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Catalonian pork value chain's resilience: ready for environmental challenge?

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Abstract. *The hog production model in Catalonia (Spain) has been, until recently, an example of success. Inventories and production have been increasing substantially and the sector has proven to have great export potential. Also, the Catalonian hog model has allowed the survival of crops and fruits' small farms, through diversification with pork. Part of this success is based on the organizational system of the value chain or, as we call, "governance instruments" of the value chain. These "governance instruments" are, on one hand, contract relationships between agribusiness firms (specially, in feed sector) and farms and, on the other, a Marketing Board to fix pig prices (Mercolleida). However, recently, there have been some tensions in hog production model in Catalonia. The tensions are related with the trade-off between requirements of international competitiveness and the implementation of new regulations in the sector. Specifically, new environmental regulation entails a great challenge to the resilience of the pork value chain in Catalonia.*

Keywords: hog production model, pork value chain, governance, Critical Success Factor analysis, environmental regulations.

1. Introduction

Spain was the 4th largest pigmeat world producer in 2007, accounting for 16% of European pig inventories. Spain is also one of the largest world exporters of pigmeat (the 5th) (Source: FAOSTAT, 2008). Hog production is concentrated in specific regions: Catalonia, Aragon and Castilla y León have the largest pig inventories. Catalonia is the largest producing region, accounting for 25% of the Spanish pig inventories.

Although agricultural production in Catalonia is quite diversified, hog is the main agrarian sector in Catalonia: in 2008, hog production meant more than 27% of total Agrarian Output and nearly, 50% of Livestock Output. Pork exports meant more than 17% of total Catalonian agro-food exports (Source: DAR, 2009).

The hog production model in Catalonia has been, until recently, an example of success. Inventories and production have been increasing substantially and the sector has proven to have great export potential. Also, the Catalonian hog model has allowed the survival of crop and fruit small farms, through diversification with hogs.

However, recently, there have been some tensions in hog production model in Catalonia. These tensions are related with the trade-off between requirements of international competitiveness and the implementation of new regulations in the sector. Specifically, new environmental regulation entails a great challenge to the resilience of the pork value chain in Catalonia.

This paper is divided into six sections. In next section, we discuss the relevance of the "filière" tradition and "Global Value Chain" (GVC) literature for the study of agro-food industries such as pork. This is followed by a review of our methods and data sources. In third section, we discuss origins and rapid rise of Catalonia's pork production. Fourth, examines linkages in the Catalonian pork value chain. We focus in governance and the power concentration evolution. We include also a final market analysis, using Critical Success Factors to characterize segmented markets in pork. The fifth section examines environmental regulations in Catalonia and their impact on hog farms and in pork value chain. The final section discusses resilience of pork value chain in Catalonia.

2. Pork value chain in Catalonia

2.1. Methodological framework: filières and Global Value Chain analysis

Nowadays, agro-food sectors are characterized by increasing complexity. This fact implies the need of new approaches to agro-food studies. In this paper we add to traditional agro-food studies- linked to the words ‘agribusiness’, ‘filière’ and ‘commodity chains’– innovative elements coming from studies of ‘Global Commodity Chain’ and ‘Global Value Chain’.

‘Agribusiness’ and ‘filières’ approaches began in the 60 and 70 and tried to explain agriculture restructuring after Second World War, especially the new relationships between agriculture and industry, that is, the ‘agriculture industrialization’.

John H. Davis and Ray A. Goldberg coined the word of “agribusiness” in 1957^[1]. That seminal work refers to a complex value chain that begins with the farmer’s purchase of inputs (seeds, feed, etc.) and ends with the food consumer purchasing .

The word ‘filière’ came from INRA (Institute National de la Recherche Agronomique) researchers in France. For Malassis, the study of the "filières" endures two methodological aspects: the ‘filière’ identification (the product, the itinerary, the agents, etc.) and their regulation mechanisms (markets structure, public regulations, etc.)^[2].

‘Agribusiness’ and ‘filière’ methodologies were used in a lot of agrarian studies during the 70s and 80s. In Spain the studies from Rafael Juan Fenollar^[3] and Lourdes Viladomiu^[4] were remarkable.

The Global Commodity Chain or Global Value Chain (GVC) analysis has become quite popular in recent years. Gereffi and Korzeniewicz coined the word ‘Global Commodity Chain’ (GCC) in their book, “Commodity Chains and Global Capitalism” in 1994^[5].

“A GCC consists of sets of interorganizational networks clustered around one commodity or product, linking households, enterprises, and states to one another within the world-economy. These networks are situationally specific, socially constructed, and locally integrated, underscoring the social embeddedness of economic organization” (Gereffi and Korzeniewicz, 1994, pp. 2)

Later, Kaplinsky and Morris changed the concept of Global Commodity Chain for Global Value Chain^[6]. Nowadays, both concepts are used as synonymous.

The ‘Global Commodity (or Value) Chain’ was first used in analysis of manufacture products, but the concept has been adapted soon to agro-food literature (see, as example, Ponte^[7], Gibbon^[8], Pelupessy and van Kempen^[9], Gwynne^[10], Kaplinsky^[11], Fragata, Seabra and Torres^[12], etc.)

Gereffi points out three main dimensions in Global Commodity Chains:

“an input-output structure (a set of products and services linked together in a sequence of value-adding economic activities); a territoriality (spatial dispersion or concentration of enterprises in production and distribution networks); and a governance structure (authority and power relationships)” (Gereffi, 1994, pp. 97)

The concept of ‘governance’ is quite relevant for our analysis. This word is quite similar to the concepts of ‘power relationships’ used in filière studies but it has added elements linked with ‘coordination’ into the chain. In Gereffi opinions, recent trends in manufactured value chains are coming from changes from “producer-driven commodity chains” to “buyer-driven commodity chains”^[13]. This process is also happening in agro-food chains (Dolan and Humphrey^[14], Burch and Lawrence^[15]).

Another interesting contribution of Global Value Chains is the characterization of final markets depending on theirs Critical Success Factors (Kaplinsky and Morris, 2002). Agro-food final markets are increasingly

segmented. Filière studies have some difficulties to incorporate product differentiation in their analysis, this problem is solved by using Critical Success Factors, as we are going to see in fourth section .

