June 20, 2011 (Monday) Pre-Congress Seminars

Ministry of Rural Development — **Kossuth Lajos tér 11. Budapest V.**

CONFERENCE ROOM — **Monday 10:00 – 18:00**

1.3. NEW QUALITY AND SAFETY REGULATIONS AND DEVELOPMENTS ON THE AGRIFOOD AREA

Seminar Chair: Zoltán Kálmán, Ministry of Rural Development, Hungary

14.40 Six Sigma in Food Production – Challenges for "Bio" Process Optimization
Detert Brinkmann, *Thorsten Klauke, Rolf Ibald and Brigitte Petersen, University of Bonn, Institute for Animal Science, Germany*

Brinkmann, Detert (Germany)

Beginning from 2007 he is coordinator of Working Group Quality and Information Management, Institute for Animal Science, University of Bonn, Preventive Health Management Group working together with Prof. Dr. Brigitte Petersen. He is EU Project Coordinator at the FoodNetCenter, Bonn and Project Manager, Assistant of the Head of Supply Chain Management at Westfleisch eG.

Between 1998 – 2003 he studied Agricultural Science at the University of Bonn focusing on Agricultural Economics, Animal Production, Animal Health and Quality Management. In 2003 – 2006 he earned PhD in Agricultural Science, at the University of Bonn focusing on Supply Chain Management in the meat industry. He is now Doctor of Agricultural Sciences. Today he is expert of Food Chain Management at the EU Commission Research Executive Agency; he is also member of the Advisory Board, Society for Informatics in the Agri-Food Industry e.V.

Six Sigma in Food Production – Challenges for 'bio' process optimization

Detert Brinkmann, Rolf Ibald, Thorsten Klauke and Brigitte Petersen
University of Bonn, Institute for Animal Science, Katzenburgweg 7-9, D-53115 Bonn

Introduction

Changes in consumer's behaviour and technological advances of the industrial food production need innovative quality strategies. Consumers prefer more and more products that have a high degree of convenience (Recke 2007). New automated classification, sorting and processing techniques contribute to satisfy this demand by allowing an extensive standardization of 'biological' (bio) processes from the raw material to the final product.

Especially the pork sector has implemented new innovative quality strategies for convenient products in recent times. For this reason, the role of quality management methods within the pork value chain (Porter 1985, Trienekens et al. 2009) is more and more important, particularly for coordinating organizations that are responsible for the quality of the chain as a whole (Brinkmann and Petersen 2010). To emphasize the customer-supplier perspective the SIPOC tool (Supplier-Input-Process-Output-Customer; Lunau et al. 2007) of Six Sigma is also promising in quality management decisions of pork producers. In addition, the concept of quality backward chains (Beaujan and Schmitt 2010) is a combinable conceptual approach to support quality relevant information flows to the suppliers. Bowersox et al. (2002) and Lin et al. (2005) have noted that quality and operational efficiency can be seen as the two largest supply chain challenges. This underlines the need of an intensive collaboration along supply chains and the implementation of process improvement methods.

Six Sigma is a method of quality management to improve the performances of processes in a strucutrized way (Magnusson et al. 2001). Starting in the 1980s at Motorola many companies have used this zero defects strategy to reduce the costs of incorrect products (Folaron 2003). The success of the method can be explained among other things by the quality loss function of 'Taguchi' that shows that the costs may increase exponentially, if the processes of production are adjusted incorrectly (Ross 1988). Klauke und Brinkmann (2009) noted that Six Sigma can be applied to improve processes and reduce costs of meat production.

In the present study the optimization potential of the Six Sigma concept in standardized industrial processes of pork production will be evaluated with the objectives

- to adopt the approach of Six Sigma to food production,
- to assess the Process Sigma and
- to discover weak points in the value chain.

For this purpose a structured Six Sigma approach will be designed. Based on the DMAIC-cycle (Define, Measure, Analyse, Improve and Control), for instance described by Lunau et al. (2007), optimization potential of the supplier-customer processes between pig farms and a meat processor will be outlined. Suitable QM tools will be selected and adopted to the demand of 'bio' processes.

