CHAPTER 10

INFORMATION MANAGEMENT IN AGRI-FOOD CHAINS

G. SCHIEFER

University of Bonn, Meckenheimer Allee 174, D-53115 Bonn, Germany. E-mail: schiefer@uni-bonn.de

Abstract. The establishment and management of information infrastructures in chains and beyond is a prerequisite for the implementation of the emerging comprehensive requirements on tracking, tracing and quality assurance in agriculture and the food sector. They support the guarantee of food safety and the focus on consumers' quality needs. The challenge for the sector is the agreement on, and the implementation of, appropriate information infrastructures. The paper discusses the issue by extending the classical enterprise information hierarchy by two additional information layers that cross the enterprise boundaries and form a sector-wide information network.
Keywords: information management; chains; tracking and tracing; quality

PROBLEM SCENARIO

Traditionally, information management 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 (e.g. Turban et al. 1999). These traditional layers are presently being complemented by two additional layers at the lower, transaction, level that incorporate information for tracking and tracing and for quality assurance and improvement activities (Figure 1).

These new layers differ from traditional enterprise information layers by their focus. Their focus 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 the consumer. The layers were initiated by requirements from legislation and markets for:

a. tracking and tracing capabilities (see, e.g., EU regulation 178/2002); and
b. increased consideration of consumer needs and expectations regarding the quality of products and production processes.

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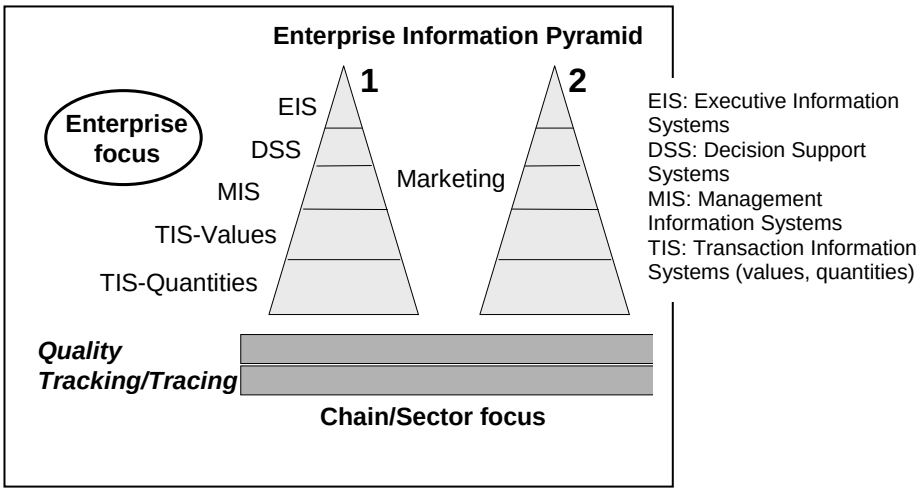

Figure 1. *Information layers with enterprise (1,2) and chain/sector focus*

Both, tracking and tracing capabilities as well as the fulfilment of quality expectations, depend on activities throughout the supply chain and, as a consequence, on communication between the various stages of the chain and the establishment of a chain or sector information infrastructure.

The implementation of tracking and tracing capabilities as well as the fulfilment of quality expectations involves chain and sector efforts and agreements on who does what, when, where and how. This complex scenario involves efforts on:

a. negotiation, mediation, engagement and investment;
b. the adaptation of process organizations to match the requirements on tracking, tracing and quality assurance;
c. the organization, management and operation of the information exchange including of necessary interfaces, data networks, data bases, data-processing activities, and data utilization through business intelligence products.

These efforts correspond with costs. The heterogeneity of the sector with its different but interlinked production lines and the diversity of enterprises place high costs on the negotiation, mediation, engagement and investment efforts. Furthermore, some parts of the sector, especially the commodity sector with its classical bulk products, might be forced to engage in major process reorganizations to meet expectations on its tracking/tracing capability and to keep costs in case of food quality failures under control.

Legal aspects put pressure on the sector to initiate the efforts. However, individual enterprises might consider the initiating costs too high when compared with potential individual market benefits from an improved tracking/tracing and quality assurance capability. They might disregard new opportunities for utilizing the infrastructure for improvements in quality assurance, chain coordination and chain management. As a consequence the sector might be forced to enter a step-by-step-development path that builds on individual development clusters of innovator

enterprises instead of identifying and implementing a comprehensive best solution. This could reduce the initiating costs but increase costs for the organization, management and operation of the information exchange.