In conclusion, both analyses- filières and Global Value Chains- have important complementariness, as Raikes, Jensen and Ponte^[16] point out:

“(…) both the GCC and filière approaches make useful contributions to the study of commodity chains. Their different strengths and weaknesses make them, to a considerable extent complementary and indicate the potential usefulness of combining aspects from both”. (Raikes, Jensen and Ponte, 2000, pp 20)

Finally, this paper is also been influenced by other authors from the "agri-food commodity chains/systems analysis" like Terry Marsden^[17], David Goodman^{[18][19]}, John Wilkinson^[20], and also by the ‘food regime’ literature- Friedmann and McMichael^{[21][22]}.

2.2. Data sources

Our data include semi-structured interviews, field observations and published secondary materials. The authors took part of two studies about pork sector in Spain and in Catalonia⁴. Published secondary materials and literature review provided the foundation for semi-structured interviews. In total, 55 interviews were conducted between November 2004 and December 2007. These included firm managers (from feed, slaughterhouses and pork processing firms) and hog farmers. Interviews were also administered to key informants coming from public officials (in the Agriculture Department both national and regional administration), consulting experts and farmer unions.

The research tested key issues from the filière and GVC literature. Interviews were crucial to examine forward and backward linkages, power relationships and governance into the pork value chain and characteristics of pork final markets (using the CSF analysis).

Interviews were supplemented with informal discussions in the ‘post-interview’ stage, as well as field observations made by the authors.

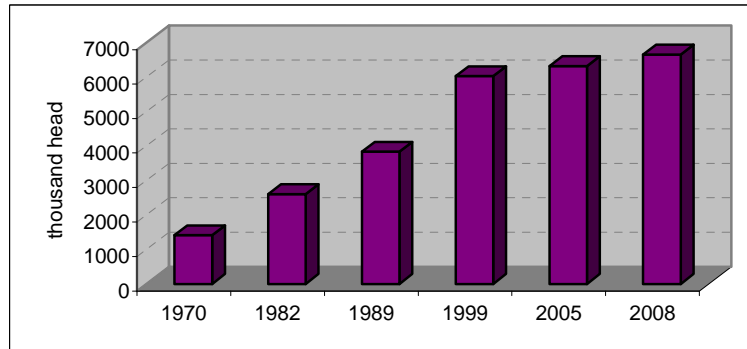
3. Origins and consolidation of Catalonian hog production model.

The hog production model in Catalonia has been an example of success. Pig inventories in Catalonia have increased from 1.4 million in 1970 to 6.6 million in 2008 (**Figure 1**). This growing of hog sector in this period is due to both demand and supply factors. On the demand side, economic development and growth in Spain in the 1960s turned out to increase meat demand. The pigmeat domestic demand is still strong nowadays. Also important to note is that there is a substantial demand for pork processing products that are traditional and popular in Spain, including Serrano ham, “morcillas”, “salchichón”, etc.^[23]. In the 1990s, Spanish hog production exceeded domestic demand, resulting in a substantial increase in pigmeat exports from that time forward.

On the supply side, farm modernization has increased productivity and efficiency. In particular, there has been specialization within biological phases of hog production: breeding and sows, weanling, finishing. This modernization has affected feed, genetics, equipments, and commercialization. There have also been organizational changes related to vertical integration between all the actors in hog production (feed firms, farms, slaughterhouses, pork processing and retailers).

⁴ The first project was the *Evaluation of the Common Market Organisations (CMO) for Pigmeat, Poultrymeat and Eggs*, coordinated by AgraCEAS for the European Commission in 2005. The other project was called “*Anàlisi estratègic del sector carni de la Garrotxa*” funded by the Town Council of Olot in 2006.

Figure 1. Pig inventories in Catalonia (1970, 1982, 1989, 1999, 2005, 2008)



Source: MAPA and DAR, 2008.

The origin of the hog sector in Catalonia is framed within the context of agricultural crises and urbanization processes in the 1950s. Population changes resulted from industrialization and urbanization in the 1950s and 1960s resulted in an increasing demand for meat products in Spain. During this time, however, it was difficult for Spain to import meat because of its economic (scarcity of currency) and political (Franco dictatorship) situations. However, Spain entered into a trade agreement with the United States to allow the import of grains (corn, soy, etc.) in 1958. This trade agreement allowed Spain to implement intensive production model in hogs and chickens. This was consistent with the United Nations report (World Bank and FAO Report on the development of agriculture in Spain, 1966) that recommended to expand livestock production in Spain^[24].

Whereas the ‘old’ model was characterized by small, diversified, family operations, this ‘new’ model of intensive livestock production included new relationships between farmers and agribusiness. The hog sector began to operate on a contractual basis through “integration contracts”⁵. In these contracts, the agribusiness firm (normally coming from the feed sector) supplied feed, piglets and other inputs (medicines, etc.) to the farmer. The farmer provided facilities, machinery, equipment, and labour. One important element, that made the Catalonian model different from other regions, is that the herd was owned by the firm not by the farmer.

This situation was seen to benefit both sides. On one hand, feed firms promoted integration contracts as a way to ensure a market for feed production but they also had good profits selling the fattened pig to the slaughterhouses. Together then, the development of intensive hog in Catalonia did not originate from the farm, but rather, agribusiness.

On the other hand, within the context of agricultural crises, farmers were looking for new incomes. Diversification with intensive livestock was one of the most successful ways. Contract production (‘integration’) was seen as an easy way to increase incomes with low risk: there was no need to buy inputs (feed, piglets and so on) or to worry about selling output (finished pigs). On the other hand, mechanization and agricultural seasonality (i.e, fruits) allowed farmers to have more free time. Intensive livestock production systems and mechanization in crops meant less labour required. ‘Integration’ hog production will allow the survival of farms using family labour but at the expense of loss farmer entrepreneurial decision (which are now in hands of the firms).

There are three important features in the origins of ‘new’ hog production model to take into account. First of all, this model implies a greater dependency of farmers on agribusiness. This relationship is not interdependent between the two parties, but rather one of dominant (agribusiness) and subordinate (farmer)^{[26][27]}.

Second one, this model implies to release (to free) livestock and land. In traditional hog production (the “old” model), farmers needed land to feed pigs. Traditional farms were diversified and ‘self-sufficient’:

⁵ In some literature these ‘integration contracts’ are called ‘production contracts’ (see, for example, Martinez ^[25]).

pigs were mainly feed with crops grew in the farm. But the intensive hog production model (the 'new' model) doesn't need land, because feed is bought in the market or provided by feed firms. So, hog production was implemented in small farms with little land, because they were 'poor' farms that needed new incomes to survive.

