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Assuring Safety and Quality along the Food Chain

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1.1 Quality and safety: issues

The term 'quality' has become a focus point in all discussions regarding the production and provision of food products to markets and consumers – quality in the broad sense of serving the consumers' needs (see also the early publication by Oakland, 1998) by providing them with the right product, at the right time, and with the right service. In today's competitive food markets, the quality approach is a precondition for sustainable market acceptance. It is a core pillar in the sustainability of enterprises and sectors, which builds on economic viability, quality orientation, ethical concerns, and an appropriate embedment in its environment.

In an enterprise, a *sustainable delivery of quality* is a result of a comprehensive effort. It involves the implementation of a quality approach at all levels of activities, ranging from enterprise management to process organisation, process management, and product control. Enterprise quality systems build on routine quality assurance and improvement activities that might encompass one or several of these levels. However, most food quality systems focus on system activities at several levels, involving process organisation, process management and product control.

Food safety is an inherent element of quality. It receives special attention not only by enterprises, but also by policy and legislation, because of its key importance for consumers' health, and the responsibility for food safety by enterprises and policy alike. Globalisation and industrialisation in the production and provision of food has increased the potential risk in food safety and has initiated increased efforts and controls in food safety assurance.

The efficient 'transportation' of quality from the farm, and any of the subsequent stages of processing and trade to the consumer as the final customer, requires efforts in cooperation along the chain. The dependency of food quality and safety from activities at all stages in the chain makes chain cooperation a prerequisite of any advanced quality assurance scheme, including food safety. Such cooperation might build on individual arrangements, sector agreements, or on any other way that avoids the loss and supports the gain of quality along the chain.

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Chain cooperation has become a crucial element in quality assurance, and especially in food safety initiatives in the food sector. However, in the food sector, chains usually develop dynamically in a network of interconnected enterprises, with constantly changing lines of supplier-customer relationships. In this scenario, chain cooperation is based on network cooperation – or, in other words, on sector agreements.

The *quality guarantee* that one can derive from the implementation of a quality system depends on the evaluation of the system as a whole. Quality and food safety deficiencies at any stage might remain with the product throughout the remaining stages, until it reaches the consumer. The most crucial need for guarantees involves guarantees for food safety. These constitute the baseline guarantee level and the prerequisite for consumers' trust and market acceptance (Henson and Hooker, 2001; Verbeke, 2005).

The delivery of quality guarantees is based on controls, both, in the organisation of processes (process controls) and in process management (management controls). However, for the delivery of guarantees, these controls need to be integrated into a comprehensive scheme (quality program) that could serve as a cooperation platform for enterprises within supply chains and networks and provide a basis for communication with consumers.

Key issues involve agreements on *chain-encompassing quality assurance* schemes, and the ability to identify the product flow through the production chain clearly, by linking the different product entities that are being produced and traded at the different stages of the chain, from the farm to the consumer as the final customer, and their quality status (tracking and tracing capability).

The following sections cover the development path from tracking and tracing towards quality assurance in food chains, the organisational concepts and quality programs for implementation, and the role of information and communication systems for operational efficiency.

1.2 Tracking and tracing through chains and networks

The tracking and tracing of food products throughout the food chain has become a dominant issue in discussions on food quality and, especially, on the assurance of food safety (Lobb, 2005). They allow, for any product and from any stage within the chain, identification of the source (backward tracing) and its destination (forward tracing). This supports the (backward) identification of sources of product deficiencies, and the (forward) isolation of any other product that might have been affected by these sources. Tracking and tracing capabilities support consumer protection in case of food contamination. Furthermore, they support the communication of the quality status of products on their way through the food chain, and provide the basis for the delivery of quality guarantees at each stage of the chain and towards the consumers at the final stage.

However, it should be noted that, beyond this discussion line, the organisation of tracking and tracing schemes (TT schemes) has also a managerial dimension in supporting efficiency in the logistics chain (supply chain) from the source (farms) to the final destination (the consumer). In fact, the managerial dimension has been at the centre point of initial discussions on tracking and tracing schemes, not just in the food sector but in other sectors as well (Golan *et al.*, 2004).

