

Developments and challenges in the European pork sector

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Abstract

This paper aims to give insight into the structure of and variety in the European pork system and suggests topics for further research of the European pork sector. It provides an overview of the different types of pork chains, their quality systems, governance structures and supporting technology. The paper further describes the concentration and up-scaling found in all links of the chain in most of the countries investigated. Moreover, a development towards chain-wide quality management systems and new collaborative structures in the various chains can be recognised. However, there is also a trend towards development of pork chains that aim at high-quality production for regional and niche markets, in particular in Southern European countries. Although the paper tries to give a European picture, it focuses specifically on five countries: the Netherlands, Germany, Greece, Spain and Hungary. The paper concludes with major bottlenecks and opportunities for European pork chains, after which new research issues are raised.

1. Introduction

Consumers in Western countries are increasingly asking for healthier food (e.g. reduced saturated fat and salt), a large choice of (processed) products, convenience foods (to meet modern time constraints) and new products such as regional and organic products. At the same time, in particular during the last decade, they have become increasingly concerned about quality and safety in agri-food supply chains. Several sector-wide crises, such as the BSE crisis, the dioxin crisis, classical swine fever and Aviaire Influenza have fuelled these concerns and indeed, when quality assurance fails, the adverse consequences can be large. For example, it is estimated that in the United States alone, contaminated food causes up to 76 million illnesses, 325,000 hospitalisations and 5000 deaths each year (Smith-DeWaal, 2003).

Box 1: Major food crises in the European meat sector in the last decade (adapted from Plaggenhoef, 2007)

- 1996:** **Boviene spongiforme encefalopathie** (BSE) or ‘Mad cow disease’ was found to be dangerous for humans. The consumption of organs of diseased cows can result in the human variant of BSE, Creutzfeld-Jakob Disease. BSE was widely disseminated among British cows, because carcasses of sick cows had been processed in animal feed. Approximately 2.75 million cows were killed.
- 1997:** In February 1997, **Classical Swine Fever** broke out in the South of the Netherlands and 429 farms were contaminated. In order to stop the virus, the animals of 1286 farms were preventively killed, resulting in 1.8 million killed pigs.
- 1999:** The Belgian firm Verkest mixed motor oil in fats intended for animal feed. As a result Belgian chickens developed too-high levels of **dioxin** in their meat and eggs. However, many of these products were already processed and retailers in many countries including the Netherlands had to withdraw many products.
- 2001:** In the United Kingdom, **Foot and Mouth Disease** broke out and reached the Netherlands via France. In the Netherlands 26 farms were contaminated and 265,000 animals of 2600 farms had to be preventively killed. Export of agriculture products from these countries was stagnated for a long time.
- 2002:** The Belgian Firm Bioland mixed Irish pharmaceutical waste with animal feed. As a result pigs were contaminated with the **MPA hormone** and became temporal infertile. Although MPA is not hazardous to public health, 20,000 contaminated pigs were preventively killed. Costs in the Netherlands ran up to 100 million euros.
- 2003:** **Dioxin** was found in German animal feed. The responsible farms had also delivered feed to Dutch farmers. As a result 243 cattle farms in the Netherlands were not allowed to sell their animals to slaughterhouses.
- 2003:** **Aviaire Influenza** broke out in the Netherlands. Animals from poultry farms in the neighbourhood of contaminated farms had to be killed. The number of chickens in the Netherlands dropped from 90 million to 40 million. The sector had a 2.5 billion euro loss of turnover and a 0.5 billion euro loss of revenues.
- 2003:** **2006: Bluetongue** a disease carried by ruminants, mainly sheep, was found in August in the Netherlands. Some days later the disease was also found in Belgium and Germany. Infected animals were vaccinated. The number of infected farms mounted to 317 in October in the Netherlands.

The crises have also increased consumer awareness of (other) side effects of bio-industrial production. As a result, consumers’ concerns now include not only safety and quality issues, but also important ethical issues, for example, the destruction of animals associated with the BSE crises (Van Kleef *et al.*, 2006). Due to this heightened attention to agricultural production, consumers have become more critical regarding the food products they buy. Nowadays, consumers demand more information about the origin and safety of their food, including about the means of production, hygiene, genetic modification, application of pesticides and other environmental issues. Use of collective or chain-wide quality management systems is regarded as the best strategy to deal with these complex quality demands, because no individual firm is able to ensure quality on its own (Omta *et al.*, 2002).

Firms increasingly respond to their quality assurance tasks by adopting (private) quality management labels, based on which firms ask their suppliers to comply with certain standards (Freriks, 2006). Big retailers in particular have developed initiatives to commit their suppliers to strict food safety regulations. These quality management systems rely on documentation of production processes, combined with third-party auditing and certification, placing strong requirements on gathering, storing, processing and transfer of quality information between the firms in the chain (Jahn *et al.*, 2004).

National and international governmental agencies have also reacted to the above-mentioned crises by establishing regulations for quality and safety of agri-food products. For example, the European Union issued the General Food Law, which emphasises that firms hold primary responsibility for quality in agri-food supply chains. In agri-food supply chains, many firms go beyond compliance with legal regulations, because they have to meet the expectations of their buyers and avoid reputation disasters (Bondt *et al.*, 2006; Freriks, 2006; Havinga, 2006). However, concerns have been raised about the burdens (especially administrative) being placed on firms, because at the moment they have to comply

in many cases with national and international quality regulations as well as with additional private quality standards (Plaggenhoef, 2007).

This article addresses major developments in the European pork sector in light of the above-described trends. It starts with a general description of the pork chain in section 2. Section 3 describes the methodology used. Section 4 presents the obtained results, particularly with regard to regulations, governance forms, quality standards and quality management systems, technology and innovations, and market performance. The section concludes with a SWOT analysis. Section 5 gives general conclusions, while section 6 highlights areas for further research.

2. The pork chain

The pork chain covers the following processes: Breeding – Farrowing – Finishing – Slaughtering – Processing – Retail (see figure 1). In most European pork chains these processes are performed by separate organisations. However, there are also many chains in France, Spain, and Greece, for example, in which farrowing and finishing are performed by the same company. Moreover, further-integrated chains exist in which slaughtering and processing are also integrated. In addition to these chain actors, figure 1 also shows major input providers, like the feed industry (extremely important for the pork chain as feed is one of the major cost components in pork production), transporters, etc., and stakeholders such as the government and branch organisations. It pictures the pork chain as a network of interacting organisations aiming at the delivery of pork meat products to consumers.

