Quality systems in the agri-food industry – implementation, cost, benefit and strategies

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Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006

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Abstract

The management of supply chains of the agri-food sector has become a very complex structure. Product variety has decreased, changes in legislatives and quality management requirements have a high influence, international trade is much higher, consumer demands about product freshness and food quality is fluctuate and processors and retailers ask for the implementation of quality systems. This has resulted in individual changes in the process and organisation level of the enterprises and in order to keep the costs minimal. The focus of this paper will be a cost-benefit analysis for the implementation of quality management/assurance systems. Only a few studies with the focus on HACCP and food safety exists in the part of costs and benefits of quality systems in the agri-food industry. And an approach with an integrated accomplishment of quality systems is still not publicised. With the view on this additional aspect a decision support model was developed. This model presents the requirements of existent quality, environmental and occupational health standards and is a basic for a cost benefit model for special scenarios and individual solutions for enterprises.

JEL Codes: Agriculture in International Trade, Food policy, Accounting and Auditing, Analysis of Collective Decision-Making, Business Economics

1 Introduction

In the past years a number of issues and trends has brought increased attention into safety and quality considerations in the agri-food sector. These include the “mad

cow” disease crisis and expansion of the international trade of food, fuelled by advances in production, transport, information technology and other deployments in the cooperation of supply chains. In order to promote food trade and maintain consumer´s trust in product quality and safety, quality management is of high importance for agri-food enterprises. Safety and quality standards, assurance systems and a legislative framework could built around the business concept “quality management”.

The development of management systems with focus on processes is not a new concept, having begun to receive attention in the eighties. Systems based on “good practices”, encompassing good agricultural, good hygienic, good manufacturing and good trade practice were developed.

Since the nineties the international standard ISO 9000 ff. has been popular in the agri-food industry. The reason for the development of the ISO 9000 was the publication of a consistent norm, which formulates a framework for quality management. In 1993, the European Union officially recognised the HACCP methodology as a standard production method for food manufacturers to implement and maintain a production control system. Furthermore, quality systems have been developed with specific requirements for the agri-food-industry and with the view on supply chains and networks (Krieger & Schiefer, 2004; Luning et al. 2002).

These different quality systems were developed by different organisations, both private and public. Wheras mandatory safety and quality systems exist, often enterprises have a choice on whether or not they should adhere to a specific system of norms and regulations. Hence, cost and benefit considerations are likely to be taken into account in decision processes regarding safety and quality management system adoptions.

The aim of this paper is to review alternative approaches and propose a methodology for the consideration of costs and benefits in decisions related to the improvement of quality and safety systems in the agri-food sector. The problems associated with the existence of different systems and the legal implications thereof are discussed in Chapter 2. Chapter 3 analyses the existing literature on the impact of methodologies and approaches for cost-benefit-estimations for quality and food safety improvements. The next part (Chapter 4) presents a description of the advisory model which was developed. The basic of this data base will be the requirements of different management standards and a comparison between these systems. The result of the procedure of this data base will be the presentation of the additional points of the standards. The next step is the sorting of these requirements in cost and benefit categories and the estimation of additional costs and the presentation of a methodological approach for the estimation of costs and benefits of management systems.

Finally, Chapter 5 discusses the steps of this research and will give an insight into the further research.

2 Business concept “Quality management”

Generally, legislation places extensive and stringent requirements on quality and safety of agri-food products. A whole range of laws, acts, regulations, norms and directives exist that are related to production of, food to the minimisation of environmental implications and to the prevention of unfair trade. Such regulations address different varied aspects such as food hygiene, traceability, reduction of pesticides, animal feed hygiene, product-related requirements and control-systems, including requirements for trade. These laws act on different levels: they can be applicable world-wide (i.e. Codex Alimentarius); on the continental level, (i.e.