This emphasises the global relevance of tracking and tracing schemes and their role as a baseline feature, not only for the delivery of guarantees for food safety and quality but also for logistics efficiency, which is at the core of enterprises' economic interests.

From a historical point of view, the TT schemes evolved from enterprise internal efforts and were subsequently extended to supply chains and networks. This historic development path also characterises a path of increasing complexity. The identification of product units and the monitoring of their movements inside an enterprise require less coordination efforts than is necessary in supply chains and, especially, in a sector as a whole, with its larger number of enterprises and different and ever-changing trade relationships.

The identification of product units and the monitoring of their movements is a problem that is easy to solve, if product modification during the various stages of a supply chain process do not affect the composition of the product. The most complex TT scenarios concern composite convenience products or commodity products, where an individual 'product unit' cannot be based on a physical product element (e.g. a piece of grain), but needs to be based on *logistics elements (batches)* that might involve production plots, transportation trucks, or storage units of any kind (Golan *et al*., 2004; Schiefer, 2006; Fritz and Schiefer, 2009; Schiefer and Reiche, 2013). The linkage of these different batches in a batch sequence generates the production flow with its modifications, and provides the basis for tracking and tracing activities.

1.3 Food safety – the baseline

The general assurance of food safety is a prime concern and responsibility of society. Traditionally, food safety rests on the formulation and implementation of standards regarding the measurable quality of products – for example, the quantity of substances in the product with potentially negative effects on human health.

This approach is increasingly being supplemented (not replaced) by a proactive approach that intends to prevent food safety deficiencies from the beginning through regulations on the appropriate organisation and management of processes in production, trade and distribution.

For some time, policy discussions and legislative actions concerning pro-active food safety improvement initiatives have concentrated on:

a) the assurance of tracking and tracing of products; and
b) the implementation of the HACCP principles (USDA, 1997).

However, as both of these initiatives require enterprise activities for implementation, any regulations regarding their utilisation in the food sector require cooperation by enterprises. This is a crucial point in food safety assurance. Society (represented by policy) has responsibilities in the provision of food safety guarantees to its members, but has to rely on activities by enterprises to substantiate these guarantees (Figure 1.1).

In this scenario, the 'value' of society's guarantees depends on its ability to assure enterprises' cooperation (i.e. on the effectiveness of the sector control systems).

However, the enforcement of enterprises' cooperation through appropriate control systems has consequences for trade and constitutes, in principle, non-tariff trade

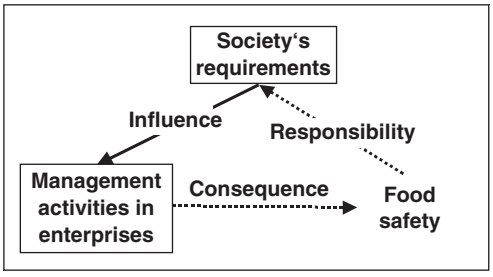

Figure 1.1 Chain of influence in food safety assurance.

barriers that have to adhere to European and international trade agreements. At the international level, the World Trade Organization (WTO) provides the umbrella for trade regulations, and allows introducing trade related regulations that avoid food safety hazards if backed by sufficient scientific evidence. An important reference in this context is the Codex Alimentarius Commission (FAO/WHO, 2003; Luning *et al*., 2002), a joint initiative by FAO and WHO. In its Codes of Practice and guidelines, it addresses aspects of process management including, as its most prominent recommendation, the utilisation of the HACCP principles.

This is the background on which the European Community could introduce its food laws (van der Meulen, 2014), based on a White Paper on food safety (EU, 2000) and a baseline regulation (EU, 2002) which require enterprises all along the food chain to formally implement the HACCP principles in their food safety assurance activities. An exception is agriculture which is exempt from realising a formal HACCP concept, but which should, anyway, follow the principles of the HACCP concept in implementing appropriate food safety controls.

1.4 Food quality – delivery concepts

In enterprises and food chains, the delivery of quality and quality guarantees that reach beyond food safety traditionally builds on four principal areas of quality activities, integrated into a systematic process of continuous improvement. These include:

a) the quality of enterprise management, as exemplified by the concepts of *total quality* or *total quality management* (TQM) (Oakland, 1998; Goetsch and Davis, 2012);
b) the quality of process organisation, frequently captured in the phrase *Good Practice*;
c) the quality of process management, usually phrased as *quality management*; and
d) the quality of products that could be captured through sensor technology, etc.