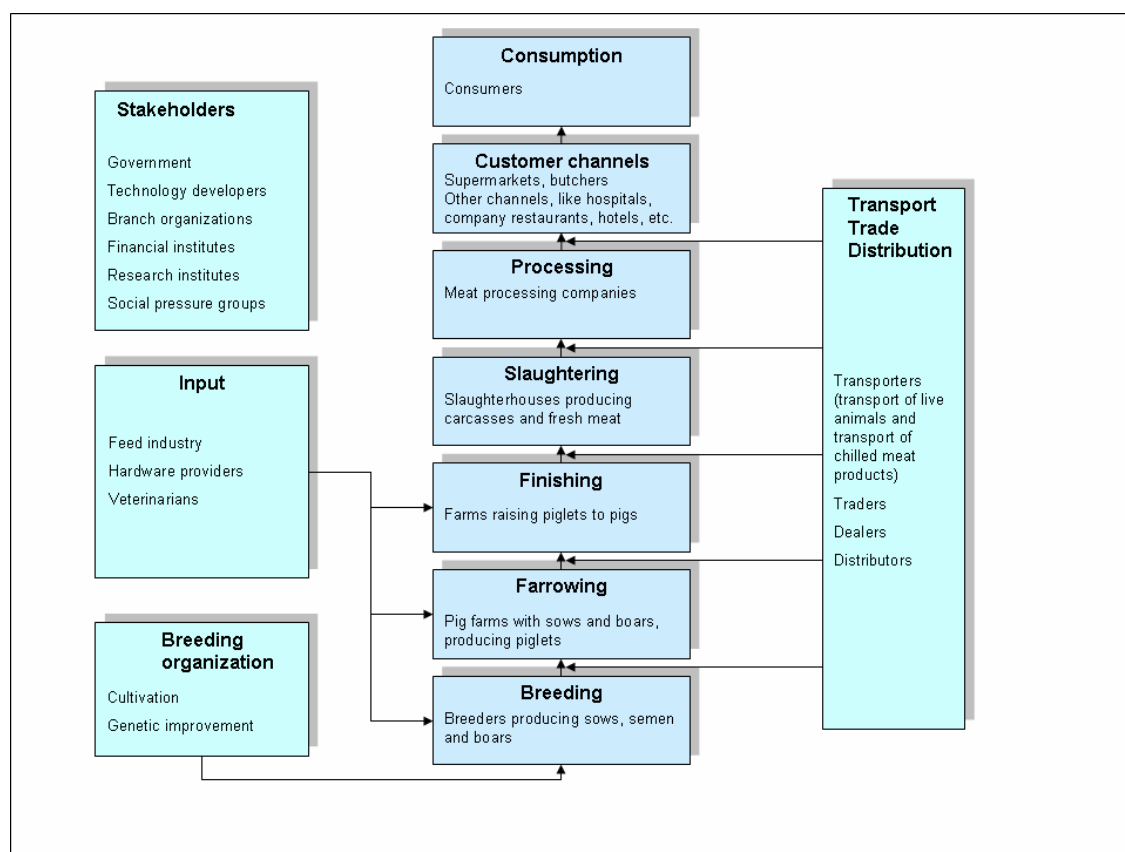


Figure 1. The pork chain

Table 1 gives an overview of major pork-producing countries in the world (FAO, 2005). China is by far the biggest producer, followed by USA, Germany and Brazil. In the list we also see the largest European producers: Germany, Spain, France, Denmark, and Poland. The list also includes some new

players on the world market for pork meat, namely Brazil and Vietnam (in addition to China). Other large producers in Europe are the Netherlands and Italy.

Table 1. Output of the world's 10 largest pork-producing countries (FAO, 2005)

Year	2005		2000		1995		1990	
	Output (million ton)	Percentage	Output (million ton)	Percentage	Output (million ton)	Percentage	Output (million ton)	Percentage
China	51,202.15	49.08	41,405.63	45.96	33,401.32	42.38	24,015.70	39.45
USA	9,392.00	9.00	8,597.00	9.54	8,097.00	10.27	6,964.00	11.44
Germany	4,499.99	4.31	3,981.90	4.42	3,602.40	4.57	4,457.99	7.32
Brazil	3,140.17	3.01	2,600.01	2.89	2,800.00	3.55	1,050.00	1.72
Spain	3,130.24	3.00	2,904.62	3.22	2,174.82	2.76	1,788.85	2.94
Canada	2,617.57	2.51	2,002.73	2.22	1,416.96	1.80	1,191.92	1.96
Vietnam	2,288.32	2.19	1,409.02	1.56	1,012.48	1.28	728.56	1.20
France	2,277.74	2.18	2,312.00	2.57	2,144.00	2.72	1,726.80	2.84
Denmark	2,014.92	1.93	1,710.98	1.90	1,516.10	1.92	1,208.61	1.99
Poland	1,955.50	1.87	1,923.86	2.14	1,963.20	2.49	1,854.95	3.05
World total	104,333.29	100	90,085.85	100	78,806.12	100	60,871.80	100

3. Research methodology

This paper presents initial results of an inventory study into European pork chains, which was performed as part of the EU's 6th Framework Integrated Project Q-Porkchains. One of the work packages in this project aims at an in-depth analysis of European pork chains and the establishment of a research agenda for the European pork sector. The present paper focuses on the first results of this work package.

As a first step toward achieving the work package objectives, a workshop was held with pork chain experts (in January 2007). The aim of the workshop was to determine key aspects that could give insight into the structure of and variety in the European pork system. Before the workshop, an in-depth literature analysis was performed to arrive at a long list of relevant items. Through in-depth discussions between the workshop participants from 17 organisations in 9 countries (7 EU and China and South Africa), five key aspects were identified: *regulations, governance forms, quality standards and quality management systems, technology and innovations, and market performance*. These aspects were deemed relevant for characterising European pork chains.