European food legislation); national level, (i.e. German food law) and on the sector level (i.e. guidelines for dairy products) (Luning et al., 2002). Next to the legislative quality and food safety standards are relevant for implementation and improvement in the quality management part. Quality management has been over a long time a relevant concern in the agri-food industry. Nevertheless, in the recent past quality management standards were more frequently developed at the public and private sectors and increasingly demanded from firms at all levels of the agri-food chains. Quality standards can contain requirements related to the production process, e.g. a farmer is not to apply more than a maximum amount of pesticide and must assure that residues in their products are within the specified limits. Processing firms, on the other hand, might be required to implement HACCP systems, with the goal that specific processes will be followed and the resulting products will be safer for consumption. The focus can also be on product quality (e.g. cleanliness, appearance), safety (e.g. pesticide or artificial hormone residue) and authenticity (geographical origin or use of traditional process) (Giovannucci & Reardon, 1999). While compliance with these requirements will allow firms to access markets, with associated benefits, they will most likely imply in a need for new investments and in increased operating costs.

The framework around quality standards is also relevant for cost-benefit analysis considerations. Quality standards can be formulated by public organisations as mandatory (e.g. HACCP in the EU) or they can be proposed by private institutions, with voluntary adoption (e.g. Q&S, EurepGAP). Furthermore, the organisation of standards can be vertically or horizontally oriented.

Before the model for the measuring of cost and benefits of quality systems will be presented an explanation about the structure of quality systems is relevant. In general, quality standards composition is a handbook with standard requirements

and interpretations, a self-control checklist and an audit checklist, other standards have only guidelines. The requirements are in most cases in different hierarchical dimensions. In some cases, the classification is in high and low priority (IKM), in critical, not critical and recommendations (EurepGAP), in basic and high level (IFS), in level 1, 2, and 3 (SQF 1000 and SQF 2000) and with the possibility of non-applicable demands and KO-Criteria or without any schedule line.

This means that to get a certification not all requirements has to be fulfilled in some systems by the processor because of the non-applicable requirements and the level of implementation. This differs from quality system to quality system. In some cases ,like the International Food Standard, the implementer has to fulfil 75% of the requirements, which has to include all KO-Criteria to get a basic level certification, the Danish Quality Guarantee standard ask for 100% fulfilled requirements. The SQF 1000 and 2000 codes are divided into three certification level. Level 1 indicates the food safety fundamental, content of level 2 are requirements of an accredited HACCP Food Safety Plan and in level 3 exists quality management requirements. The certification in level 2 or level 3 indicates the requirements of level 1 or level 1 and 2 respectively. Other systems like the Q+S-Standard from Germany groups the results of the audit in three categories due to the number of fulfilled checklist points.

The audit checklist is the basis for the valuation of the implementing quality system and the basis for the following model to measure cost and benefits of quality systems.

To estimate the costs of a quality improvement scheme, three alternative approaches were presented by Antle (1999), namely the engineering analysis approach, the accounting approach and the econometric estimation approach. In contrast to quantitative cost estimations, at the firm level the benefits of compliance with quality norms and standards have often been assessed in a qualitative way (Romano et al.

2005). In addition, two further approaches are typically used to estimate the benefits of a quality system or improvements in food safety: the willingness-to-pay-approach and the cost-of-illness method.

The following theoretical framework discusses the costs and benefits, which arise due to the implementation of a quality management system with an econometric approach. Firstly, a way to find the requirements, which arise due to the new system, is presented.

3 Description of the advisory model

The aim of the advisory model is the development of an integrated description model to simplify the management of different quality, environmental and occupational health systems in the agri-food industry. The model utilizes a data base, which automatically generates operational system descriptions. The model is an advisory model for the minimization of costs in different quality management, environmental and health occupation scenarios (see figure 1) and also for the presentation of a best practice solution in the implementation of different management systems. Their exists a lot of benefits for an integrated management system in enterprises , which are for example: use of synergies, reduction of time and costs and an easier integration of new management systems (Petridris &Schlüter, 2001).

But how does this data base exactly works?