Discussions on the assurance of food quality in the food sector concentrate primarily on the quality of *process organisation* and *process management*, and combine it with specific requirements on product quality characteristics. This integrated view is based on the understanding that not all food product characteristics with relevance for quality could be identified and competitively evaluated through inspection of the final product. It refocuses attention from traditional product inspection to the prevention of deficiencies in food quality.

However, it should be noted that successful quality initiatives of enterprises usually build on leadership initiatives related (even if phrased differently) to the TQM approach, and with a strong focus on continuous improvement activities. In this scenario, the quality-oriented process management is an integral part of the more comprehensive management approach, and not a 'stand-alone' solution for the elimination of quality problems.

A quality-oriented *process management* is characterised by management routines as, for example, audit activities that support the organisation and control of processes to assure desired process outputs, with little or no deviation from output specifications (*process quality*). The integration and specification of these routines constitutes a *management system* or, with a view on the quality-focused objectives, a *quality management system*. Well-known examples include the standard series ISO9000 (Hoyle, 2006) or the HACCP principles (USDA, 1997; Newslow, 2013).

The traditional view of quality assurance in supply chains of any kind builds on the isolated implementation of quality management systems in individual enterprises, and assumes a sufficient consideration of quality objectives through the chain of supplier-customer relationships, in which each supplier focuses on the best possible fulfilment of quality expectations of its immediate customers (Spiegel, 2004).

However, this traditional view does not match with the specifics of food production and the requirements on quality assurance in the food sector. These specifics suggest that substantial improvements can only be reached through increased cooperation between stages regarding the specification of quality levels, agreements on process controls, and the utilisation of quality management schemes. This requires agreements on information exchange and the establishment of appropriate communication schemes.

Initiatives towards integrated food supply chains were a focus of developments during the 1990s, especially in export-oriented countries such as the Netherlands and Denmark (Spiegel, 2004). These developments were primarily initiated for gaining competitive advantage in a quality-oriented competitive market environment while improvements in the sector's food quality situation were initially of secondary concern.

1.5 Quality programs – steps towards sector quality agreements

1.5.1 Overview

A variety of initiatives in different countries have focused on the formulation of comprehensive *quality programs*, which ask for the simultaneous implementation of a set of activities in process organisation and process management that assure a certain level of food quality and safety in enterprises and food chains. These programs, also referred to as *quality systems* or (if restricted to process management) *quality management systems*, are of a universal, regional or national scope.

Principal examples with focus on food chains include (Schiefer, 2003):

a) initiatives on the basis of rather closed supply chains, such as the Dutch *IKB chains* (IKB for *Integrated Chain Management*) (Wierenga *et al*., 1997); and
b) sector-encompassing approaches that have little requirements on focused organisational linkages between enterprises, such as the German Q&S system (Nienhoff, 2003).

Specific alternatives are programs that evolved from retail trade. These do not involve the supply chain as a whole, but function as a quality filter for deliveries from supplier enterprises and the food chains to which these are connected.

1.5.2 A closed system concept – the case of IKB

The *IKB concept* is a chain management concept for food supply chains that was designed in the Netherlands in the 1980s for improvements in the efficiency and quality of food production. Its initial focus was on closed production chains, with a central coordinating body linked to processing industry (Wierenga *et al.*, 1997). Product deliveries into the IKB chains are restricted to enterprises that conform to certain quality requirements. A key example involves conformity to the Dutch standard series GMP (Luning *et al.*, 2002). Today's developments open the closed chain approach and move it closer towards a network system.

1.5.3 An open sector system concept – the case of Q&S

The system of Q&S addresses all stages of the vertical supply chain. However, it can be implemented by each individual enterprise on each stage, with the exception of agricultural enterprises that can only act as a group (Figure 1.2) and without any further coordination with the group's suppliers and/or customers.