Second, to obtain the data necessary for characterising European pork chains, a number of interviews were conducted in five European countries: the Netherlands, Germany, Spain, Hungary, and Greece. The rationale for the selection of these countries was to include two big producers, one in Northern Europe (Germany) and one in Southern Europe (Spain), a big exporting country (the Netherlands), a small pork producer (Greece), and one of the relatively new EU countries (Hungary). The information presented in this paper is derived from expert interviews in the five countries and from in-depth secondary material analysis. To arrive at an overall picture of the European pork chain experts were asked to also reflect on the situation for the whole of Europe.

Table 2 shows the number of interviews conducted in the participating countries with research, government and industry representatives. The variation in the numbers of respondents per country is due in part to the varying availability of up-to-date secondary material and the size of the country (e.g., in the Netherlands an institute specialised in pork sector analysis provided a significant amount of data ; in Greece interviews with a selected number of key experts and companies and in-depth secondary material analysis gave the information necessary).

Table 2. Number of interviews per country with different stakeholders

	Research	Government	Industry
Netherlands	2		6
Germany	2	3	7
Spain	4	2	17
Hungary	9	4	11
Greece	2		4

Through the expert interviews and analysis of secondary material, knowledge was gathered about the five aspects mentioned above. Based on this information, each of the aspects was described in further detail, and relationships between the aspects were identified.

4. Results

The next sections outline the (preliminary) results obtained through the expert interviews and analysis of secondary material.

4.1 Regulations: European food law and the pork sector

The European Union has developed a wide range of legislative demands with regard to food safety. European Union Directive 93/43 on the Hygiene of Foodstuffs states that food business operators shall identify any step in their activities that are critical to ensuring food safety, and further ensure that adequate procedures are identified, implemented, maintained and reviewed on the basis of HACCP. In 2002 the cornerstone of the new European food law was laid through passage of Regulation 178/2002. This regulation is often referred to in English as the ‘General Food Law’, (GFL). The main objective of the GFL is to secure a high level of protection of public health and consumer interests with regard to food products. It should be noted that the GFL is not a code encompassing all food legislation. It is the foundation of a general part of food law. Aside from the GFL, many other European and national rules and regulations continue to apply. The GFL, implemented in January 2005, gives food (and animal feed) companies primary liability in the event of unsafe products. This necessitates implementation of monitoring systems at company level. Information from these systems should make it possible to determine the source of safety or quality problems and to find out where other items with the same problem are located in the supply chain (Trienekens, 2001). With regard to traceability, since 1 January 2005 companies have been obliged to register data on raw material supplies and customer deliveries on a transaction basis. Besides EU legislation in general, additional requirements specific for each country apply.

In addition to the general EU regulation 178/2002, EU hygieneregulations 825/2004, 853/2004 and 854/2004 are particularly important for the pork sector. These demand implementation of self-control systems by food companies. At the beginning of 2009 it will become compulsory for farmers to provide special information about slaughter-pigs to the official veterinarian of the slaughterhouse 24 hours before the pigs are to be slaughtered. So far it has been common for this information to be given to the carrier when he collects the slaughter-pigs at the farm (Reg.(EG) No.853/2005) (FoodnetCenter, 2008).

4.2 Quality management systems: private food quality and safety standards

This section will focus on the many private quality management systems that exist in addition to public regulations for assuring quality and safety in agri-food chains. Recently, large European retailers in particular have developed initiatives to commit their suppliers to strict food quality management systems. These standards contain comprehensive norms with regard to food safety,

product and process management, and hygiene of personnel. Retailers expect legal, technical, and financial advantages from these systems. The standards were developed to help retailers fulfil legal obligations and protect consumers, but they now include more stringent demands for food safety and quality than required by law (Havinga, 2006). Table 4 describes a number of retail-initiated quality management systems. Being largely based on HACCP and ISO hygiene and food safety regulations, these systems are similar in many respects.

Table 3. International quality management systems in agri-food supply chains (adapted from Plaggenhoef, 2007)

System	Based on	Origin	Aim/set up of the system
British Retail Consortium Standard (BRC)	HACCP, ISO	British retailers	Requires an operational quality system and an HACCP plan that includes environmental issues, product, process and staff. Aims at processing/distribution stage of the chain.
International Food Standard (IFS)	HACCP, ISO, BRC	German, French and Swiss retailers	Aims to ensure food safety and the quality level of retailer-branded food products. Aims at processing/distribution stage of the chain.
Safe Quality Food (SQF)	HACCP, ISO	Australian retailers	Addresses food safety and quality, but also other issues such as animal welfare, environmental impact, ethical production, organic production and religious preparation requirements. Aims at all stages of the chain.
Dutch HACCP	HACCP	Dutch retailers	Management standard for the primary sector, processing industry, distribution and logistics.
International Standard Organisation (ISO 22000)	HACCP	ISO	Management standard for any organisation in the food chain, including feed producers and service providers.
Retailer Produce Good Agricultural Practices (Global-GAP; formerly Eurep-Gap)	HACCP	European and US retailers	Global-Gap supports the use of HACCP and members are obligated to comply with national and international legislation. Primary producers have to show commitment to issues such as reduction of environmental damage, pesticide use, efficient use of natural resources, health and safety for employees and traceability efforts.
Qualität und Sicherheit (QS)	Eurep-GAP, IKB	German retailers	Makes sure that firms fulfil the legal requirements and food safety criteria that go beyond legal regulations. Focuses on all stages of the food chains.

With regard to the direct suppliers of retailers, such as food manufacturers, processors, and traders, the Global Food Safety Initiative (GFSI, www.ciesnet.com) was established to harmonise the various standards on a global scale. As a result suppliers will now be treated more equally throughout the world. At the moment, supermarket chains work with different standards. Some use firm-specific standards, whereas others support a retail standard (for example, BRC, IFS, Dutch HACCP, SQF2000). There are also retailers who still have their own auditing standard in addition to a GFSI-recognised standard. For example, the British retailer Tesco accepts BRC and also accepts IFS, but still undertakes its own audits based on a Tesco checklist. Most of the French retail firms that are members of the FCD (Federation du Commerce et Distribution, www.fcd.asso.fr) participated in the IFS working group. However, each individual French retailer has developed its own policy towards accepting IFS audit reports. The Belgium retail federation FEDIS has decided that its members will accept all GFSI-recognised standards (www.fedis.be) (Plaggenhoef, 2007).

Furthermore, the Global-GAP system (www.globalgap.org) is especially aimed at the primary producers.