This 'new' model emphasized location in areas closer to processing plants resulting in localization economies. As a result, new industrialized operations are located closer to communications infrastructure, slaughterhouses and urban markets. Catalonia became then the main regional producer because of high endowment of road and rail infrastructure, the proximity of seaports to entry crops (Tarragona and Barcelona), and the proximity to large urban markets (Barcelona). Slaughterhouses were located in the region to supply urban areas.

The 'new' model became for many years a 'successful' model and it seemed as everybody were winning. Feed companies- involved in integration contracts- had high benefits, because on one hand, they had a "loyal" market for their feed production, and, especially, they won a lot of money by selling the pigs. Farms had a new income that allowed them to "survive". And slaughterhouses and pork processing plants benefited from a low cost commodity that, first, allowed them to supply the huge domestic demand, and later, in the 90s, allowed them to be competitive in foreign markets.

But changes in world markets, pork value chain and regulatory framework are creating tensions in the model. In this paper, we are going to focus specially in changes in pork value chain.

4. Catalanian pork value chain

4.1. Agents in Catalanian pork value chain

Feed companies, hog farms, slaughterhouses, pork processing plants, and wholesalers and retailers are the main agents in the traditional pork value chain in Catalonia (**Figure 2**).

Feed companies have great importance as input suppliers in pork value chain⁶. In Catalonia, feed is nearly 60% of production cost of a marketing pig. Catalanian feed producers are highly dependents from imported crops. In 2007, Catalanian production of pig feed was more than 4.3 millions tones. There are some big companies as 'Cargill', 'Vallcompanys' or 'Cooperativa de Guissona', but also there are more than one hundred medium producers and a lot of small ones. Feed production in the farm is not much usual.

The "Pig Farm Directory" from the Catalanian Agriculture Department (DAR)⁷ shows up than there are 6.743 **hog farms** in Catalonia in 2008. The general trend is for a decline in number of farms, specially small and medium size farms (see point 5).

Due to the huge weight of integration contracts in hog sector in Catalonia, the most important **hog producers** are firms and cooperatives (because of, with integration contracts, herds are owned by the firm). These firms come from the feed sector, but also some slaughterhouses are involved. The most important one is 'VallCompanys' (which is the largest pig producer in European Union). 'Cooperativa de Guisona', 'Piensos del Segre', 'Baucells' are also big ones, and their area of influence is expanding in Spain.

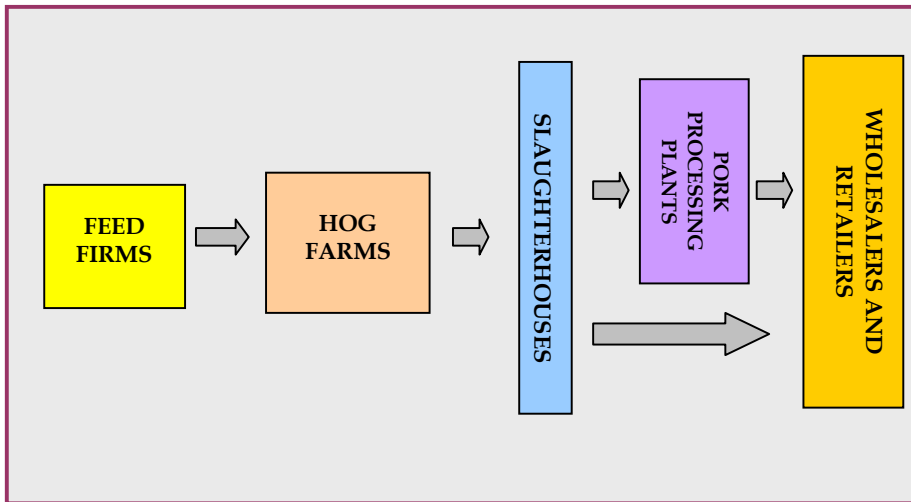
Meat industry (including slaughterhouses and pork processing plants) is the largest agro-food industry in Catalonia (24 % of total Catalanian agro-food industry). There are more than 670 meat firms in Catalonia (Source: Idescat, 2007). Most of them are medium and small size enterprises and national owned.

In Catalonia, meat sector is geographically concentrated around the "*Eix Transversal*", one of the main communication infrastructures in the region. There are huge concentration of pork firms in Osona, Selva and Garrotxa counties: slaughterhouses, pork processing plants, providers of meat packaging, labeling firms, cold logistics transportations, equipments enterprises, etc. So that, some authors named this area as "Catalonian meat cluster"^[28].

⁶ The genetics firms or equipments producers are also relevant suppliers.

⁷ Agriculture Department is called nowadays "Departament d'Agricultura, Alimentacio i Accio Rural (DAR)", that is Agriculture, Food and Rural Action Department.

Figure 2. ‘Traditional’ pork value chain in Catalonia



In comparison with other pork producer regions, Catalonian **slaughterhouses** are little concentrated: the fifth main slaughterhouses in Catalonia mean 35% of total slaughtered animals. As an example, in Denmark there are only two big pork slaughterhouses; in Netherlands, Vion means 70% of total pig slaughtered in the country^[29], and in Germany, Vion means 20,3% of pork slaughterhousing^[30]. Some of Catalonian slaughterhouses are very exported-oriented: there are some firms than send more than 80% of their production to foreign markets (‘Cárnicas Toni-Josep’, ‘Cárnicas Solà’).

Pork is the most used meat in industrial transformation. In Spain, pork processed products, as “Serrano” jam (cured ham) o “chorizo” (a type of salami) are very popular: Spain is the largest world producer and consumer of cured ham. **Pork processing** is an innovative and dynamic sector, with new products coming on, as pre-cooked meals, ready-to-eat products, functional foods.

There is a huge range of enterprises: from big ones (as ‘Casa Tarradellas’, ‘Guissona’, ‘Noel’) to small artisans. Although the Spanish’s largest producers – ‘Campofrío’ and ‘ElPozo’ - are not settled in Catalonia, in the ranking of ten Spanish’s largest producers, seven ones are from Catalonia.

Big **wholesalers and retailers**, as supermarkets chains like ‘Carrefour’, ‘Mercadona’, ‘Erosky’, ‘Dia’ or ‘Lidl’ among other, are playing an increasing role in pork value chain, with supplier’s contracts with slaughterhouses and pork processing firms.