The Q&S system is an open system, and its coordination is determined, in principle, by common agreements on the quality responsibility of the different stages. The approach tries to best adapt the food quality control activities to the actual market infrastructure that builds on open supply networks with continuously changing trade relationships. It places neither new organisational requirements on enterprise cooperation, nor restrictions on the development of individual market relationships within the supply chain.

The system preserves flexibility in market relationships between enterprises but, as an open flexible system, it does require substantial efforts to move the whole system to higher quality levels. Furthermore, the approach does not support the implementation of more advanced quality assurance systems of individual groups within the general

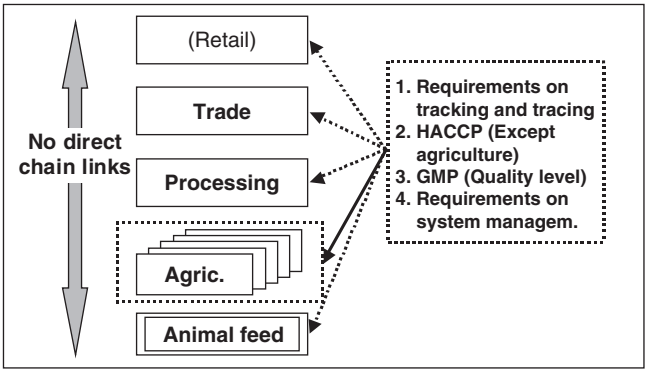

Figure 1.2 Q&S system organisation.

system environment. Such efforts would reduce the guarantee value of the general system for the remaining participants, and would contradict the interest of the system as a whole.

1.5.4 Trade initiatives

The retail sector has designed its own standards for requirements on quality activities in their supplier enterprises, including those from agriculture that deliver directly to the retail stage (for an overview see Hofwegen *et al*., 2005; van der Meulen, 2011). Examples include: the international active standard, *GlobalG.A.P.*, which focuses on agricultural enterprises (GAP: Good Agricultural Practice; GAP, 2016; Newslow, 2013), initially in the production of fruits and vegetables, and today in most agricultural production lines, the *IFS* standard (the *International Featured Standard*; IFS, 2016; Newslow, 2013), with a stronghold in Germany and France; and the *BRC* standard (Kill, 2012), the standard of the British Retail Consortium, which has influenced many quality initiatives in food supply chains in the UK and elsewhere.

Furthermore, a global retail initiative, the *Global Food Safety Initiative* (GFSI; Newslow, 2013) has formulated requirements on food safety assurance activities for retailer-based standards which, if requirements are met, receive formal acceptance status by the GFSI (Figure 1.3).

1.6 The information challenge

1.6.1 Information clusters

Both tracking and tracing capabilities, as well as the fulfilment of quality expectations at the consumers' end, depend on activities in enterprises throughout the supply chain and, as a consequence, on the collection of information from chain participants and its communication throughout the chain, with the consumers as the final recipients. This requires the availability of a feasible sector-encompassing communication infrastructure.

Traditionally, the organisation of information in enterprises builds on a number of information layers that correspond with the different levels of business management and decision support. They reach from transaction information at the lowest level, to executive information at the highest level (Turban *et al*., 1999). These layers are presently being complemented by two additional layers at the transaction level, that

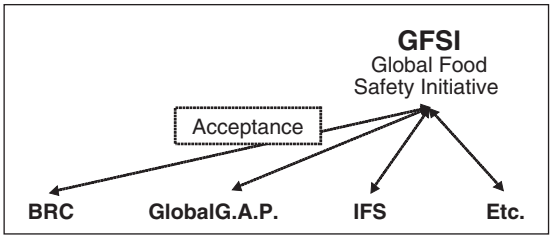

Figure 1.3 Relationships between retail quality initiatives.