User could enter existing and new management systems into the description model.

And the requirements, which are not fulfilled by the already existent management systems are the result of this procedure. The presentation of these requirements act on different scenarios:

1. integrated into the ISO 9000
2. hinge on department
3. unstructured or in
4. combination of 1. and 2.

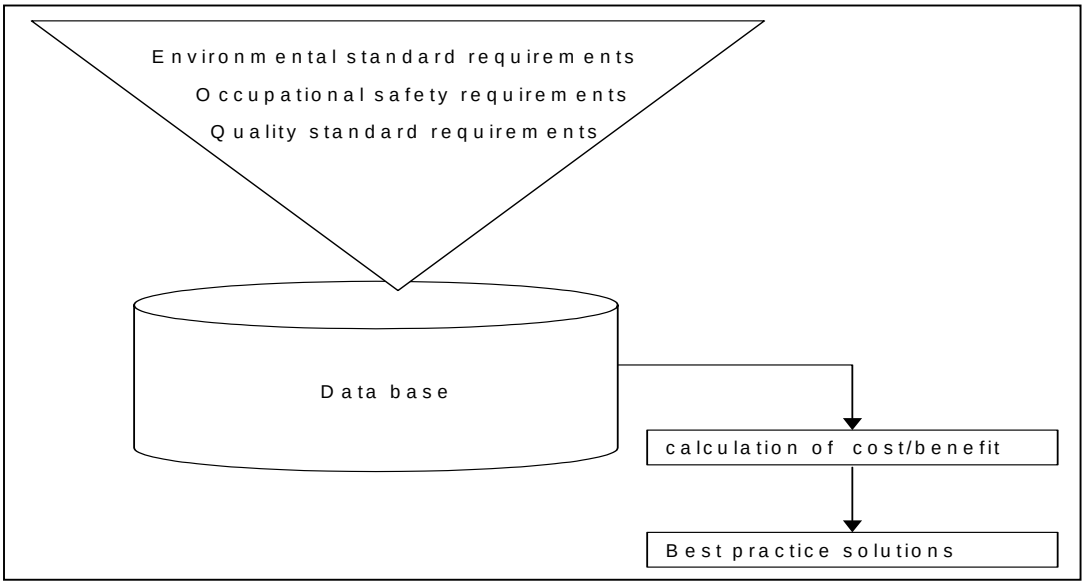

Figure 1: Construction of the Advisory model

4 Proposed methodological approach

4.1 Estimation of costs

The audit checklist is the basis for the valuation of the implementing of quality systems and the basis for the following model to measure cost and benefits of quality systems. The following theoretical framework discusses the costs and benefits which arise due to the implementation of a quality management system, adopting an econometric approach. Firstly, a way to find the requirements, which arise due to the new requirements is presented. The next step is the sorting of these requirements in cost categories and the estimation of additional costs. In the subsequent part, benefits are presented and the hierarchical order concerning the importance of this cost and benefit categories will be part of the following research.

The first step of this model is to find out the additional requirements, which the enterprise has to fulfil $R_a \in \mathbb{N}$, when it will implement a new quality system. The sum of the new requirements R_n (result of the procedure of the advisory model), without the non-applicable requirements (R_{na}) and the recommendations (R_R) (if the implementer doesn´t see a benefit) of the new system is the basis of this analysis (1).

(1) $f(R) = \sum (R_n - R_{na} - R_R)$

Then the requirements, which the firm has fulfilled based on the already implemented systems $R_i \in \mathbb{N}$ and have to find out (also procedure of the advisory data base). The same requirements of R_n and R_i are the next sum (R_d) of this analysis (2).

(2) $R_n \cap R_i = R_d$, with $\{X/(x \in R_n) \wedge (x \in R_i)\}$

The difference of (1) – (2) will give the result of the number of additional requirements (R_a) the firm has to implement (3) to have a fulfilment of the quality system demands of 100%.