Nevertheless, traditional retailer meat sector is quite *specialized*, with some retail stores, called “charcuterías” that only sell pork products (pigmeat, sausages, cured ham, etc.). Some of these “charcuterías” are surviving by selling special products (more value added) or artisan products. Nowadays, in Spain, there are more than 40.000 butcheries and “charcuterías” (Source: CEDECARNE, 2006). So that, concentration index in meat retailers are far lower than in other European countries or in Canada and US.

In brief, there are some differences between Catalonian (and Spanish) pork value chain and value chains from other largest pork producers. First, Catalonian pork value chain is quite segmented compared to others pork value chain where slaughterhouses and pork processing plants are the same activity and the same firm (‘packers’). In Catalonia, nearly 50% of pork is used in processed products, as ‘serrano’ ham, ham or salamis (Source: DAR, 2007). This is a crucial difference with other pork producer countries and explains the segmentation between slaughterhouses and pork processing plants. Second, although a concentration process, linkages in Catalonian value chain are not as much concentrated as in other value chains.

4.2. Governance in Catalanian pork value Chain

Power relationships between links into the Value Chain (VC) are less than symmetric.

In traditional studies of filière it is called ‘core’ to the agent (or link) in the VC that has more “power” to articulate the VC in order to satisfied his own interests. Normally, the “core” is determinate because of control of good of “high economic relevance” or strategic character^[31]. Frequently, it is the concentration level in each link of the VC, which determinates the “power”: oligopolistic and monopolistic link is who has more ‘power’ inside the VC.

In recent studies of Global Value Chain is used the concept of “governance”. Governance concept refers to **who** decide *what to produce and how to produce* in the VC^[32].

Using both perspectives- filière and Global Value Chain- we can consider different phases in the evolution of internal governance in Catalanian Pork Value Chain. In each phase there are two special relevant issues in the governance analyses. First, is “*who is the core?*”, that is, who has the power in the VC. Second, “*how has it became the core?*” and, also “*how does the core impose their conditions to the other agents?*”, that is, which are the ‘**governance’s mechanisms**’ in the VC. Briefly, we can see three different phases in pork value chain governance in Catalonia:

1st phase: from the 50s to 80s.

The “core” of pork value chain were feed companies. As we have seen, the feed companies had been the promoters of intensive hog model in Catalonia.

With regard to “how” they became the “core”: the main tool are integration contracts. With integration contract they could impose to hog farmers all the production conditions (which feed to use, which breed pig to raise, etc.). Another important tool is the power in Mercolleida.

Mercolleida is the most important Marketing Board for pigs in Spain: the Mercolleida prices are the reference prices for almost 90% of marketing pigs in Spain. Mercolleida is working from 1971. Weekly reference prices are negotiated by the eight largest pig buyers (slaughterhouses) and the eight largest pig sellers (integration companies, mainly feed companies). Until the 80s, ‘VallCompanys’, the largest pig producer company in Catalonia, had power to settle the price in Mercolleida.

2nd phase: From middle 80s to 90s.

With Spain’s entry into the European Community in 1986 and technological changes in meat storage, there was an important power change in the pork chain. Slaughterhouses needed high investments to accomplish strictly regulations coming from European Union. The smaller ones quit the business and there was a concentration process in the slaughterhouses sector.

So that, feed companies had to ‘share’ the power in the VC with slaughterhouses. Slaughterhouses increased its negotiation power in Mercolleida and they began to have integration contracts with farms to guarantee pig supply. Some authors called that period the “bipolar oligopoly” in pork production^[33].

3rd phase: From middle 90s until present

Increasing production and excess meat supply in the 90s result in the “core” moving to processing companies, and especially to big retailers. Slaughterhouses have increased their capacity and new ones are entering in the market (sometimes in rural areas, with financial support coming from rural development programs). Excess meat supply has become obvious from the 90s with increasing sales to foreign markets.

Big retailers are agreeing to contracts with big slaughterhouses and processing companies. This “marketing contracts” are very strictly in production processes, and especially, pushed for low prices.

This increasing pressure to reduce prices is affecting all the agents in VC. All the links are coping with reduced margins. This situation is increasing “conflicts” in VC, especially in the Mercolleida board where sometimes is difficult to fix the weekly price. In this case, the Mercolleida’ arbitrators which are representatives from local and regional government, are in charge to fix the price. Even in that case, some slaughterhouses are reluctant to accept the Mercolleida price. These situations are eroding Mercolleida as governance mechanism in the pork value chain.

In addition to increasing power of large retailers in VC, there are increasing costs coming from environmental regulations. This fact is also eroding the other governance mechanism: integration contracts. There are ‘potential’ conflicts between farmers and feed companies about integration contracts: there is not clear who has to assume new costs (especially, environmental costs) in this new context. Pressed by farmer unions, Catalanian government has been forced to regulate integration contracts⁸.

So that, ‘traditional’ self-governance mechanism in Catalonia pork value chain- Mercolleida, integration contracts- are increasingly externally regulated and losing their capacity to articulate the pork value chain.

4.3. Pork final markets analysis

The pork market is increasingly segmented. To identify the “segmented markets” we use the “Critical Success Factors” (CSF) methodology proposed by Kaplinsky and Morris. Each of these segmented markets will have its own distinctive ‘market characteristics’ which are referred to as Critical Success Factors (CSFs). The CSFs in each market can be grouped into those factors which are “*order qualifying*” (that is, producers *need* to achieve them in order to participate in the market), and those which are “*order winning*” (that is, these are the critical factors which lead particular firms to *succeed*)^[34].

Data sources for CSF analysis are coming both from interviews and specialized magazines about meat and food consumption (‘Eurocarne’, ‘Distribución y consumo’, ‘Alimarket’, etc.). Final market analysis will provide us additional information about ‘what is demanded’ in the ‘intermediate’ market, that is, the pig market.

A preliminar segmentation in final markets is the ‘pigmeat’ market and the ‘pork processing products’ markets. In the case of Catalanian pork sector, this distinction between ‘pigmeat’ and ‘pork’ is highly relevant: nearly 50% of pork production is “pork processing products”, especially ‘Serrano’ ham, regular ham and different types of salamis. According to this preliminary segmentation, we can distinguish three segmented markets in pigmeat- ‘low cost’, ‘organic production’ and ‘exports markets’ and up to six segments of market in ‘pork processing products’- ‘low cost’, ‘convenience foods’, ‘functional foods’, ‘artisan production’, ‘labelling’ (as PDO and PGI) and ‘exports’. Using the CFS methodology, we focus on strategies used by firms in each segmented markets. The strategies used by slaughterhouses in pigmeat ‘low cost’ market are quite similar that these ones used by packers in pork processing products ‘low cost’, so that, we analyse both together.

