Matching Diverse (Quality of) Supply with Market Differentiation Opportunities in the Pork Chain

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1 Introduction

Currently, in most pork chains there is still a mismatch between delivered quality and expected quality, leading to unsatisfied customers and value losses because products are not sold against the best possible price. Differentiation of quality of pork starts already in the breeding stage, depends on feeding and living conditions of the animals at the farmer stage and is also influenced by the way the animals are transported and slaughtered. At the breeding stage a lot of research is being done that will eventually make it possible to use DNA technology to help guide breeding programs and to better predict the quality of animals and meat. However, because pigs are living creatures with a natural variation, 100% prediction accuracy is not to be expected and slaughterhouses still will have to cope with a large variation in quality characteristics, even within batches that come from the same farmer.

This article focuses on what research challenges lay ahead related to the question how (natural) quality variation in the pork chain can better be used to bring the right quality at the right time at the right price to the right customer in the European pork net-chain. It will thereby focus on the slaughterhouse link.

Much of this paper is based on discussions within the frame of the EU's 6th Framework Integrated Project Q-Porkchains. One of the work packages of Q-Porkchains aims at in-depth analysis of European pork chains regarding the matching of demand and supply (Trienekens et al., 2009). Connected to this work-package is an industry pilot project on quality measurement methods and technologies at slaughter-line level, supported by (PhD) research into design of new logistics concepts and research on information system development, to make optimal use of the opportunities of the new technologies.

Section 2 gives a short description of the pork chain. Section 3 gives insight into consumer demands with regard to food and pork products. Section 4 goes into quality variability in pork supply chains. Section 5 defines major research challenges in management and supply chain research to deal with quality variability in the pork chain. Section 6 concludes.

2 Description of 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, although farrowing and finishing are sometimes combined. In addition to these chain actors, figure 1 also shows major input providers, like the feed industry, 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.

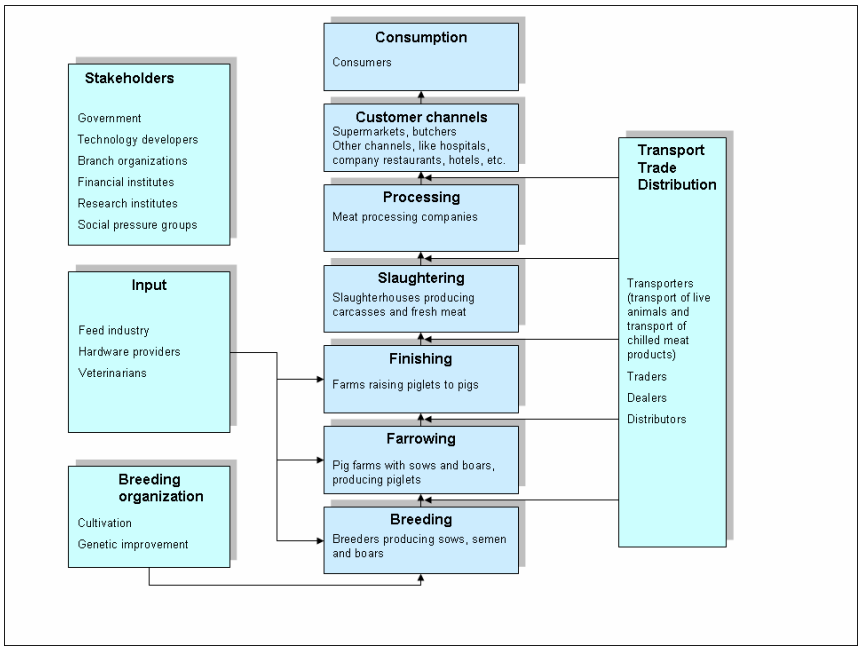

Figure 1. The pork chain (Trienekens et al., 2009)

3 Consumer demands with regard to food products

Grunert (2005) distinguishes four groups of quality attributes for food products: *sensory attributes, health attributes, process attributes,* and *convenience attributes*. *Sensory attributes* are related to sensoric quality, such as taste, tenderness and juiciness. *Health-related quality* is a more subjective category, with often conflicting opinions about claims of the producer. Regulations on health-related labelling of food products have recently been enforced in most Western countries. *Process attributes* refer to the way a food product has been produced. Typical process attributes of interest for the consumer are animal welfare, environmental load, organic production, etc. Finally, *convenience attributes* are defined as 'those aspects of the product that save time or energy for the consumer during shopping, storage, preparation, eating and disposal'.