(3) $R_n \backslash R_d = R_a \{X/(x \in R_n) \wedge (x \notin R_d)\}$

Now, the implementer is in the position to decide on which level he will integrate the new system (4).

So, let $r_+ = \{r_+ \in \mathbb{N}: r_+^{min} \leq r_+ \leq r_+^{max}\}$ be the set of percent of the different quality system requirements, where $r_+ = r_+^{min}$ represents the minimum standard requirements, which have to be fulfilled to get a certification and $r_+ = r_+^{max}$ represents 100% implementation of the new requirements.

(4) $R_+ = (R_d + R_a) * r_a/100$, under the condition that all KO Criteria are fulfilled

The variable R_+ presents the number of new requirements, which the implementer has to fulfil to get a certification on his chosen level. In addition, the calculation of additional costs will be part of the second step of this analysis.

First, the categorisation-blocks were developed, which will be basis for the hierarchical order concerning the amount of investments. The following cost-blocks were analysed through literature analysis and expert interviews:

a.) process quality (R_p): workers safety, veterinary and medicines, storage, HACCP-concept, traceability, transport, environmental measures, animal welfare measures, cultivation

b.) administration costs (R_c): labelling, self control, documentation, reclamation management, management costs, training and qualification, certification costs

c.) infrastructure (R_i): structural measurements and technical equipment.

d.) food safety/product quality (R_f): hygienic measures and laboratory tests/monitorings

4.2 Benefits of quality system

Benefits of quality management have very different dimensions and are very specific for different enterprises. Results from expert interviews, questionnaires and literature reviews present that the following benefit aspects are the important ones and are the

basic categories for this methodological approach for the evaluation of quality concepts:

1. Market entry

In some cases, a quality system certification is an entry to markets. The reason is that without a certification it is not possible to sell on special markets. Standards can also be a barrier to trade for poorer developing countries because the cost of meeting them is assumed prohibitively high.

2. Improvements in product liability

Since the year 2000, product liability has been a catchword not only in the food and agri industry. A key example is the legal standard to meet the due diligence requirements of the product liability law. The requirements that firms practice due diligence simply means that a firm must have taken all necessary steps to assure the safety of the products.

3. Fulfil of Cross Compliance/legal requirements

Cross Compliance has been relevant for farmers since this year in Europe. The subsidy payments will now be paid according to the fulfilment of 19 EU-Regulations. In addition, in some cases the requirements of those regulations have intersections with requirements of quality management systems. The points of intersection are for example in the part of animal welfare, environment, plant protection.

4. Improvement in process quality

Process quality is the organisation of the internal process and transactions between firms. An optimal organisation of a process means lower costs. Moreover, the requirements of different quality systems have a special focus on the optimal organisation of the processes in firms.

5. Improvement in product quality/food safety

Product quality concerns on the one hand physical product attributes (taste, shelf life, etc.) and on the other hand safety of a product with regard to health aspects. Quality standards and especially quality assurance/product standards define the requirements for a good quality product really clear and the implementation of a quality system can result in a better product quality.

6. Improvements in traceability/coordination of the chain

The EU regulation 178/2002 contains general provisions for traceability (have been binding since the 1. January 2005), which cover all food and feed business operators, without prejudice to existing legislation on specific sectors such as beef, fish, GMOs etc. (EU Commission, 2002). Importers are similarly affected, as they will be required to identify from whom the product was exported in the country of origin. Traceability has to be done one step back and one step forward. Quality system like the IFS standard ask for the implementation of a traceability system, which means that a part of this quality system is also legal in Europe.

Like Hobbs (1996) are transaction costs defined as the costs of undertaking an exchange between a customer and a supplier or between a buyer and a seller. They include the informational search costs, the negotiation costs and the monitoring and enforcement costs of undertaking an exchange. Transaction costs encompass all aspects of the contractual relationship between the customers and suppliers. Due to a contractual arrangement that the supplier has to implement quality systems transaction costs can be lesser, because of the reduction of asymmetric information.