Low cost (pigmeat and ‘pork processing products’). “Low cost” (or ‘low price’) is the predominant market in pigmeat, where there are high price-substitution between pigmeat and poultry. Also in pork processing products, ‘low cost’ is a big market. Obviously, on this market the CSF is price.

There is growing significance of supermarket ‘own brand’ products in pigmeat and pork processing products markets. That means, increasing competence with the premium products of brand manufacturers. Traditional brand manufacturers are forced to increase advertising and to adapt to the logistical demands of large-scale retailers. As we have noted in point 3, ‘marketing contracts’ between slaughterhouses-processing companies and big retailers are becoming a new ‘governance mechanism’ resulting from increasing power of retailers in pork value chain. Some successful slaughterhouses and pork producers firms in ‘low cost’ have ‘high trust’ relationships with supermarkets, that is, ‘marketing contracts’ resulting in long-lived relationships, some kind of assistance to the supplier in order to achieve the retailer requirements, and sometimes, exclusivity works (that is, firms that are totally dedicated to the production of own brand products for particular supermarkets).

⁸ In 2005, Regional government promulgated the *Law 2/2005 about integration contracts*.

In the other side, there are 'low trust' relationships between retailers and slaughterhouses-processing firms. In these situations, retailers are able to exercise enormous purchasing power and to force suppliers to reduce prices. To avoid this situation some firms have create their own supermarket and restaurants chains: this is the case of 'Guissona Corporation' and his own meat stores called 'BonArea'.

Anyway, food firms in 'low cost' market need quite large dimension: they must have large supply capacity and to take advantage of scale economies in order to reduce production costs and achieve price requirements coming from retailers.

Organic and less-intensive production (pigmeat). In Catalonia, there are only 3 organic pig farms. The requirements to be labelled as 'organic' imply high production cost and organic demand doesn't seem to increase in pork. Nevertheless, some farms have tried less intensive and extensive productions (sometimes forced by environmental regulations). They don't fulfil all requirements to be organic, but they aren't so intensive as conventional farms. They are small and diversified farms that commercialized their production to artisans and prestige restaurants in their area.

Conventional foods (pork processing products). This is a "new" market that has valuable features like "easy-to-eat" or "ready-to-cook". Technology and product innovations are crucial in convenience market. Products have short-life cycle and there is a more radical multi-product strategy. Pioneering pork processing firms in convenience have been medium-large companies that have succeeded with 'new' products ('Casa Tarradellas' with their pre-cooked pizzas, as example). 'Brand' companies have been able to achieve 'loyal' consumers that associated 'brand' with the 'new' product.

Functional foods (pork processing products). The 'functional foods' concept has been notoriously hard to define^[35]. The term is generally understood to refer to foods with especially healthful qualities. In pork, ham less fat, ham less salt or ham with Omega3 are the more popular ones. It is a dynamic market. The addition of new qualities to foods offering a specific health claim implies a 'new' concept of product innovation based on R&D, patents, regulatory approval, etc, only affordable for large companies^[36].

Artisan production (pork processing products). Another important market in processing pork is the artisan production, where the local butcher prepares the products (sausages or salamis), sometimes using traditional receipts that are very "local". These kinds of products are frequently linked with rural tourism and the traditional product is sold as 'typical' souvenir. Production is 'short' and, as we have pointed, sometimes pigmeat is coming from less intensive hog farms in the area.

Labelling productions (pork processing products). In EU, there is special labelling for some productions that are produced with "traditional" processes very local or regional. These products are labelled like "Protected Designation of Origin (PDO)", "Protected Geographical Indication" (PGI) and "Traditional Specialty Guaranteed (TSG)". In PDO and PGI, the CSF is linked to the *location* of the production (origin). In Spain, PDO and PGI in pork are mainly linked to 'iberic' production⁹.

In 'regular' swine is very important the 'Jamón serrano' Traditional Specialty Guaranteed (TSG). This designation does not refer to an origin, but highlights the traditional composition or means of production of the product¹⁰. 'Jamón serrano' TSG has been crucial in the identification of 'traditional' Spanish ham in foreign markets. Most dynamic and export-oriented Catalonian firms are part of 'Jamón serrano' TSG.

Export markets (pigmeat and pork processing products). Export markets are segmented: from markets which CSF is the price (markets *low cost*) to others with high requirements for quality and food safety¹¹. In exports, besides the CSF of every segmented market, it is necessary to add two more CSF: homologation

⁹ 'Iberic' is a special kind of swine grown by extensive production in the 'dehesa' areas and feed mainly by acorns. This special production is located in South Spain.

¹⁰ TSG are regulated by *Council Regulation (EC) No 509/2006 of 20 March 2006 on agricultural products and foodstuffs as traditional specialties guaranteed*. Unfortunately for Catalonian hog farmers for to be labelled as 'Jamón serrano' TSG is not compulsory that the pig is raised in Spain.

¹¹ Russia is an example of the first case, and Japan of the second one.

(*order qualifying*) and adaptability to 'local' tastes (*order winning*). Homologation requirements are strict and, frequently, they force technological change to exporters. In pork, there are local components regarding tastes and habits of the consumers. Nevertheless, the 'Serrano' ham is becoming popular in foreign countries and has turned into the most successful pork product of Catalonian producers: 95 % of all Catalonian exports coming from pigs (that is, pigmeat, pork processing and lived animals) is ham, mainly 'Serrano' ham (DAR, 2008).

Table 1 summarizes each market characteristics according to his CSF (*order qualifying* and *order winning*), marketing channels and strategies in order to adapt to each market.