In general consumers must make trade-offs in their buying decision: for example, increased marbling in a piece of meat may increase juiciness, or tenderness, but it will be considered less healthy than a leaner steak. When these trade-offs are made, there is evidence that intrinsic cues (cues that are part of the physical product) usually carry more weight than extrinsic ones (Steenkamp & van Trijp, 1996). In general consumers first have to be satisfied with the sensory properties of products, before other quality cues become relevant (Verbeke et al*.,* 1999).

With increasing variety of food products and growing assortments, consumers become increasingly selective about the products they buy. Besides the above-mentioned product characteristics, consistent quality of products in time and tighter product specifications become more important: consumers want to get the same (high and specified) quality at every purchase and are not satisfied with varying quality (Ngapo et al*.,* 2003). While repetitive purchases and customer loyalty are of extreme importance for retail success, achieving a predictable and, at the same time, diverse product port-folio are currently major challenges for the pork sector. Managing the variability of pork aims to achieve lower

variability in the final product, compliance with specifications and higher levels of customer satisfaction.

Box 1: uniformity of pork quality
Hypor, an important breading company part of Nutreco, in its website states that uniformity is probably the most important trait in pork quality, although it is difficult to define uniformity as a trait.
"Carcass quality at the packing plants is classified by grids, and high uniformity is achieved when the proportion of hogs hitting the maximum section of the packers grid is maximized, obtaining higher premiums. The most extreme market requirements are the Japanese. The Japanese market has a very high emphasis on uniformity, insisting that all carcasses be close to identical. It would be in the best interests of both the producers and the processors if pigs could be grown in homogeneous groups to a specific end point rather than requiring extensive sorting at slaughter". Source: Hypor website. (Varsi, 2009).

Grunert et al. (2005) argue that the extent of heterogeneity and dynamism in end-user markets is a determinant of the degree of market orientation in the chain. The future market for pork will be more heterogeneous and dynamic, thereby asking for more market oriented activities in this chain, at slaughterhouse, farmer and breeding stages. So far, however, in most food sectors heterogeneity of raw materials upstream in the chain is not exploited for serving market heterogeneity downstream in the chain (Grunert et al., 2005). To be market oriented and efficient at the same time, quality variation (heterogeneity) upstream the chain should be better used to match with differentiated quality demands in the market. Through flexible management of quality differences for specific market outlets, chain revenues can be increased due to an improved matching between delivered and demanded quality (van der Vorst et al., 2007).

Box 2: Quality variation
In a recent Wageningen University research project it has been discussed that roughly 20% of bacon customer specifications are not being satisfied today. This 20% of mismatch generates extra costs for the company. If detected before delivery, deviations result in internal failure costs (scrap and rework costs, costs of corrective action, or in downgrading costs when sold at a lower price); if the "wrong" product reaches the customer, external failure costs are generated, principally in the form of customer complaints and returns (Varsi, 2009).

4 Research challenges in managing quality variability

Even though in current research a lot of attention is paid to better predict quality of pigs through breeding schemes and innovative feeding and housing regimes, in this paper we pay less attention to this part of the chain and focus on the challenge of managing quality variability in the processing phase.

In the following we define major management and research challenges for this link in the chain. To deal with quality variation main requirements are:

- large batches of incoming materials
- advanced quality measurement and quality prediction tools
- market differentiation and advanced grading systems and sorting tools
- coordination and integrated information exchange in the chain
- advanced logistics and distribution systems

4.1 Large batches of incoming materials

A high variability of incoming materials, that can be used to serve a variety of market outlets, assumes large batches of incoming (live) materials, with natural variation in quality. A large inflow also implies a large outflow, meaning that market partners must be of sufficient size to maintain efficient sales and distribution processes. The current concentration tendencies (Box 3) in most food chains on the one hand and the extension of world-wide distribution systems and globalization on the other hand in fact fulfil these conditions.

Box 3: concentration tendencies in the European pork sector.
One of the most striking developments in the European pork sector, among other food sectors, is up-scaling and concentration in all links of the chain. In Northern and Western European countries the 5 largest retailers have market shares of up to 90%. Although 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 (e.g. in Germany and Spain). In the farrowing/finishing stage we still see many small farms in countries like France, Spain, and Germany; although in other countries we see a strong decrease of the number of farms (like in The Netherlands, where the number of farmers have been halved in the last 10-15 years). Also in the feeding as well as in the breeding stages there is a strong concentration tendency in all countries (Trienekens et al., 2009).

4.2 Advanced quality measurement and quality prediction tools

Pork quality can be defined in many different ways, like percentage of leanness, weight, visual aspects, sensory perception and suitability for further processing, and it also varies in different markets. The pork processing industry has until now mainly focused on sorting based on carcass quality: weight, lean meat ratio, fat/meat layer thickness. These are static features and relatively easy to measure. However, these features are not directly related to the quality of the meat that is produced. Here factors like microbiological quality, pH value and water holding capacity are important, which are more difficult to measure, are dynamic and are affected by multiple factors.