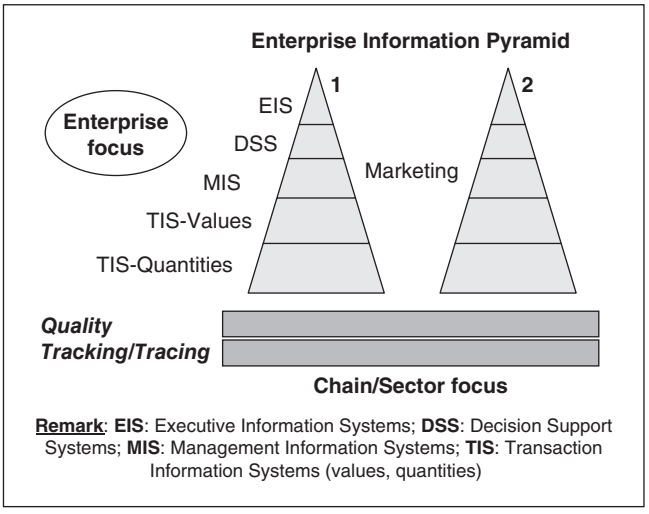

Figure 1.4 Information layers with enterprise (1, 2) and chain/sector focus.

incorporate information for tracking and tracing, as well as for quality assurance and improvement activities (Figure 1.4).

These new layers differ from traditional enterprise information layers due to their focus, which is not the individual enterprise but the vertical chain of production and trade. They are linked to the flow of goods and connect, in principle, the different stages of production and trade with each other and with the consumer. Their realisation depends on agreements between trading partners on responsibilities, content, organisation and technologies.

The layers were initiated by requirements for tracking and tracing capabilities from legislation (EU, 2002) and markets, and by increasing expectations of consumers regarding the quality of products and production processes. A number of European projects have dealt with tracking and tracing opportunities (e.g. project TRACE; www.tracefood.org), as well as with transparency requirements for meeting the emerging challenges towards sustainability, including food safety and quality (e.g. Project Transparent Food; www.transparentfood.eu; Schiefer and Reiche, 2013).

A sector encompassing general agreement is restricted to the lowest level of legal requirements. Any communication agreements beyond this level are subject to specific business interests, and might limit themselves to clusters of enterprises with common trading interests. In a network environment, individual enterprises might be members of different clusters, resulting in a future patchwork of interrelated and overlapping communication clusters (Figure 1.5).

The content of quality communication layers depends on the quality requirements of enterprises and consumers. However, the diversity of interests in a sector could generate an almost unlimited number of possible requirement sets – or, in other words, of needs for communication clusters. This is not a feasible approach.

In this situation, the quality requirements of quality programs could serve as a basic reference for the separation of communication clusters. First initiatives towards this end are under way. These developments will separate the sector's food production into

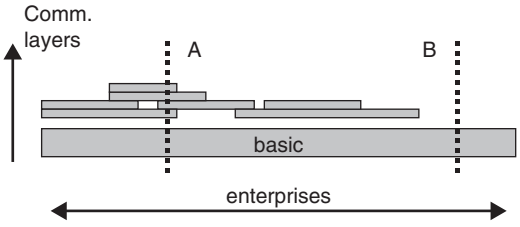

Figure 1.5 Agreed communication clusters with participation of enterprise A in five, and enterprise B in one of the clusters.

different segments with different quality guarantees. Examples are some of the retail-driven quality programs, such as the program 'Proplanet', by a major retail group (Proplanet, 2016), which builds on the establishment of a clearly defined supplier chain reaching from agriculture to retail, and provides information from each stage of the chain on a number of selected sustainability characteristics.

1.6.2 Organisational alternatives

The principal alternatives for sector-wide information infrastructures focus on two different dimensions. The information may be communicated between enterprises directly, or it may be communicated between enterprises through a common data network that is linked with enterprises' internal information systems. These approaches mirror classical network approaches, such as bus or ring network topologies (Turban *et al*., 1999).

Apart from establishing data networks, there is an additional alternative form of communication that avoids the communication of data, but communicates assurances that certain information is true. If enterprises are assured that their suppliers fulfil the requirements of a certain quality system, information linked to the requirements do not have to be communicated, and the assurance (e.g. in terms of a certificate) is sufficient. As information infrastructures for quality assurance are not yet established sufficiently, this last approach is still attractive and utilised with a number of quality programs (Reardon *et al*., 2001).