Table 1. CSF in pork markets, marketing channels and producers strategies

Market	Critical Success Factor	Marketing channels	Producers strategies
<i>Low cost</i>	<i>O.Q</i> : Price <i>O.W</i> : Adapted to shelter space	Large retailing Hotel and catering (HORECA)	Firms size: large- medium <i>High-trust</i> relationships with retailers Some examples of total verticalization
<i>Convenience</i>	<i>O.Q</i> : Easy-to-eat, ready-to-cook <i>O.W</i> : Innovation	Large retailing	Firms size: large- medium Investments in product diversification, packaging, advertising. Technologies in appropriation cooking activities.
<i>Functional</i>	<i>O.Q</i> : 'Healthy' <i>O.W</i> : Innovation	Large retailing Specialized food retail stores (nutriceuticals)	Firms size: large- medium Investments in product diversification and in new processes.
<i>Organics and artisan</i>	<i>O.Q</i> : - Organics: environmental friendly and animal welfare - Artisan: traditional processing <i>O.W</i> : Quality	Traditional butcheries ('charcuterías') and specialized food retail stores ("delicatessen", organic shops)	Firms size: medium-size 'Short' value chains. High-trust relationships between buyers and suppliers. Links with other economic activities: rural tourism.
<i>Labelling (PDO, PGI, TSG)</i>	<i>O.Q</i> : Origin <i>O.W</i> : Quality	Traditional butcheries and specialized shops. Large retailing	Firms size: medium 'High-trust' relationships and verticalization in order to fulfil PDO, PGI or TSG requirements.
<i>Export</i>	<i>O.Q</i> : Homologation <i>O.W</i> : 'Local' tastes	Export channels	Firms size: medium-large 'High-trust' relationships (in 'Serrano' ham). 'Low-trust' in pigmeat (occasional exports)

From previous analysis, we found some important points:

- Largest market in pork and pigmeat is *low-cost* (CSF is price).
- In functional and *convenience* market, the "value" is added at the end of production process. Quality of raw material (that is, the marketing pig) is not a "critical" element on these markets. Even some artisans are working with 'standard' pigmeat: the elaboration process provides the 'value' to the product.
- Only markets linked to PDO and PGI, organics and some artisans are not only focussed in price in their pigmeat provisioning. The "added" value is generated also in pig raising. Nevertheless, these markets are small ones and, though their size is growing, it doesn't seem that they become big enough to change hog production model.

Consequently, we can deduce that **the price will continue being the CFS (the *order qualifying*) for most of pig farmers**. Filière demand is raw materials (pigs) at low price and hog farms are trying to fulfil this requirement, as we see in next point.

5. Hog farms and environmental problems in Catalonia

Environmental problems generated by hog farms come, principally, from manure disposal. Traditionally manure was used to fertilise crop land. Soil has limited capacity to absorb nutrients coming from manure. Over-fertilization means potential harm to water and soil quality, and also, more air pollution with ammonia and odours. A special concern in Europe is water pollution. In pig farming areas the disposal of excess nutrients, principally nitrogen and phosphorus, from pig manure are among the principal causes of pollution of surface water, groundwater, and marine waters. Excess nutrients can damage aquatic ecosystems. Nutrients in surface water and groundwater can also impair drinking water quality and in high enough concentrations lead to human health problems.

We analyze environmental problems caused by hog farms from a perspective of *joint productions*. OECD refers to 'joint products' as to 'the situation when two or more products are produced simultaneously by a single productive activity' (OECD, 2001). We consider that pigmeat and manure are *joint products*, so that, problems linked to manure can't be dissociate from pigmeat production¹². This relationship has allowed us to analyze environmental impact coming from hog farms from a *filière* perspective. Farmer's production decisions are determined by *filière* requirements.

In point 5.1 we see some aspects of Catalonian farm restructuring with environmental and economic consequences. Next, we see the recent environmental problems that are coming from hog farms in Catalonia. Finally, we analyze environmental regulations and their consequences in pork value chain.

5.1. Hog farm restructuring

From the 80s, Catalonian hog farms have experienced a restructuring process. Recently, this process has been deepened according to 'governance' changes in the *filière* that we have analyzed in previous point. As we have seen until now, *filière* is demanding low commodity price, that is, low price in marketing pigs. Restructuring farm tries to accomplish that requirement: for the farm, the way to supply pigs at low prices is to reduce production cost and to be more efficient. Hog farms have tried to reduce cost by increasing farm size and territorial concentration, and this performance has environmental impacts. Another important change in farming is that farms are becoming more specialized in hogs.

Increasing farm size. Scale economies and intensification are the ways chosen by hog farms to reduce costs and to be more efficient. Modernization has implied increasing fix costs. To amortize these facilities farms are increasing substantially pigs per farm. Small and medium hog farms are quitting the business, and only large farms seem to be able to be profitable. So that, average size in finishing farms in 1990 was less than 400 pigs per farm. Now, it is than more than 1000 pigs per farms. In this period, number of finishing hog farms is decreasing: from 6700 to 4500. And this process is even further in farrowing farms: in 1988 there are more than 14000 farrowing hog farms in Catalonia, nowadays there are only 2800, and average size has increased from 39 pig per farms to more than 208 (Pig Farm Directory, DAR, 2008).

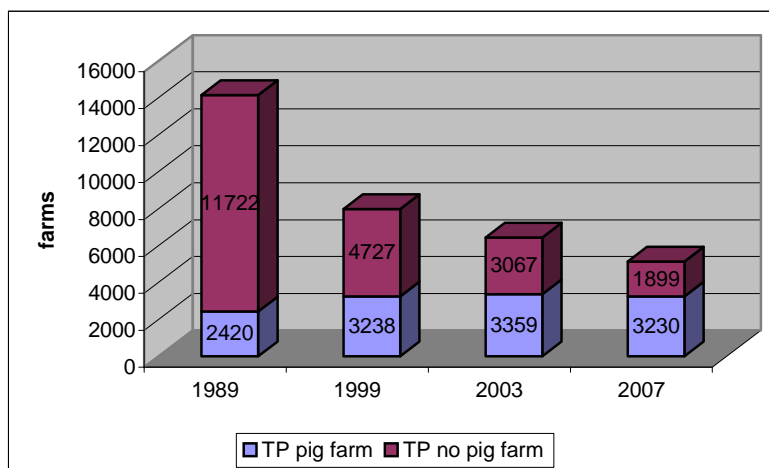
Territorial concentration. Integrators firms tried to reduce transportation costs and to take advantage of scope economies. So that, hog farms are located near feed factories, slaughterhouses and main roads (specially, near the "*Eix Transversal*"). Pig inventories are very geographically concentrated: three counties- Osona, Segrià and Noguera- have 42% of pig inventories in Catalonia .