Box 2. Eurep- and Global-Gap

The predecessor of Global-Gap was Eurep-Gap, a standard for European retailers, which was extended to a global level in September 2007. Eurep-GAP stands for Euro-Retailer Produce Good Agricultural Practices working group and was a platform in which the major European food retailers were grouped. The Eurep-GAP system was introduced and fully developed in the fruit and vegetable chain, but was later expanded to other sectors, like flowers and ornamentals, meat and fish (Van Plaggenhoef *et al.*, 2003; Bondt *et al.*, 2005).

Global-GAP supports the principles and encourages the use of HACCP, but also takes the reduction of environmental damage into account, such as pesticide reduction, efficient use of natural resources and health and safety for employees (Van Plaggenhoef *et al.*, 2003; Havinga, 2006). In the pork chain, systems like the Dutch IKB (Integrated Chain Control) and the German QS (Qualität und Sicherheit) are in the process of being acknowledged as equivalents of the Global/Eurep-GAP systems.

Qualität und Sicherheit GmbH (QS, www.q-s.info) is a merger of stakeholders in German agriculture, including major (especially German) retailers, such as Metro, Edeka, Rewe, Kaiser's Tengelmann, Aldi, Coop, Globus, Kaufland, Marktkauf, and Wal-Mart. QS is internationally active and already works with different standards used in neighbouring countries. For example, firms complying with the IKB system in the Dutch pork meat chain can participate in QS. The difference with other quality management systems, summarised in table 3, is that QS is oriented toward the total supply chain, whereas the other systems are mainly limited to direct suppliers of retailers or to primary producers (like Global-GAP).

Systems used in European pork chains, such as IKB, QS, and Global-Gap, are based on HACCP, GMP (Good Manufacture Practice) and ISO9004 rules. Some systems in other countries, like the new pork sector quality systems in Greece, are also based on these standards. Input providers for the pork chain, such as feed providers and veterinarians, have their own systems based on HACCP and Good Practices. The German and Dutch IKB and QS systems are described in box 3 below.

Box 3. IKB and QS systems

Nearly all (95%) of the firms in the pork meat chains (primary producers as well as slaughterhouses and cutters) in The Netherlands and Germany, participate in Integraal Keten Beheer (IKB or in English: Integrated Chain Control) and/or Qualität und Sicherheit (QS or in English: Quality and Security). These systems encompass strict measures for the reduction of Salmonella and Campylobacter, and also include additional requirements related to traceability, quality and registration. IKB and QS pigs are raised on farms that undergo regular inspections by independent organisations focused on feed, medicine use, hormones, hygiene, as well as animal welfare and transport. The systems also include a range of possible sanctions including warnings, fines, or in the case of repetitive non-compliance, exclusion from the system or even closing of the firm. Depending on their performance, primary producers are inspected once to four times a year and processors are inspected twice a year. Firms participating in the IKB in The Netherlands can also participate in the QS System, by complying with an additional QS module dealing with antibiotics in the feed.

Apart from the chain-wide quality systems described above, there is a trend, in Southern European countries in particular, towards adopting specific certification systems for regional products (often Products of Designated Origin) and specialty products. One interesting example is the PDO standard for Iberian ham (Jamon Iberico).

Box 4. Regulations for Iberian pork meat

Iberian cured ham has four denominations of origin: Dehesa de Extremadura, Guijuelo, Jamon de Huelva and Valle de los Pedroches. Most Iberian pigs come from the South-Western regions of Spain, in the “dehesa” (meadows and woods). Aside from Iberian, there are two other Spanish PDOs in cured ham, Jamon de Teruel and Trevelez. Moreover, there are two brands of quality cured ham; Jamon Serrano, a traditional specialty, and Serrano Espanol (produced for export). (In this regard it is interesting to mention that some Hungarian companies export Mangalica pigs, a special Hungarian breed, to Spain for the production of high-quality Serrano ham). The basic regulation for meat products of the Iberian breeds is RD 1469/2007. The objective of this regulation is to establish quality characteristics for “Iberian” meat products. There are two breed designations: “Iberico puro” from sow and boar of pure Iberian breed with genealogic documentation, and “Iberico” from pure Iberian sows. Feeding practices in the finishing period (Iberian pigs grow up to 160 kg) are also grouped into four designations: “Bellota” (finished on a diet of acorn, grasses, etc. in the “dehesas”) ; Recebo (finished on partly the same diet as the “Bellota” animals but with additional concentrates); and Cebo (mostly fed with feed concentrates and sometimes additional acorn and grasses). The regulation preserves quality and competitiveness of these traditional products in a transparent market. The aim is to protect the rights of both consumers and the sector as a whole. Additional control mechanisms are also in place that include inspections and certifications by independent bodies focused on enforcing breed and feeding controls and traceability, as well as compliance with quotas for the maximum number of pigs that can be fattened in extensive farms (Briz et al., 2008).

In various European countries chain-wide quality systems are emerging that encompass all processes in the pork chain. So far, Northern European countries like the Netherlands, Denmark, and Germany are up-front in implementing these kinds of systems. In southern countries like France and Spain, larger companies are following the Northern European trend, but an interesting development has also emerged towards PDO products and regional specialties. Special attention is given in these countries to (further) development of regulations and standards to protect the brand names of these products. Another clear trend is towards less use of medicines, increased use of organic feeds, etc. However, organic pig production is moving forward quite slowly and currently only accounts for a limited (niche) market share of 0-2% in most countries.

4.3 Governance forms in the European pork chain

Horizontal relations

One of the key developments in the European pork sector, among other food sectors, is up-scaling and concentration in all links of the chain. This section presents an overview of concentration trends in various links of the European pork chain.

Retail

- In Northern and Western European countries the 5 largest retailers have a market share of up to 90%. In Germany, for example, 74% of meat is sold in supermarkets.
- Southern European countries still have more grocery shops (Spain, Italy, Greece). In Spain, for example, 39% of meat is still sold in traditional shops; Greece still had numerous butcher shops and more than 4300 *souvlaki* shops in 2006.
- In Eastern European countries concentration and buy-ins by foreign producers have been emerging fast since these countries joined the EU and opened their markets.