7. Improvements in trust/image

Trust in business networks is important for customers to get an optimal product due to quality and safety. However, trust can be supported by quality standards and quality labels. A link between trust and transaction costs was presented by literature. Hagan and Hathaway (1995) and Ganesan (1994) note that trustworthy behaviour lowers the cost of transactions. So systems has more than one effect in this part on the one hand the reduction of transaction cots and on the other hand quality signs are important for customers. But there exists also different points of view in this point. Salaün and Flores (2001) claim that much of today´s information about food quality and safety is irrelevant to customers, as it does not address particular needs or expectations. And Marette et al. (1999) and Mazzocchi et al. (2004) present that food quality and safety information to consumers may result in considerable welfare effects. And also other studies present that f.e. meat quality labels improving consumers meat quality perception (Verbeke & Viaene, 1999; Hermann et al. 2002; Roosen et al. 2003; Hobbs et al. 2005).

8. Improvements in workers safety

Workers safety like safety equipment etc. can also be a benefit of quality management systems. Results of a good worker safety management can be the reduction of injuries and sick-leave.

9. Improvements in environment

Special standards exit for the improvement of the environment, but also quality standards set requirements for the environment. The importance of environment aspects are also relevant due to legal aspects and Cross Compliance. Next to the fulfilment of quality requirements, social welfare can arise.

Example for a cost-benefit analysis:

Till now a cost estimation model and benefit aspects of quality systems were presented. The next step in the research will be the estimation order of the costs and benefits categories and case studies for the validation of the system.

The method for the analysis of the order of the costs/benefits categories will be the Analytical Hierarchic Process:

Saaty (1995) has developed the Analytical Hierarchic Process to structure and solve complex decision situation. This decision support system can increase firm profit and other measures of performance" (Wierenga et al. 1999).

Aspects for the use of the Analytic Hierarchy Process (AHP) are:

1. AHP is one of the few methods where hard (e.g. costs) and soft (e.g. market entry) facts can be combined. The combination and analyses of hard (quantitative) and soft (qualitative) aspects is often required (Mingers 2000).
2. AHP is also very easy and flexible to use. This is also one of the main requirements for the application in this project.

Basic of the AHP is that specific foundations and Axioms will be accepted:

Axiom 1: The decision maker can compromise two different elements, which will be done in a pair wise comparison.

Axiom 2: It is not possible that a decision maker has no concrete comparison between two criteria.

Axiom 3: A decision problem can be formulated in a hierarchical order.

Axiom 4: All criteria and alternatives, which are relevant for the decision problem, are integrated into the hierarchy. These hierarchy elements will be evaluated by priorities. And these priorities are compatible with the perceptions of the decision maker

In general, AHP consists of the following steps:

1. Definition of a specific decision making problem
2. Formulation of relevant criteria, which can be taken to structure the decision making process and selection of available alternatives (i.e. the decision hierarchy)
3. Pair wise comparison to weigh the criteria
4. Pair wise comparison to weigh the alternatives in view of each criterion
5. Synthesis of weights/priorities on the basis of a matrix calculation combining the weighting of criteria/alternatives
6. Sensitivity analysis to determine how sensitive the final alternative priorities are to changes in the criteria weights

Selecting alternatives with highest weights/priorities (Meixner & Haas 2002). This is the “normal” way for an AHP, but the AHP method is in this model for the identification of the hierarchical amount of cost and benefits. To give insides into specific costs and benefits of quality systems case studies will be done with support by the cost utility method.

5 Conclusion

In conclusion: This paper has given an overview of quality standards and their structure in the agribusiness and food industry in Europe. The main aspect was to give an insight into a cost/benefit analysis of quality management systems and the advisory model for the integration of different systems in enterprises. The goal of this model is the estimation of marginal costs and benefits in firms concerning the implementation of standards. The next steps of this analysis will be the determination

of the hierarchical order of the amount of costs and the importance of benefits and case studies to apply the model.

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