Hog specialization. As we have seen before, hog production was a diversification strategy in crop or fruits farms. But eventually, pigs are becoming the main economic activity on these farms. And the other farm productions (crops, fruits, vineyards) are becoming less significant in the economic structure of the farm. TF (Type of farming) classifies farms based on the agriculture production prevailing in their economic

¹² There are few studies about hog production and manure management in Economics. Nevertheless some ones have taken a joint-production perspective: Roka and Hoag, 1996; Bontems, Dubois and Vukina, 2002, Piot-Lepetit and Le Moing, 2007^[37].

activity¹³. We can see this process of ‘hog specialization’ in the Figure 3: in 1989 only 17% of farms with pigs are *specialized* in pigs (that is, they are ‘pig type of farming’). By 2007, 63% of farms with pigs are farms specialized in pigs. This implies a huge economical dependency from hogs in many Catalanian farms.

Figure 3. Hog farms Type of farming (1989,1999, 2003, 2007)



Source: IDESCAT and DAR, 2008.

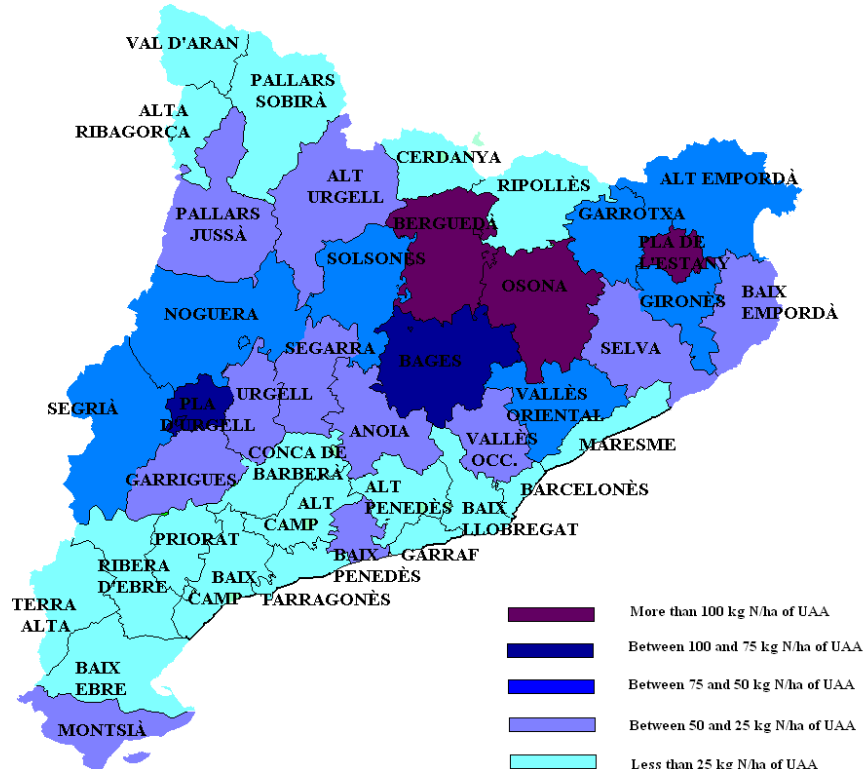
5.2. Environmental problems in Catalonia.

Manure disposal wasn't a problem many years ago when hog farms were crop farms with little pig inventories. As we have pointed previously, in 50s and 60s, hog production was a diversification strategy for ‘poor’ farms, that is, farms with little land. In the 80s and 90s, there were new ‘incomers’ in hog sector attracted by high incomes and easily integration contracts. These “new farmers” (part-time farmers) built pig facilities with little or no crop land. In short, Catalanian hog farms have little land. On the other side, during the 90s and nowadays, hog farm size is increasing faster. A greater number of animals per farm lead to a larger volume of manure that must be disposed of. If there is less land available per pig, the quantity of nutrients supplied to the soil will increase, with potential harm to water and soil quality, and also, more air pollution with ammonia and odours.

The main problem is water polluted by nitrates. The “vulnerable zone”, that is, area where the groundwater is polluted with nitrates is increasing in Catalonia. The vulnerable zones have increased from 291,000 hectares from 1998 to more than 500,000 hectares in 2004. Hogs are responsible for almost a half of nitrogen kg generated in Catalunya. Hog farms generate 46 annual millions of kg of nitrogen. Manure is used as fertilizer in crop land, so that, the relevant variable is nitrogen per hectare of Used Agricultural Area (UAA). Map 1 shows nitrogen per UAA hectare coming from pigs. As we can see, the situation is ‘critical’ in some counties as Osona, Berguedà and Pla de l'Estany, where they overcome the 100 kg/N for UAA hectare.

¹³ A pig farm is a ‘pig type of farming’ if more than 66% of Gross Income comes from pig production. As an example, a farm with two agricultural activities, let's say pigs and fruits. If 66% or more of the income of the farm is coming from pigs, we said that the farm is a “Pig type of farming” or also, we can say the farm is “specialized” on pigs.

Map 1. Nitrogen by hog farms in Catalonia, 2006



Source: GESFER, 2008.

5.3. Environmental regulations in Catalonia.

Environmental regulations in Spain are coming from European Union. The main environmental regulation affecting hog production is the *Directive 91/676/EEC on nitrates from agricultural sources* (or Nitrates Directive). The Nitrates Directive set up limitations in nitrogen on land and establishes the “vulnerable zone” concept. The *Royal Decree 261/1996, of 16 February, on water protection against pollution induced by nitrates from agricultural sources* transposed Nitrates Directive into national legislation. In Spain, competences about environmental policy have been transferred to regional (Autonomous Communities) government, although central (Spanish State) government had the competence for water quality. So the administrative competence related to implementation of Nitrates Directive was not clear. So that, laws implementation had suffered from important delays and misunderstandings. But finally, the competence for implementing the Nitrates Directive passed to regional government^[37].

Manure Management has become a crucial point to accomplish Nitrate Directive. In Catalonia, a Manure Management Plan is compulsory for all hog farms. In a Manure Management Plan the farmer must include the annual foresight of manure and, how he is going to manage this manure.

The main way of managing manure is to use it as fertilizer in the crop land of the farm. Consequently, in Manure Management Plan the farmer must indicate the availability of enough agrarian land to spread the manure. But some farms doesn't have enough land to do a right manure management, so that, they need an agreement with another farm who allows spread the manure on her land. A lot of hog farms in Catalonia need to have an agreement with other farms to fulfil the Manure Management Plan. In this situation, crop farms have been able to demand a payment to agree with hog farms. Sometimes the hog farmer only pays

the transportation cost of manure, but in some areas, with high livestock density, these payments could be quite high.