In this paper, the main focus is on the organization, management and operation of the information exchange, summarized in the following as information management. In addition, it will take up some aspects of process organization that are closely interlinked with information-management issues and extend the discussion towards the potential benefits of the new information infrastructure.

The paper's main goal is to identify the need for information infrastructures that evolve from sector developments, to evaluate the managerial implications of potential and actual development alternatives, and to link the infrastructure developments with potential benefits beyond the actual development drivers.

THE FOCUS: INFORMATION INFRASTRUCTURE EXTENSION

The establishment of information infrastructures for enterprise communication is not a unique or new scenario. E-commerce and the digital exchange of trade documents in business transactions have been the focus of much attention in the agri-food business community since many years (Schiefer et al. 2003). However, the establishment of information infrastructures for tracking/tracing capabilities and quality assurance are different and much more complex tasks.

While agreements on the communication of trade documents primarily depend on agreements on technical specifications (see, e.g., the agreements on the EAN codes and the EDIFACT document exchange format (Kuhlmann 2003), communication on the new information layers is closely related to business policies in a competitive business environment. 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 patchwork of interrelated and overlapping communication clusters (Figure 2).

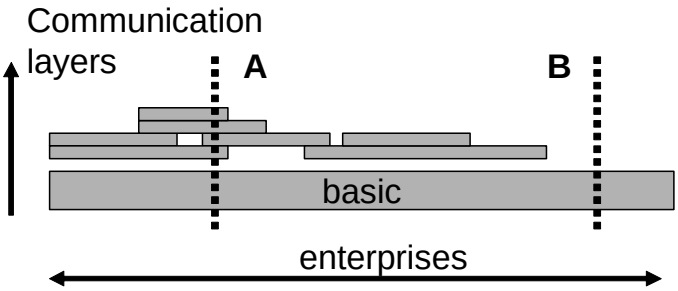

***Figure 2**. Agreed communication clusters and examples for enterprise participation in five (enterprise A) and one (enterprise B) of the clusters*

The feasibility and 'value' of the information infrastructure depend on participation of each individual enterprise within a group of similar interests. In a net chain environment with open and changing business relationships (Lazzarini et al. 2001), the level of legal tracking and tracing communication requirements may involve most of the enterprises within a certain food sector on a national or even global scale. The dependency between enterprises makes the value of the infrastructure dependent on the weakest link. This forces the sector into the establishment and management of a generally accepted and implemented basic communication layer that leaves room and provides the format for higher levels of agreements between participating subgroups.

This structural model might be the basis for a general sector solution or, alternatively, for independent infrastructure clusters that might be implemented independently of each other by different groups. From a sector point of view, the first alternative requires a higher degree of agreement throughout the sector but is characterized by simplicity in system organization and management. The second alternative allows individual initiatives to develop independently. This reduces the initial need for sector-wide agreements but adds coordination complexity in system organization and management. However, whatever the development path, the principal problems in the design, establishment and management of the information infrastructure are the same.

INFORMATION ORGANIZATION

Organization level: tracking and tracing

The information for tracking and tracing involves an enterprise and a chain dimension. The information is linked to the flow of goods. Within agri-food enterprises, traditional ERP (Enterprise Resource Planning) solutions do not support the monitoring of individual product items or individual batches in commodities. The integration of this aspect into ERP solutions is a software development issue that does not require any chain- or sector-wide agreement initiatives.

The major challenge is the monitoring of individual products or batches on their path through the vertical supply chain of trading partners. In trading environments with a well-defined and limited number of potential trading partners, as is the case with closed supply chains, the establishment of an appropriate information infrastructure could be built on agreements by the trading partner group (see Figure 3).

However, in a net chain environment with continuously changing trading partners, the chain communication model (Figure 3) represents agreements within one of the communication clusters of Figure 2 that need to build on a basic communication layer that extends the chain approach to the whole trading environment.

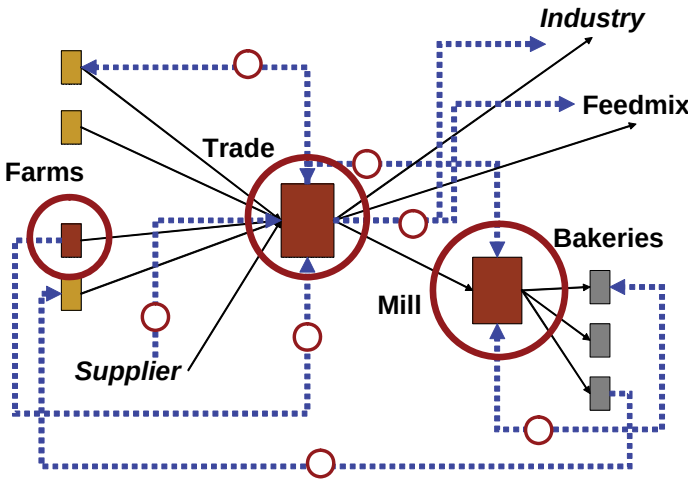

***Figure 3**. T&T information infrastructure for a chain-based tracking and tracing capability*

Organization level: quality assurance

The quality information layer adds content to the tracking and tracing capability. Information for the support of quality assurance of products towards the consumer as the final customer builds on enterprise-internal requirements, the requirements of the direct customer, and the requirements of the consumer as the final customer.