The investigated pork value chain

Food production of today can be characterized by highly standardized processes. So-called 'biological' processes are playing a central role, whereby the growth of an animal or the production of milk is meant for example. One important branch of the food sector is the pork production with about 22,5 mil. tons having been produced in the EU in 2009 (Marquer 2010, FAPRI 2010). Only China is producing more pork having a 52%-share of the global production (FAPRI 2010).

Germany is the largest pork producer and consumer in the EU-27. The pork value chains in this member state are predominantly driven by large industrial meat processors acting on the

spot market and by integrated supply chains of large scale retailers. Especially within these integrated chains new innovative solutions and methods for quality management will have good chances to enforce the quality, safety and efficiency. This poses a big organizational and methodological challenge, because of the high division of labor of up to seven production stages of the chain and many small actors on farm level.
Against this background a study was designed to test the Six Sigma method in an integrated pork chain of a large German retailer (38 bill. € turnover 2010). In the observation period 391 farms (supplier) delivered 295 thousand pigs to be processed to 'schnitzel' or sausages for example in the retailers meat processing plant.
A neuralgic point of the quality evaluation in the process of pork production is the mandatory carcass grading in the abattoir that is required by law (EC 1985). For market transparency pork is evaluated by a classification technology at the start of the meat production. Important pork quality traits are the carcass weight and lean meat percentage that are used to pay the supplying farmers and to control the meat processing upstream of the chain. These traits seemed to be suitable for the Six Sigma method.

Design of a Six Sigma approach

Specific methodological features of Six Sigma are the promoter concept, the toolbox and the improvement cycle. Initially an interdisciplinary team consisting of six persons was built in a first stage: a marketing specialist of a producer cooperative, a manager of the abattoir, a plant manager as well as a quality manager of the meat processor and two external researchers.
The existing process has been approached by designing a project according to the DMAIC-Cycle and by selecting, adapting and applying a range of suitable QM tools in the several phases of 'bio' process optimization.
In the *Define* phase the project scope was defined by focusing on the above mentioned neuralgic point of pork production. The customer oriented 'Critical to Quality Matrix' (Lunau et al. 2007) was used to collect the 'Voice of Customer' (VoC) that pork should fulfill specific quality requirements in the field of meat quantity (1.VoC) and meat-fat-ratio (2.VoC). In a next step the core topic was identified: Improvement of the product conformity.
Specification limits were set relating to the quality requirements of the meat processor, but also to the practicability on the supplying farms. Afterwards the so-called CTQ (Critical to Quality) was defined for the farms: '60% percent conformity of delivered products', which considers the biological variation of pork quality traits. Thus the basis for the evaluation of DPMO – defects per million opportunities – was created that subsequently allows assessing the Process Sigma (short and long term).
By using production data the *Measure* phase was organized. An inter-company database provided quality information about 295 thousand pigs that have been routinely processed during an observation period of one year. Seasonal effects were not taken into account in this study. To evaluate the selected pork quality trait 'lean meat percentage' the FOM (Fat-o-Meater) technology was used that is working with reflection measurements and regression formulas. This technology has an error of ca. 5% that has to be taken into account. The other trait 'carcass weight' was detected by a calibrated scale.
During the *Analyse* phase, distribution of the parameters was tested and the data was analyzed with descriptive and analytical statistics to characterize the measured quality traits. The results were visualized as matrixes and figures (resp. histograms and Pareto charts) afterwards. In the next step the defect rates were calculated for each quality trait in combination with the defect opportunities to evaluate the DPMO and to classify the Process

Sigma. This was done by using a specific software tool and by taking into account a standard process variation of 1.5σ. Alternatively standard sheets of the DGQ (published by the German Association for Quality or Lunau et al. 2007) can be used. Hence Ishikawa diagramms were adapted to the topics of the study. They were used to figure out as well as to categorize possible causes of the identified defects. Possible causes were elicited with brainstorming techniques.
Finally, the promoting team prioritized the causes of the defects to derivate improvement measures. At this point of the DMAIC cycle the study was finalized by proposing the content of the next steps *Improve* and *Control* to be performed by the producers.

