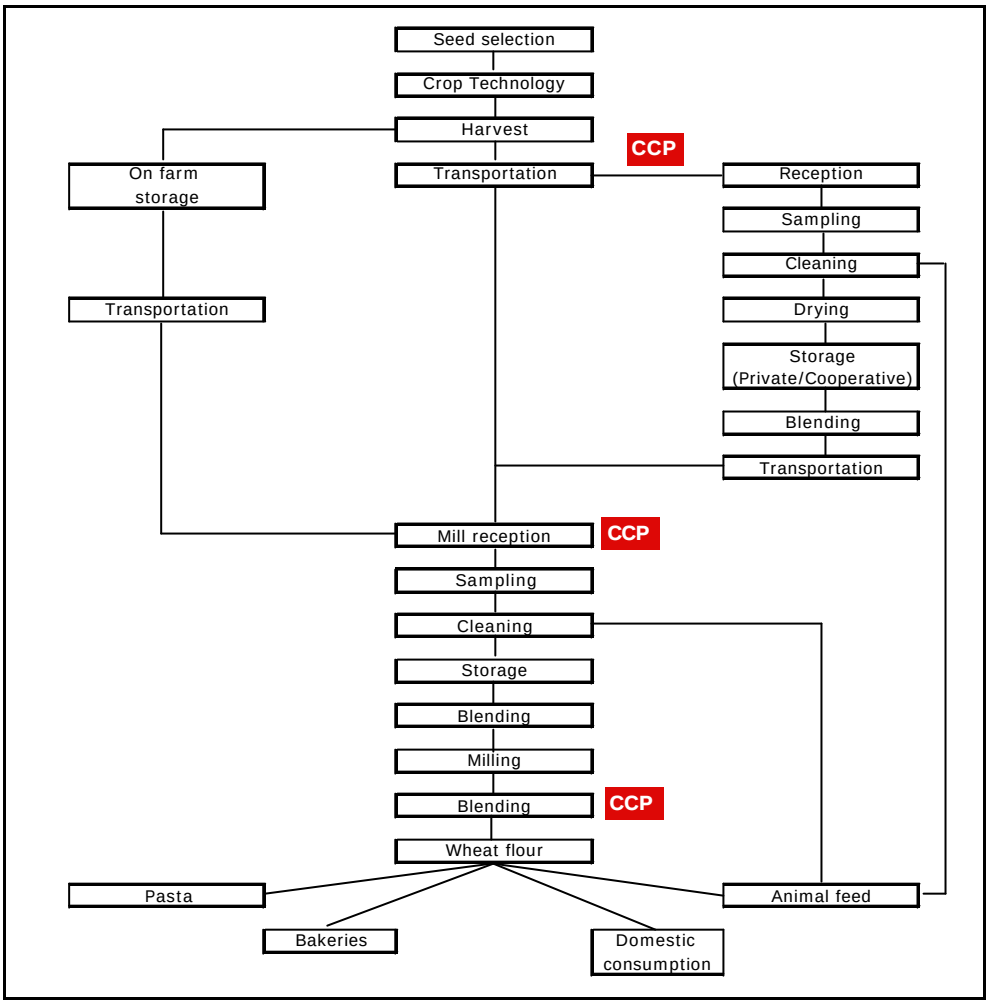

Figure 2: Commodity Flow Diagram (CFD)

To consider the harvest as a CCP, a prediction instrument for the state of the crop that is representative of the prospective levels of contamination, is required. Without a good prediction or representative information, it would be impossible to consider this point like a CCP, because there is no rapid laboratory analysis method available. In our case the main CCP is the reception of the cereal at the mill or in the private storage.

4.3 HACCP adoption incentives and restrictions

For each case study the possible financial, informational and organizational incentives and restrictions along the supply chain to implement QAS as HACCP system, as well as the associated transaction costs, was analyzed. These incentives and restrictions are summarized in Table 3 and 4, showing the most important elements for each case study.

Table 3: Financial Incentives and restriction to implement HACCP along the wheat supply chain, by country

	Argentina	Uruguay	Chile	Summary
Price premium	At this time, there is not a "Price premium" for any of the actors of the supply chain; price premium is one of the strongest disincentives to adopt 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 from the mill. Bakeries and supermarkets do not for pay quality and the price is the strongest attribute to compete.	No evident price premium. This is a strong disincentive.
Access to market	The adoption 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 referring 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, exists.	The implementation of QAS allows the mill to access the salmon industry.	Allows for accessing specific markets. Is an incentive in specific cases.
Product differentiation	In the country they are developing in isolated form some cases of "wheat (bread) of quality." The market, through the commercial standard and the allowances for protein, doesn't generate the necessary incentives to provide such a product.	Almost non existent due to structural difficulties on the storage sector. Yet, some selection 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 milling industry produces today different types of flour (on average 25 different kinds) 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	The incremental cost is important due to the low grain rotation flow; although in the last years a new storage technology ("Silo bag") has been developed, of interest to help segregation to farms and storages.	Segregation based on quality is difficult because of structural deficiencies in 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.	Production 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 4: Organizational Incentives and restriction to implement HACCP along the wheat supply chain, by country