Slaughterhouse

- In the Netherlands the largest company covers more than 70% of the market.
- In Germany 50% of the market is covered by the three biggest companies.
- In Spain, on the other hand, the 10 biggest slaughterhouses control about 25% of the market. In 2004, there were still 589 slaughterhouses, many of which supplied regional markets.
- In Hungary 6 large slaughterhouses already account for over 50% of production (out of a total of 140 slaughterhouses).

- Greece still had 195 slaughterhouses in 2006.

Table 4 illustrates the concentration in the slaughterhouse stage of the chain in 2005. Many mergers took place in the preceding years; most significantly, Vion Food Group was formed by a series of mergers of Dutch and German slaughterhouses.

Table 4. Ten largest pork-producing companies and their market shares in Europe (2005)

Slaughterhouse	%Market share	Country
Danish Crown	10	Denmark
Vion Food group	8	Netherlands/Germany
Westfleisch	2.4	Germany
Tonnies	2.3	Germany
Cooperl	1.6	France
Socopa	1.5	France
Glou Sanders	1.0	France
Grampian	1.0	UK
Swedish meats	1.0	Sweden
Gausepohl	0.8	Germany

Processing

A trend towards larger-scale firms is also taking place in the processing link. However, there are still many small processing companies, in particular in Southern European countries, focusing on special ty and regional products. An interesting development can be seen in Germany where the number of pork processing companies has increased in the past few years.

- In the Netherlands there are currently about 1000 processing companies, 54 of which are large.
- In Germany there were 1014 companies in 2006, but that number is increasing.
- In Spain the 2 largest companies together control more than 40% of the market. In 2006, there were 1413 cured ham companies, 275 of which produced products of designated origin (PDOs). . The country also had more than 4800 pork processing companies.
- In Hungary a lot of home-processing still takes place. There were about 90 large plants in 2006.
- In Greece 6 companies control 65% of the market. Further concentration is taking place.

Farrowing/finishing

Many small farrowing/finishing companies still exist, especially in Southern Europe, but also in the southern part of Germany. Further concentration is expected, though. The first very large farms emerge in various countries in Europe (some with more than 50,000 pigs).

- In the Netherlands there are currently about 8000 (farrowing/finishing) farms. This number is decreasing and the average size of the farms is increasing.
- Germany still has 80,000 of these farms, including many small ones in the South.
- In Spain has more than 96,000 farms, many of which are small. This also includes 13,500 extensive production farms that produce Iberian pork and other special meat products.
- Hungary, with a relatively small pork sector, still had 316,000 farms in 2005. This number is rapidly decreasing at the same time that very large farms are emerging. Already 80 very large farms are responsible for more than 50% of production.
- Greece has only about 740 pig farms, and that number is decreasing.

Feed industry

In the feed industry there is also a strong trend towards concentration.

- In the Netherlands the largest 10 companies have more than 65% market share.
- In Germany 10 companies control almost 50% of the market.
- The Spanish market is dominated by 15 large companies.
- In Hungary there are still many small feed producers, but feedstuffs are increasingly imported.
- In Greece there is also a strong tendency toward concentration: 13 companies cover 88% of the market.

Breeding

The breeding market is also strongly concentrated. The Netherlands, Germany, and Denmark have the largest breeding companies, which deliver to the whole of Europe (including Spain and Greece).

The above summary of concentration trends in various pork chain links gives the following picture. In Northern and Western European countries the 5 largest retailers have market shares of up to 90%. Southern European countries still have more grocery shops. In other (e.g., Eastern European) countries supermarkets are emerging rapidly. In most countries large slaughterhouses have the biggest market share, or are growing rapidly (e.g., the largest slaughterhouse in the Netherlands has more than 70% market share). In the processing stage concentration and up-scaling are also taking place, although many small, often specialised, companies remain (Germany, Spain). In the farrowing/finishing stage we still see many small farms in countries like France, Spain, and Germany. In the feeding stage there is a strong concentration tendency in all countries, just as in the breeding stage.

Vertical relations

Different governance structures can be found at different stages in the supply chain, and major differences can also be found between chains and between countries. For example, while contracts exist in the breeding stage of the chain in various countries, market transactions can be found in farmer-slaughterhouse relationships in several countries besides hybrid or integrated governance structures in other chains (e.g., in Spain and Greece). In major European chains, however, (formal) contractual relationships are relatively rare: even though most relationships are long term, they are often not formalised in written contracts. Rather than through contracts, vertical coordination is achieved by means of product and process standardisation: widely accepted, private quality standards, like IKB and QS, implicitly align chain-wide activities. Communication involving more than two chain actors is, usually, only necessary when quality standards have to be modified. As a result, coordination of activities in the chain is possible without large-scale integration of governance structures. However, one development that can be recognised is integration of finishing and farrowing in various chains, with the aim of reducing animal health and food safety risks caused by the transportation of animals (Wever and Wognum, 2008).

In Northern Europe farmer cooperatives still play an important role in the pork sector. In the Netherlands the largest slaughterhouse is fully owned by farmer cooperatives. However, these cooperatives have only little say in the day-to-day business operations. In Germany strong cooperative organisations exist, in particular strong regional cooperatives. Germany has 121 marketing cooperatives (about 2/3 focused on fattening-slaughter and about 1/3 on breeding-fattening) as well as 150 producer associations. This makes the German pork sector one of the most strongly organised in Europe. Box 5 gives an example of a German cooperative organisation (FoodNetCenter, 2008).

Box 5. Example of a cooperative chain organisation in Germany

One particular supply chain in Germany is organised as a corporate cooperation in a closed system for the purpose of managing quality and health issues. The pig farmers organised in the farmer cooperative are the main owners of a slaughter and processing enterprise. The farmer cooperative produces special meat products for the regional market making use of its own meat brand programme. A large part of the production is delivered directly to local butcher shops and regional food retailers. All actors in the chain are obliged by contract to follow a joint quality policy, whereby the meat brand programme sets specific demands for animal husbandry, feeding, health management and quality assurance. The farmer cooperative is thus characterised by contractual agreements between the agricultural enterprises, respective suppliers and service providers as well as the slaughter and processing organisation. Typical of this kind of production system is the fact that market partners work together without exception on a long-term basis; the individual actors also know each other personally and information is exchanged directly from enterprise to enterprise. This also enables a constant information exchange between the various stages of the chain. Written long-term contracts define the quality requirements adhered to by all actors in the chain and which services and products are included (FoodNetCenter, 2008).