However, technological developments in internet technology, with its wireless networks and the *internet of things*, the establishment of *cloud services*, the ability to deal with *Big Data*, and the availability of advanced network devices such as sensors or intelligent smartphones with libraries of *Apps* for easy network access, are providing supporting means that will push the utilisation of information networks across the food sector. To this end, the European Commission has initiated the program *FI-PPP* (FI: Future Internet), which develops a European network and system development infrastructure (FIware; www.fiware.org), including stores of so-called *Generic Enablers* for supporting app development, and an experimental European-wide network for experimental use, as well as the simulation of scaling-up of applications. In addition, the program supports the development of more than 1000 apps that build on this technology, with more than 100 focusing on the food sector (see, for example, the accelerator projects FINISH – www.finish-project.eu; or SmartAgriFood – http://smartagrifood.com). It is expected that such initiatives will provide a major push towards the development of a transparent food sector.

1.6.3 Data ownership and data markets

With technology limitations becoming less a barrier, deficiencies in agreements on standardisation and content of data exchange receive increased attention. Dealing with data ownership and data utilisation has emerged as a major issue for clarification. At the moment, most data of interest are to be collected at early stages of the chain. These bear the costs of collection, while benefits of data utilisation are concentrated at later stages of the chain and, especially, at retail, with its link to consumers. A sustainable data exchange network needs to assure a balanced consideration of costs and benefits (Schiefer and Deiters, 2015).

One of the proposals discussed within the sector is to separate data from products, and to establish data markets separated from product markets. This may lead to products at retail with less or more information available, resulting in lower or higher market prices based on the argument that 'information has its price'.

A specific model based on a separation of data from products is realised in the *book and claim approach* (Greepalm, 2016), which is suitable for quality issues linked to differences in production systems, not in quality issues linked to measurable food characteristics. In this model, quality certificates for products from highly valued production systems, such as systems with positive environmental effects, may be sold independently from the actual product. Later stages of the chain may purchase the certificates and link them with products from other sources, while the initial products are sold without any quality premium. In the end, the market may receive products that are sold as being from environmental production supported by the respective certificate, while they are not. However, as the initial products will be sold without any quality premium, the balance is unchanged. The quantity of products with certificate resembles exactly the quantity of products produced under the preferred condition.

1.6.4 Added value of emerging information infrastructures

The quality interest of customers and consumers, the chain efficiency aspect, and the legal requirements on the tracking and tracing capability of the food chain, together provide the argument for the establishment of a sector-wide information infrastructure. However, newly emerging aspects of quality communication schemes involve the potential for possible added values that these infrastructures could provide. As an example, chain-focused extension services might utilise information from various stages, to arrive at recommendations for improvements in chain quality performance or chain efficiency.

All these benefits combined are the long-term matching part for the costs of a sector-wide information infrastructure.

1.7 Conclusion

Initiatives to improve tracking and tracing capabilities, as well as the delivery of trustworthy and stable quality products, are the means to control risks and to assure and develop markets. From this point of view, they are prerequisites for a sustainable economic position of enterprises in the food market. Considerations of public health and legal requirements support the development, and are not contradictory.

Increased globalisation, industrialisation and sophistication of food production and trade increase the need for improved process control, process management and communication inside enterprises, but especially between enterprises along the vertical food production chain. This requires substantial investments in: the design of new quality assurance concepts; in cooperation agreements throughout the sector; in the identification of accepted quality levels; in the allocation of quality assurance responsibilities; in the design and implementation of communication systems; and in the distribution of investment and operations costs.

This makes the move from the traditional view on quality production to today's requirements difficult, and a challenge for the sector – but a challenge that needs to be met.

References

EU (2000). *White Paper on Food Safety*. Report COM (1999) 719. EU-Commission, Brussels.

EU (2002). Regulation (EC) No. 178/2002 of the European Parliament and the Council. *Official Journal of the European Communities*.

FAO/WHO (2003). *Codex Alimentarius Commission*. Joint FAO/WHO Food Standards Programme, Food Hygiene Basic Texts. Rome.

Fritz, M., Schiefer, G. (2009). Tracking, tracing, and business process interests in food commodities: A multi-level decision complexity. *International Journal of Production Economics* **117**(2), 317–329.

GAP (2016). *GlobalG.A.P. standard* (www.globalgap.org).