Quality properties at the operational level should be measured with high accuracy and precision, guaranteeing compliance with tightly specified quality demands. Measurements should in particular consider variability, implying that not only batch averages are recorded but also quality data of individual parts. The aim is to achieve a large variety of end-products that match with the demands of various markets, but at the same time a low variation of quality within product lots that are delivered to specific markets.

To be able to better predict meat quality, new measurement methods are currently being developed, for example of water holding capacity of pork meat (box 4).

Box 4: New methods of quality measurement
A group of scientists in Q-PorkChains is studying a new method to predict water-holding capacity. Water-holding capacity (WHC) is one of the most important pork quality traits, as it improves the sensory appreciation of pork by consumers, affects the amount of saleable meat by reducing purge loss, and increases the yield of further-processed products. WHC of pork is the result of many conditions of genetics, pig husbandry, animal transport, stunning and killing of pigs and the cooling conditions of carcasses. Sorting based on aspects like WHC has not been achieved mainly due to the lack of rapid on-line, non-invasive pork-quality measurements. Near Infra Red (NIR) has been identified as a potential measuring technique that could sort primal cuts according to different WHC categories.

4.3 Market differentiation and advanced grading and sorting tools

A successful extension of quality measurements will open up opportunities for further market differentiation because quality prediction of meat products will be far more reliable. Consequently, quality can be better tuned to the specific wishes of market partners (globally), thereby maximizing value added.

Differentiation strategies are based on high throughput production models for which we assume the inflow (of pigs and quality of meat) to be characterized by a normal distribution, making the delivery of different qualities to different markets possible (figure 1).

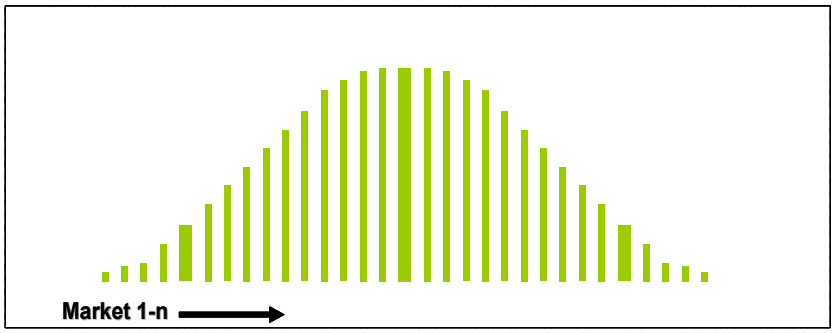

Figure 1. normal distribution of product inflow quality and market differentiation

The challenges at the marketing side will be to persuade buyers to pay a better price for products with consistently higher quality (consistent because measurement methods are improved) and to find niche markets for special quality products. Moreover, such a development implies the design and implementation of new logistic concepts for storage and handling, as well as more fine-tuned distribution concepts for delivering the right product to the right customer at the right time.

4.4 Coordination and integrated information exchange in the chain

Because of safety and quality considerations but also because quality and logistics planning has become increasingly important in the supply chain, coordination of processes with other parties in the chain has received major attention from companies in the last decade (Trienekens and Zuurbier, 2008). Therefore, implementation of chain-wide quality and safety management systems is a strategy now undertaken by many pork-producing companies. Box 5 gives examples of two of such systems.

Box 5. IKB and QS systems

Nearly all of the firms in the pork meat chains, in particular primary producers, slaughterhouses and cutters, in the Netherlands and Germany participate in Integraal Keten Beheer (IKB , in English: Integrated Chain Control) and/or Qualität and Sicherheit (QS, in English: Quality and Security). In 2006, 98% of all pigs slaughtered in the Netherlands were IKB pigs (**www.european-meat-alliance.eu**). The market share of QS in Germany is 90% of pigs slaughtered. Systems like IKB and QS 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 firms that undergo regular inspections by independent organizations 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 one to four times a year and processors are inspected twice a year. Firms participating in IKB in the Netherlands can also participate in the QS System by complying with an additional QS module dealing with antibiotics in feed.

One of the key conditions for chain wide coordination and quality control is transparency. Transparency of a chain is the extent to which all the chain's stakeholders have a shared understanding of, and access to, the product-related information that they request, without loss, noise, delay or distortion (Hofstede et al., 2004). This definition implies that data must be relevant, accurate, factual, reliable, timely and available in an appropriate quantity. Moreover, quality information must be readable, while information exchange must be reasonable and properly arranged (Hofstede et al., 2004). Apart from well-designed information systems, trust between partners is key to achieving transparent supply chains (Lindgreen et al., 2005), leading to higher levels of loyalty and better formal and informal communication.