In Spain cooperatives cover 20% of production and 10% of the market (cooperatives between farmers and feed industries, cooperatives for trade in live animals, and cooperatives for trade of fresh meat). Hungary and Greece, on the other extreme of the spectrum, only have few associations. In Greece we see a strong tendency towards vertical integration: feed, fattening, finishing, slaughtering. Some chains even include butchers and retail outlets.

Because sales of fresh pork meat to consumers increasingly go through the supermarket channel, most chains are directed at sales through this channel. On the other hand, there seem to be quite a few opportunities for sales by farmers and slaughterhouses to the processing industry aimed at meat specialties and/or regional products. (An exception is Greece where most fresh meat is still sold through butchers and processed meat through small shops or *souvlaki* shops of which there are thousands in Greece).

In Germany, the Netherlands, France, and Denmark developments towards chain-wide information systems can be recognised. In these countries we see systems emerging that provide extensive on-line quality data from slaughterhouse to farmer and vice-versa that enable these companies to decide on the right prices for meat delivered, but also to optimise their processes in the mid- and long-term based on these data. The most modern systems are chain-wide systems that include breeding, farrowing, finishing and slaughtering stages. A big challenge is still to provide the consumer with sufficient product and process data (including origin) upon which to base his or her buying decision.

4.4 Technology and innovation in the European pork chain

Technological innovations are taking place at various stages of the pork chain. In the breeding stage, for example, ongoing research is focusing on stress-free animal breeds and certification for special-bred sows/semen. Organisationally we see integration of breeding lines and the use of breeding contracts. Furthermore, decision making processes are becoming more centralised.

Box 6 Use of molecular genetics in breeding programmes (Alfasan Diergeneesmiddelen B.V. et al., 2008; Wever and Wognum, 2008)

Molecular genetics techniques are increasingly used in breeding programmes. Quantitative genetics are used in combination with DNA technology. DNA tests that isolate hair roots of the animals assist in the selection of both breeding traits and breeding animals. This is called gene marker assisted selection: genes are identified that are responsible for particular traits, as well as gene markers that indicate the presence of these traits in the animals. Genes (markers) that can be easily identified, and that are responsible for economically useful traits, are used to modify the breeding programmes. These techniques are useful especially for the identification of traits related to resistance to diseases and meat quality.

In the feeding stage new feeding concepts are being developed to reduce piglet mortality. Also new types of dried raw material are being introduced. For example, in Spain, feed producers are using new raw materials and developing new feeds with high oleic concentrates or Omega-3 fatty acids. On a regional level strategic relationships with key suppliers are being developed.

At the farmer stage, stables are being adjusted to meet legislative or private labelling demands. Moreover, in farm management computers and PDAs are increasingly used to track health and weight data of animals and to analyse farm performance. With regard to health aspects, new vaccines and new and more efficient drugs in general are being developed. Also, health management systems (capture, storage and analysing of animal/herd health data) are being developed in various countries like the Netherlands, Germany, and France. Furthermore, transportation methods have improved, both for live animals (well-ventilated vehicles with automatic drinking water installations) and for cold meats.

At the slaughtering/processing stage we see an increase of the application of CO₂-stunning instead of electrical discharges at the slaughterhouses, further improvement of the cold-chain, new automatic dryers for ham (Spain) and development of new health and convenience-related products. Furthermore, inter-organisational information systems between slaughterers and farmers are being developed in various countries. These systems are the main enablers for coordination between the various links of the pork chain.

Box 7. Inter-organisational information systems

FarmingNet was launched in 2005 by Vion. It is a web-based information system providing farmers with on-line access to data about the pigs they have supplied. Analysis of the data is performed by Vion, which shows the farmers the quality level and (lack of) uniformity of their pigs influencing their net profit. Cost savings are the result of lower failure costs. In other countries and chains inter-company information systems for the pork chain have been developed, in particular in the Western part of Europe, including France and Spain. Although most of these systems focus on the relation slaughterhouse – farmer, we see also chain-wide information systems emerging, including the breeding and feed supply stage. These systems not only focus on better planning and control of operational processes in the pork chain, but also on mid- and long-term optimisation of various production and distribution processes. A recent study (van den Hazel, 2007) into the economic value of using these kinds of systems found two advantages for the slaughterhouse-farmer link: 1. An overview of body and carcass deviations per batch, and thus per stable, possibly provides better insight into climate control per stable. This information could lead to additional returns (increased pig growth and reduced throughput and cycle times), reduced costs (decreased deviations), and increased resource usage. 2. Using such a system could also contribute to improved accuracy of weight partitioning of pigs at delivery time related to pig pay-off. This information could result in additional returns (reduced throughput and cycle times), reduced costs (increased optimisation of weight at delivery) and increased harmonisation of market quality concepts.

At the retail stage in the chain, various developments towards convenience food and specialty products can be distinguished. Out-of-home sales are also increasing, such as in Hungary, where the sector is trying to gain ground in major tourist areas. Moreover, more pre-packed meat is being sold by supermarkets in Europe. Private labels are becoming more and more important, although some processing companies are trying to develop A-labels.

4.5 Market performance, bottlenecks and opportunities for the European pork chain

In this section major product-market combinations for pork meat in various countries are discussed. Furthermore, results of a SWOT analysis are presented for the pork sector in the countries studied.

Analysis of product-market combinations revealed the following picture:

- In the Netherlands the focus is on bulk fresh meat. There is only very little specialisation in, for example, special regional products, while organic pork only has a 1-2% market share. However, although the organic sector in NL is small, it is very well structured and organized, providing opportunities to grow further in the future.
- In Germany the focus is also on bulk fresh meat. However, in contrast to the Netherlands, there is also a strong market for regional and processed meat products (such as different kinds of sausages). The organic market for pork meat in Germany is very small, only 0.5% of the total pork market.
- In Spain there is, besides the market for bulk fresh meat, a large market for regional, PDO and specialty processed products. The trend is towards convenience food, sliced pre-packed meat and healthy products (e.g., prepared with olive oil). Spain has 6 denominations of origin (PDO) of cured ham.
- Since 2005 Hungary has been a net importer of pigs (e.g., live pigs from Poland). Although most production is bulk, some traditional products are also produced. These could develop into an interesting niche market.
- In Greece most meat is still sold through butchers, although the supermarket market share is increasing. There are also many small (*souvlaki*) shops where consumers can buy prepared meat dishes.