Goetsch, D.L., Davis, S. (2012). *Quality Management for Organizational Excellence: Introduction to Total Quality* (7th Edition). Prentice Hall.

Golan, E., Krissoff, B., Kuchler, F., Calvin, L., Nelson, K., Price, G. (2004). *Traceability in the US food supply: economic theory and industry studies*. Report AER-830, USDA/ERS.

Greenpalm (2016). *GreenPalm* (www.greenpalm.org).

Henson, S., Hooker, N.H. (2001). Private sector management of food safety: public regulation and the role of private controls. *International Food and Agribusiness Management Review* **4**(1), 7–18.

Hofwegen, van G., Becx, G., Broek, van den J. (2005). *Drivers for competitiveness in agro-food chains: a comparative analysis of 10 EU food product chains*. Report, Wageningen University, (http://www.eumercopol.org).

Hoyle, D. (2006). *ISO 9000 Quality Systems Handbook*. Butterworth-Heinemann.

IFS (2016). *International Featured Standard* (www.ifs-certification.com).

ISO (2001). *ISO standards compendium: ISO 9000 – quality management*. ISO-Publisher, Genf.

Kill, R. (2012). *The BRC Global Standard for Food Safety: A Guide to a Successful Audit*, 2nd Edition. Wiley-Blackwell, Chichester.

Lobb, A.E. (2005). Consumer trust, risk and food safety: a review. *Food Economics* **2**(1), 3–12.

Luning, P.A., Marcelis, W.J., Jongen, W.M.F. (2002). *Food quality management – a techno-managerial approach*. Wageningen.

Newslow, D. (2013). *Food Safety Management Programs: Applications, Best Practices, and Compliance*. CRC Press, Boca Raton, FL.

Nienhoff, H.J. (2003). QS Quality and Safety: A netchain quality management approach. In: Schiefer, G., Rickert, U. (eds). *Quality assurance, risk management and environmental control in agriculture and food supply networks*, pp. 627–630. University of Bonn/ILB, Bonn.

Oakland, J.S. (1998). *Total quality management*. Melksham.

Proplanet (2016). *ProPlanet* (https://www.rewe-group.com/en/nachhaltigkeit/gruene-produkte/pro-planet).

Reardon, T., Codron, J.M., Busch, L., Bingen, J., Harris, C. (2001). Change in agrifood grades and standards: agribusiness strategic responses in developing countries. *International Food and Agribusiness Management Review* **2**(3/4), 421–435.

Schiefer, G. (2003). From enterprise activity 'quality management' to sector initiative 'quality assurance': development, situation and perspectives. In: Schiefer, G., Rickert, U. (eds). *Quality assurance, risk management and environmental control in agriculture and food supply networks*, pp. 3–22. University of Bonn/ILB, Bonn.

Schiefer, G.(2006). Computer support for tracking, tracing and quality assurance schemes in commodities. *Journal for Consumer Protection and Food Safety* **1**(2).

Schiefer, G., Deiters, J. (2015). Moving towards sustainability in food chains: dealing with costs and benefits. *International Journal on Food System Dynamics* **6**(1), 50–61.

Schiefer, G., Reiche, R. (2013). Transparency in Food Networks – Where to Go. *International Journal on Food System Dynamics* **4**(4), 283–293.

Spiegel, van der M. (2004). *Measuring effectiveness of food quality management*. PhD study, Wageningen University.

Turban, E., McLean, E., Wetherbe, J. (1999). *Information technology for management*. New York.

USDA (1997). *Hazard Analysis and critical control point principles and application guidelines*. Washington (www.cfsam.fda.gov).

van der Meulen (ed., 2011). *Private Food Law*. Wageningen Academic Publishers, Wageningen.

van der Meulen (ed., 2014). *EU Food Law Handbook*. European Institute for Food Law, Wageningen Academic Publishers, Wageningen.

Verbeke, W. (2005). Agriculture and the food industry in the information age. *European Review of Agricultural Economics* **32**(3), 347–368.

Wierenga, B., Tilburg, A.van, Grunert, K.G., Steenkamp, J.-B.E.M., Wedel, M. (eds, 1997). *Agricultural marketing and consumer behavior in a changing world*. Kluwer, Boston, MA.