Results and Conclusions

In general, the observed variation of the quality traits carcass weight (CV=7,2%) and lean meat percentage (5,6%) is typical in regular processes of pork production. The delivered products of the farms achieved a conformity of 48% (CTQ=60%) that implies optimization potential.
A Process Sigma of 2,2 (short term) and 0,7 (long term) underlines the need for improvement. By comparison to other industries, like aviation, this seems to be a quite low Process Sigma. But it has to be taken into account that the standardization of the above mentioned biological variation is naturally limited.
Furthermore following major weak points in the pork value chain were identified:

- Inaccurate incentives of the abattoirs pricing system for the quality trait lean meat percentage
- Incorrect sorting of pigs before marketing
- Animal diseases

These are the main causes of defects that strongly affect the process capability.
Based on the outcomes of this study it can be ascertained that the Six Sigma method has a high potential to bring benefits to the food production. However the integrated quality tools should be adapted to the specific properties of 'bio' processes.
In conclusion, it can be emphasized that an intensive collaboration and communication between stages of production is a critical success factor for supply chain management from the farm to the consumer to achieve a high Process Sigma of food value chains.

References

Beaujean P and R Schmitt (2010): The Quality Backward Chain - The Adaptive Controller of Entrepreneurial Quality Proceedings of the 6th CIRP-Sponsored International Conference on Digital Enterprise Technology. Advances in Soft Computing, 2010, Volume 66/2010, 1133-1143.

Bowersox, DJ, DJ Closs and MB Cooper (2002): Supply Chain Logistics Management. McGraw-Hill, New York.

Brinkmann D and B Petersen (2010): Qualitätsverantwortung in der Wertschöpfungskette. In: Vom Viehvermarkter zum Dienstleistungsprofi. B. Petersen, A. Spiller and L. Theuvsen (eds.), GIQS e.V., Bonn. ISBN: 978-3-00-031973-0.

EC (1985): Commission Regulation (EEC) No 2967/85 of 24 October 1985 laying down detailed rules for the application of the Community scale for grading pig carcases. Latest amendment: Commission Regulation (EC) No 1197/2006 of 7 August 2006.

FAPRI (2010): FAPRI 2010 Agricultural Outlook, World Meat. Food and Agricultural Policy Research Institute, Iowa State University. Available at: http://www.fapri.iastate.edu/outlook/2010/text/16Meat.pdf, Accessed: 30 Dec. 2010.

Folaron J (2003): The Evolution of Six Sigma. http://www.asq.org/qic/display-item/index.pl?item=19535. Status: 13.12.2010.

Klauke T and D Brinkmann (2009): Kosteneffizienz durch Six-Sigma-Methode, Chancen für die Fleischproduktion durch Prozessoptimierung. Fleischwirtschaft, Vol. 8 (2009), 16-22.

Lin C, WS Chow, CN Maduc, C-H Kueic and PP Yua (2005): A structural equation model of supply chain quality management and organizational performance. Int. J. Production Economics 96, 355–365.

Lunau S, O Roenpage, C Staudter, R Meran, A John and C Beernaert (2007): Six Sigma+Lean Toolset, Verbesserungsprojekte erfolgreich durchführen. 2. Auflage, Springer Verlag Berlin Heidelberg, Germany.

Magnusson K, Kroslid D, B Bergman (2001): Six Sigma umsetzen. Die neue Qualitätsstrategie für Unternehmen. Hanser Verlag, Munich, Germany

Porter ME (1985): Competitive Advantage. The Free Press. New York, USA.

Recke G (2007): Wertschöpfungskette im Wandel - von der Landwirtschaft zum Verbraucher. Statistische Analysen und Studien NRW 2007, Band 45. Landesamt für Datenverarbeitung und Statistik North-Rhine Westfalia, Germany.

Ross J (1988): Taguchi Techniques for Quality Engineering. Quality Press, Milwaukee, USA.

Trienekens JH and PM (Nel) Wognum (2009): Chapter 1. Introduction to the European Pork Chain. In: Trienekens J, Petersen B, Wognum N and D Brinkmann (eds.): European pork chains – Diversity and quality challenges in consumer-oriented production and distribution, Wageningen Academic Publishers, pp. 19-37, ISBN 978-90-8686-103-3.

Acknowledgement

The authors gratefully acknowledge from the European Community financial participation under the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, for the Integrated Project Q-PORKCHAINS FOOD-CT-2007-036245.