To give an overview of typical challenges and opportunities in the European pork sector, table 5 presents a SWOT analysis of pork chains in the five countries.

Table 5. SWOT analysis of pork sector in five countries

Strengths	Weaknesses
<p>Netherlands: knowledge-intensive sector, high productivity, IKB quality system, strong export position</p> <p>Germany: high technology level, regional products, QS quality system, strong cooperatives</p> <p>Spain: growing sector, flexible market adaptation, strong regional brands</p> <p>Hungary: long tradition of regional products, good feed grains, low labour costs</p> <p>Greece: dynamic market for processed products, government investments, selling based on personal relationships</p>	<p>Netherlands: mass-product oriented, sector has a poor image, growing production costs</p> <p>Germany: lack of communication in the chain, waste treatment problems, dependent on import of piglets</p> <p>Spain: pork meat has a poor image, fragmentation of production, lack of labour</p> <p>Hungary: obsolete production technology, little room for investments, low productivity</p> <p>Greece: dependent on import of genetic material, low adoption technology, high production costs, large black markets</p>
Opportunities	Threats
<p>Netherlands: improvement of sector's image, improvement of logistics and information exchange, collaboration with foreign mass-producers</p> <p>Germany: larger farms, increase in export, niche market development, network coordinators</p> <p>Spain: product development (health/convenience), immigration labour force, brand development (e.g., Iberian pork)</p> <p>Hungary: niche market (Mangalica) development, government support, sales to Greek and Croatian markets, improved technology</p> <p>Greece: improvement of sector's image, new product development, consumer preference for Greek pork</p>	<p>Netherlands: reduced social acceptance for industrial pig production, no solution for waste management, increasing production costs</p> <p>Germany: many small farms, federal structure slows down decision making, low piglet production, imbalanced relationships between links in the chain</p> <p>Spain: increase of input costs (feed), decreasing domestic consumption per capita, increase of costs related to legislation</p> <p>Hungary: poor image, illegal slaughterhouses, large price fluctuations, lack of sector strategy and government support</p> <p>Greece: eco-tourism competes with pork industry, high input costs compared to competitors, reduced social acceptance of industrial pig production</p>

5. Conclusions

This paper presents major developments in the European pork sector. Further concentration is expected in the different links of the pork chain. Southern and Eastern European countries are following this trend that started 10-15 years ago in Northern European countries like the Netherlands, Germany, and Denmark. However, there seems to be room for specialty and/or regional products that focus on niche markets (ham, sausages, etc.). Important examples are the PDOs for cured ham from Spain (e.g. Jamon Iberico) and Mangalica pork meat from Hungary. Moreover, there are many more examples of processed products that have a regional basis or that aim at a high-quality segment of the market (e.g. the "Bellota" ham from Spain).

Quality management systems in North-Western Europe increasingly cover the whole chain, and are supported by chain-wide information systems. These systems now even extend to small and medium-sized companies. Contrary to such developments in other food sectors, the development toward chain-wide quality management systems in the pork sector is being led by slaughterhouses rather than retailers.. Southern European countries are following suit, while Eastern European countries have just started to catch up with EU legislative quality demands.

Especially in North-Western Europe, the slaughterhouse link in the pork chain has been consolidated and this trend is expected to continue. Prime examples are the two largest European companies: Danish Crown, in which a large part of the Danish pork sector is integrated, and the Dutch-German Vion Food Group that now covers more than 50% of the Dutch-German pork meat processing sector. However, in the Netherlands and Germany pork producers have remained independent from the slaughterhouses (coordination takes place through quality and information systems). In Southern Europe there is (still) much more fragmentation and competition between companies in different stages of the pork chains.

A large challenge for the European pork sector is to improve its image. In some European countries, like the Netherlands, Denmark, and Greece, consumers are critical with regard to industrial meat production and concerned about issues like animal welfare, environmental pollution, etc. In other countries, including Spain, it is the image of the pork meat itself, which is seen as fatty and unhealthy, that threatens the sector. Moreover, competition from other economic activities, like bio-fuel production in Hungary or tourism in Greece, is putting pressure on the position of the pork sector.

Competition from mass producers inside and outside the EU, such as Brazil and China, as well as competition from traditional producing countries like Canada, could become another challenge in the future. Within Europe, competition is emerging between producers from the “new” countries (like Poland) and producers from the “old” countries, like the Netherlands. This competition will further re-structure the European pork sector and push it towards low-cost production. On the other hand, the high productivity of in particular Northern European countries can help them keep or gain a strong position in international markets, while their strong knowledge base and technology can help them export knowledge and technology and/or start collaboration or joint ventures with foreign mass-producers.

6. Discussion and further research

Based on the results of the study, tentative relations between the aspects examined can be formulated.

Public institutions formulate baseline (quality) regulations which chain actors have to comply with. These regulations to a large extent shape the quality management systems chain actors implement. The quality management systems are also shaped by the additional private quality standards set by chain actors. Additionally, innovations enable chain actors to improve quality management systems through new integrated information systems or governance forms. For example, large feed producers in the Netherlands developed a collective system to control and secure a safe supply of inputs. Importantly, a two-way relation seems to exist between quality management systems and governance. This is because different quality management systems need different governance structures to set and enforce quality throughout the chain. For example, as is discussed in section 4.3, in the Netherlands and Germany widely accepted quality systems like IKB and QS implicitly align chain-wide activities, making (quality-related) chain-wide coordination possible without large-scale integration of governance structures.

Different quality management systems also lead to different (quality) performance, and thus make different types of product-market combinations accessible for chain actors. Performance is also directly related to (innovations in) technology and governance forms. To compete in the European pork market, continuous development in technology is necessary. For example, the use of obsolete technology hampers the productivity of the Hungarian pork industry. The link between governance and performance is less clear, but certainly also present, in other countries. For example, in the Netherlands the decentralised structure of the industry allows chain actors to focus on their core competencies, and has thus increased the efficiency of actors in the Dutch pork chain.

The relations identified between the various aspects examined in the study are illustrated in figure 2.