In spite of increasing environmental concerns, the environmental regulations have been implemented very slowly and, until recently, there hadn't been much control for the Public Administration who has prioritized economic issues on the environmental ones.

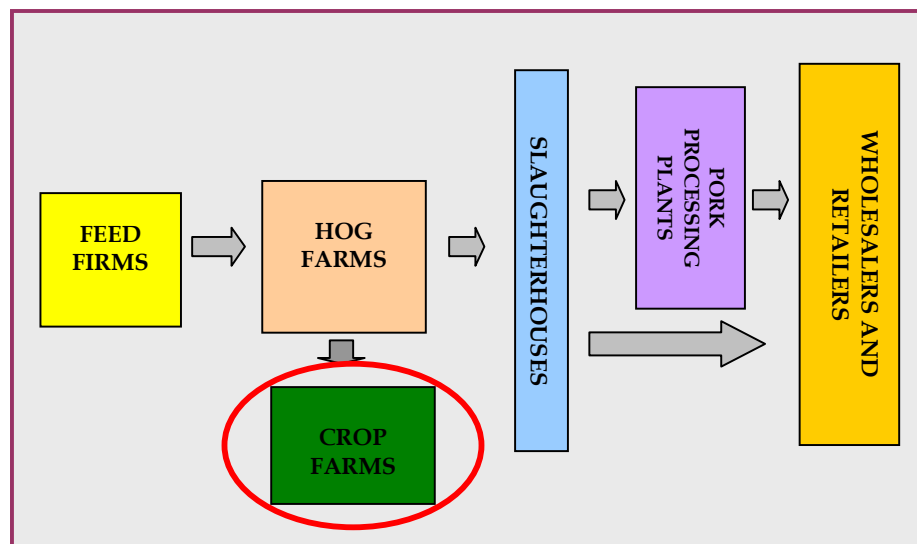
5.4. Consequences of environmental regulations on pork value chain.

Environmental regulations direct impact is to increase hog farms production costs. According to SIP Consultors Data Base¹⁴, manure management is 2,5% of total cost in a hog farm. Nevertheless, this percentage changes considerably among farms: in some farms manure management costs are more than 8% of total cost.

Filière and *Global Value Chain's* approaches contribute with interesting points at hog farms environmental problems analysis. First, the study of the *filière* allows visualizing this problem as consequence of increasing demands of non-farm *filière* agents. The challenge for hog farms is how to face increasing costs and, at the same time, to comply with *filière* requirements mainly low prices of marketing pigs.

On the methodological side, environmental regulations imply a redefinition of the pork value chain (Figure 4). Crop farms must now be considered as part of Pork Value Chain in Catalonia. Because of crop farms are nowadays *indispensable* for hog production and are crucial for expanding the pig farms. The fact is that environmental regulations imply to re-establish the links between hog farms and land. In 'traditional' model (before 50s), hog farmers needed to have croplands in order to produce grains to feed the pigs. Nowadays there is not need for cropland in a farm to feed hogs (grains and feed are coming outside the farm), but there is need of land to manage manure. Therefore, hog production is, again and in a new way, dependent on crops land. Until now, pork value chain studies have 'omitted' a new agent: crops farms.

Figure 4. 'New' pork value chain in Catalonia



Finally, it is shown that there is a "basic" contradiction about the 'type' of farm promoted by the *filière* requirements and the environmental regulations requirements. The *filière* looks for large and specialized farms, with high-technologies and skilled labour. The *filière* favours geographical concentration to reduce transportation costs. On the other hand, the model "supported" by the environmental regulation are diversified farms (that is, with crops land), small and medium hog farms with less intensive productions and farms geographically dispersed.

¹⁴ SIP Consultors Data Base gathers the costs of 66 hog farms in Catalonia that assess more than 70.000 sows and piglets and more than 150.000 marketing pigs.

6. Conclusions: resilience factors in Catalanian pork value chain.

Resilience is defined as ‘the ability of a system to return to its original state or move to a new, more desirable state after being disturbed’^[39]. Implicit in this definition is the notion of strengthens but at the same time, flexibility and ‘adaptability’ after suffering an external ‘shock’. In our case, we can see environmental regulations as an ‘external shock’ affecting pork value chain. The analysis of pork value chain can show us the ‘resilience’ factors in Catalanian pork value chain.

First of all, comparing with other pork value chains, Catalanian one has an important ‘resilience’ factor: a big market for pork processing products. In ‘commodity’ products (as pigmeat) is difficult to assume increasing costs, but in processing pork products cost could be more ‘easily’ assumed. Another important point is that Serrano ham is becoming popular in foreign countries and there is a demand expansion. It is a very ‘Spanish’ product, so that, probably consumers are going to valorise Spanish origin (and SGT Jamón Serrano). Some others traditional Spanish pork products could profit new export markets opened by Serrano ham.

Secondly, Catalanian pork value chain is not as concentrated as other pork value chains. This fact reduces oligopolistic behaviors and profits could be more equitably distributed among different agents in the VC avoiding ‘strangulations’.

Although tendency to higher concentration, retailer link is less concentrated than in other countries. There are other marketing ways and there are some opportunities for small and family farm productions using local butchers and ‘charcuterías’. Artisan sector is quite dynamic and it seems that their market is going to increase. This ‘artisan’ market could be a good opportunity for less intensive hog productions.

Thirdly, integration contracts could be used as a way to share environmental costs between farmers and integration companies. Some integrator firms are providing farmers with special feed more environmental-friendly in order to reduce manure environmental harms. This is an ‘indirect’ way of sharing environmental cost between farmers and integrator firms.

Finally, Regional Government is trying to help farmers with their manure management. GESFER is created in order to help hog farms to find available land to spread manure. That is, to link hog farms with crop farms in the same area. Nevertheless, the situation is not easy: Catalanian hog farms have little land and it turns out difficult to acquire new lands. On the other hand, it is increasing reluctance to hog production in rural areas.

Hog production in Catalunya will be able to be kept only if it is profitable and at the same time, environmentally friendly and socially accepted. So hog farmers, all the other agents in pork value chain and policy makers must to bear in mind this triple challenge.

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