	Argentina	Uruguay	Chile	Summary
Reorganization of activities (GAP´s implementations)	It's still a very incipient practice in grain. It implies economies of scale and due to a mixed farm production, it needs a full farm GAP´s implementations. There are no grain GAP programs	Although well publicized GAP are not of common usage among farmers for mycotoxin contamination problems. Poor information flows lead 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 market, 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-how, cultural change)	Human capital limitations is a very important issue. This needs much time in training & learning by doing. There is no 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 adoption.
Traceability	It's necessary to implement a traceability system for grain for this institutional environment.	No plans to implement traceability in 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 farmer's level. Some cost information is available as a general management tool.	Data recording is still an important issue. Data needs to be specific and producers are not used to this. Many mill suppliers 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 provides 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 an important restriction to adoption

In the Argentinean case, although an official standard for traded grain exists, the knowledge about mycotoxin is scarce. However, it recognizes the existence of fusarium as a major source of contamination. The premium/discount policy in the milling industry is basically a concept determined only by the millers according to their best interest (Mill can purchase wheat based on a very large supply). Opportunism and insufficient and asymmetric information affect principally the primary producer, but this also extends along the chain. The lack of transparency and tax equalization generates a marginal economy. The absence of market signals (incentives) discourage farmers to achieve wheat quality, they don't perceive the advantage of differential prices of the final product.

In the Uruguayan case, after a serious contamination problem that widely affected farmers, millers and consumers, government officials were unable to coordinate an effective policy to handle the issue in the long term. This partially is because the current market structure of a spot market, without any regulation on quality and/or the existence of a black market, that allowed the milling and consumption of contaminated wheat. Hence, it is clear that in imperfect markets the enforcement of a quality standard for mycotoxin contamination was extremely difficult to impose and even to control. The absence of an official domestic grain quality standard, that could signal, through prices, the needs of the industry in quality terms, makes it almost impossible to find of a common language, regarding what class of wheat should be produced and of which quality. This is perhaps one of the main reasons why Uruguay doesn't evidence a wide usage of production contracts.

The Chilean case is interesting because it shows a supply chain that is already developing integration with producers based on quality management. Therefore, they initiated this development some time ago and constituted an example. The incentive for Chile was to obtain high quality grain with local producers since importing grain was too expensive for them. The milling industry usually imports high quality grain to mix with national grain. Today this strategy allows the mill access to markets that require quality and traceability and that pay a premium for that attribute. This mill developed a stable relationship based on trust that is stronger than a contract. Today, they are working in implementing GAP in all farms. The cost is shared among the mill, the producers and the government.

4.4. Lessons learned and policy recommendations

From the cost and benefit point of view, the chain faces high financial burdens in implementing QAS such as HACCP. There are economies of scale in HACCP implementation. 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).

A lack of quality enforcement mechanisms doesn't help to mitigate the problem because there is a lack of clear quality signal incentives. A duality "Wheat quantity versus quality" exists with a lack of structure for wheat differentiation.

The actual governance structure does not add value because the relationship does not generate a quasi-surplus. We can distinguish 2 principal governance structures, the spot market contract and "credible informal verbal agreements" between the mill and some farmers. The choice of governance structure is also influenced by the existing institutional environment, the lack of transparency and tax evasion that generates a grey economy. Mandatory food safety regulations without any strict control give raise to a kind of black market, and a dual structure

of the food industry has been developed, depending on internal (small mills) or external market (large mills) as a final product sales.

On the other side, it has been evidenced that coordination along the supply chain is possible. The Chilean case proves that producers and the mill can joint efforts in order to improve quality and results. In this case, they need each other in order to compete in a market that does not have strong premiums for quality.

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 as the Chilean case shows. However, the public intervention should be analyzed carefully since inappropriate incentives may cause an increase in transaction costs making the supply chain less efficient. Instruments should be able to generate an efficient transmission of quality incentives. Today the market signals are not strong enough to assure that enforcement and government incentives can be efficient, as the Uruguayan and Argentinean case shows.

In order to get "chain partnership", there exists a need to strengthen cooperation between institutions and different chain actors, educational training with reliable information directed to producers, agronomists, bakeries and end-users educations about good mycotoxins practices and regulatory frameworks. This is needed so that cultural change issues and information asymmetry become smaller.

Under current conditions only the wheat mill is the CCP for a mycotoxin occurrence forecasting tool. There is not a single mechanism of control, and a combination of several strategies needs to be used. Farm GAP´s and Mill GMP´s are the first step to an HACCP type approach.

The GAP´s have benefit/cost scale economies often difficult to quantify due to mixed farm production, with externalities to all the farm activities. Farmer association strategies need to be promoted. The costs of HACCP include a substantial "human capital" component in plan development, training of personnel, and on-going monitoring activities. HACCP costs also may include investments in specific processes (data management) and result in additional operating expenses. The government agencies and farmers and industries' associations do play an important role in these issues.

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