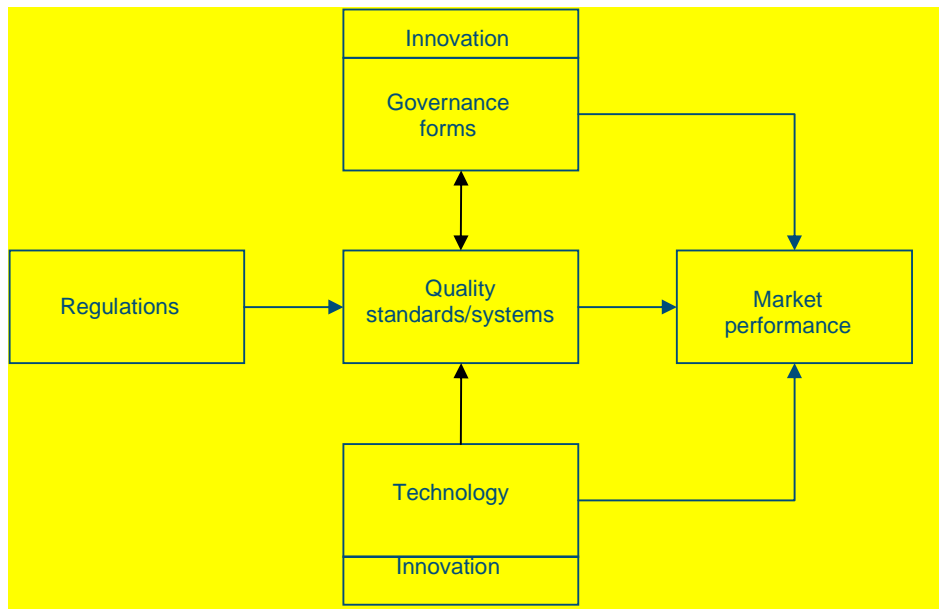


Figure 2: Framework for further research

Based on the results of this analysis, some important questions for further study can be formulated:

- Which combination of governance forms and quality systems/standards will lead to the best market performance, in terms of profitability, compliance with consumer demands and diversity of products?
- How can product and process technology contribute to improving quality systems and strengthening the connection between companies and the market?
- Which product, organisational and marketing innovations are necessary to improve quality systems and market performance?
- How can governments help the sector further develop regulatory frameworks for various types of chains (e.g., DOP product chains) to comply with market demands and at the same time strengthen the competitive position of the European pork sector?

References

Alfasan Diergeneesmiddelen BV, Boehringer Ingelheim, Intervet, 2007. Diergeneeskundig Memorandum: Pig Breeding Today. Diergeneeskundig Memorandum, Spring 2007.

Bondt, N., S.D.C. Deneux, I. Van Dijke, O. De Jong, A.J. Smelt, G.M. Splinter, S.O. Tromp and J.J. De Vlieger, 2006. Voedselveiligheid, ketens en toezicht op controle, LEI, The Hague, The Netherlands, 94p.

Briz, J., I. de Felipe, S. Pena, 2007. General description of pork chains in Spain, Universidad Politecnica de Madrid, ETSIA.

Briz, J., I. de Felipe, S. Pena, 2008, Description of specific pork supply chains in Spain: fresh meat and Iberian cured ham, Universidad Politecnica de Madrid, ETSIA.

Central Food Research Institute, 2007. General description of pork chains in Hungary, Budapest, CFRI.

FoodNetCenter, 2007. General description of pork chains in Germany, University of Bonn, Preventive Health Management Group.

- FoodNetCenter, 2008. Improving the quality of pork and pork products for the consumer, Case Study Report Task 4.1- Deliverable 4.1.1, University of Bonn, Preventive Health Management Group.
- Freriks, A.A., 2006. Ketenssystemen in de Agro-Food sector. Jurdische vormgeving van afspraken binnen de keten en de relatie tot de publieke taken van de overheid (in Dutch). University of Utrecht, The Netherlands, pp. 31.
- Havinga, T., 2006. Private regulations of food safety by supermarkets. *Law & Policy*, 28(4).
- Jahn, G., M. Schramm and A. Spiller, 2004. The trade-off between generality and effectiveness in certification systems: A conceptual framework. In: H. J. Bremmers, S. W. F. Omta, J. H. Trienekens and E. F. M. Wubben (Eds), *Dynamics in Chains and Networks. Proceedings of the sixth international conference on chain and network management in agribusiness and food industry*. Wageningen Academic Publishers, Ede, The Netherlands, pp. 335-343.
- Omta, S.W.F., J.H. Trienekens and G. Beers, 2002. A framework for the knowledge domain of chain and network science. In: J. H. Trienekens and S. W. F. Omta (Eds), *Paradoxes in Food Chains and Networks. Fifth international conference on chain and network management in agribusiness and food industry*. Wageningen Academic Publishers, Noordwijk, The Netherlands, pp. 13-20.
- Plaggenhoef, van W., M. Batterink and J.H. Trienekens, 2003. *International Trade and Food Safety: Overview of legislation and standards, EU concerted action Global Food Network*, Wageningen, The Netherlands, 52p.
- Plaggenhoef, van W., 2007. *Integration and Self Regulation of Quality Management in Dutch Agri-Food Supply Chains*, Doctoral Thesis, Wageningen University, The Netherlands.
- Smith-DeWaal, C., 2003. Safe food from a consumer perspective. *Food Control*, 14(2): 75-79.
- Trienekens, J.H. and A.J.M. Beulens, 2001, The implications of EU food safety legislation and consumer demands on supply chain information systems, *International Food and Agribusiness Management Association 2001 Agribusiness Forum and Symposium*. IAMA, Sydney, Australia.
- Van Kleef, E., L.J. Frewer, G.M. Chryssochoidis, J.R. Houghton, S. Korzen-Bohr, T. Krystallis, J. Lassen, U. Pfenning and G. Rowe, 2006. Perceptions of food risk management among key stakeholders: Results from a cross-European study. *Appetite*, 47(1): 46-63.
- Vlachos, I.P., 2007. *General description of pork chains in Greece*, Agricultural University of Athens, Greece.
- Wever, M., and P.M. Wognum, 2008. *Fresh Pork Meat Chain in The Netherlands*, Wageningen University, Management Studies Group
- Wognum P.M., M. Wever, O. Nijhoff-Savvaki, 2007. *General description of pork chains in The Netherlands*, Wageningen University, Management Studies Group