Transparency is of utmost importance for the pork chain for a number of reasons:

1. A reliable exchange of quality and health data throughout the chain provides actors with an instrument to better plan their production and sales processes and better match the right quality to the right market.
2. Availability of operational quality and safety data across the chain supports adequate risk management.
3. The increasing complexity of logistics flows caused by product differentiation, market segmentation and internationalization, demands insight into production and stock data throughout the pork chain, so that companies can make better forecasts and more effectively plan logistics and distribution processes.
4. Consumers require more and more information about the origin of products and the way the product is produced.
5. Based on experience gained during the recent crises in the European pork sector, traceability has been shown to be a key capability for companies to find the origin of problems and recall hazardous products quickly.

Transparency in many modern pork chains in Europe is supported by integrated information systems. Box 6 gives an example of an integrated information system for the pork chain.

Box 6. Farmingnet
FarmingNet was launched in 2005 by Vion. It is a web-based information system that provides 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 degree of uniformity of their pigs, both of which influence their net profit. The system not only focuses on better planning and control of operational processes in the pork chain, but also on mid- and long-term optimization 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 potential additional advantages for the slaughterhouse-farmer link: 1. An overview of body and carcass deviations per batch/stable may provide better insight into the influence of climate control on growth of the animal, which again may lead to additional returns (increased pig growth and reduced throughput and cycle times), reduced costs (decreased deviations), and increased resource usage (energy). 2. Better use of information on animals to be delivered may also lead to improved accuracy of weight partitioning of pigs at delivery time related to pig pay-off. This information can result in reduced costs (increased optimization of weight at delivery) and increased harmonisation of market quality concepts.

These type of integrated (quality and information) systems are essential to support various parties in the chain to plan their production and quality control, but also to support quality segmentation processes at the entrance gate.
Quality control tools may further support the grading and sorting processes. A quality control tool currently used by many food companies is Statistical Process Control, originally developed by quality gurus such as W.E. Deming, who recognized that variation in incoming materials and half-fabricates is an important cause for poor quality, and prevention ('doing the things right the first time') is the basis for success (Luning et al., 2002). In relation to management of quality variation SPC may be used to guide the sorting processes and subsequently control the processing of batches of homogeneous quality.
Another tool, that can support further optimization of quality control and sorting processes is On-line Analytical Processing (OLAP). With OLAP long-term patterns in quality data of incoming and outgoing materials can be analyzed, so as to optimize sorting and marketing processes.

4.5 Advanced logistics and distribution systems

From a logistics point of view, a pork supply chain comprises organizations that are responsible for the production and distribution of pork products. These products travel within and between organizations before they reach the final stage ready to be sold to the consumer (vd Vorst and Vlajic in: Wognum et al., 2009). Vd Vorst and Vlajic mention a number of challenges related to increasing complexity of logistics processes and distribution network processes:

- Problems in (long-distance) transport of livestock
- Decreasing meat quality due to inappropriate logistics processes
- Inventory management problems
- Difficult to value all parts of the pig and match supply and demand
- Chilled/frozen meat contamination in transport and storage
- Problems in information sharing to support logistics along the chain
- Problems in lot traceability
- Forecasting problems

- Fleet management difficulties
- Difficulties to make transport optimisation
- Problems in control of production process at farms

In the current business environment in which companies source and sell globally new concepts are necessary to deal with these logistics challenges and the increasingly fine-meshed (global) distribution network of supply and demand. In this regard simulation and optimization tools for food logistics and distribution networks are currently being developed.

5 Summary and conclusions

Increasing consumer demands in high quality and specialty meat products on the one hand, and better use of quality variation in the pork chain on the other hand may lead to a large increase in product diversity in the years to come.

This paper has focused on the formulation of conditions for a better use of quality variation, in particular by processing/slaughtering companies in the pork chain. The case in this paper was the pork chain, although in other fresh food chains (fruit, vegetables, other meat, fish) challenges regarding management of quality variation are similar, as consumer demands, concentration trends in various links of the chain and technology developments are comparable.

The topic discussed in this paper poses a number of highly interesting opportunities for supply chain and management research:

1. design and introduction of new meat quality measurement methods and technologies at the slaughter line (in the pork chain measurement of meat quality in addition to carcass quality which is current practice)

2. investigation of market opportunities and design of marketing tools for further product differentiation based on (intrinsic) product quality

3. further integration of quality and information systems for the exchange of quality data in particular of retail, slaughterhouse and farmer stages (to support more fine-tuned and balanced pricing between these parties and transparency in general in the pork chain).

4. new logistics and distribution systems to be designed to cope with the higher complexity and uncertainty of the future product flows and to be able to deliver the right product of the right quality at the right time to the right customer.

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