The diversity of interests could generate an almost unlimited number of possible requirement sets. However, the sector builds on a limited number of quality systems that incorporate certain sets of quality requirements (see, e.g., Krieger and Schiefer 2004). Some of these quality systems are widely accepted in the sector and incorporate an invaluable degree of agreement regarding the relevance of quality characteristics. Furthermore, some of these systems build on a chain view and cover the different stages of the supply chain. Examples are the IKB system in The Netherlands and the Q&S system in Germany. Other systems like the IFS system of retail focus on retail's immediate suppliers but influence, indirectly, the whole supply chain of the suppliers.

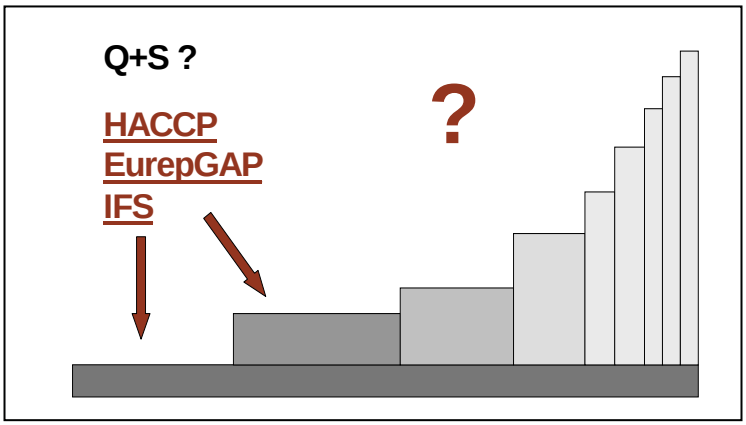

Figure 4. *Production segments with different levels of quality guarantees*

These quality systems could serve as a basic reference for different levels of quality communication within the quality information layer. First initiatives towards this end are under way. They include the organization of databases with enterprise information of groups of enterprises that participate in certain quality systems. The establishment of different levels of quality communication would separate the sector's food production into different segments with different quality guarantees (Figure 4).

To structure communication in a well-organized information infrastructure, one could take advantage of the fact that the quality aspects in quality systems correspond with four different layers of quality focus. The quality aspects in quality systems may focus on the quality of products, the quality of process organization, the quality of process management or the quality of enterprise management (Figure 5). This approach supports the integration of different quality systems.

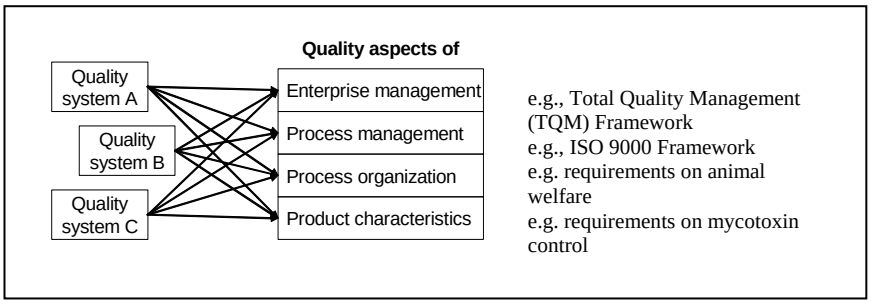

Figure 5: *Layers of quality focus (see Schiefer and Rickert 2004)*

INFORMATION INFRASTRUCTURE

The principal alternatives for sector-wide information infrastructures focus on two different dimensions.

The information may be communicated between enterprises through a common data network that is linked with enterprises' internal information systems (see Figure 6). Alternatively, the information may be communicated between enterprises directly as shown in Figure 3. These approaches mirror classical network approaches as, e.g., bus or ring network topologies (Turban et al. 1999).

The second dimension concerns the initiation of the communication. Information might be communicated on demand (trigger system) or, alternatively, the information might be communicated any time according to specified communication rules irrespective of actual needs.

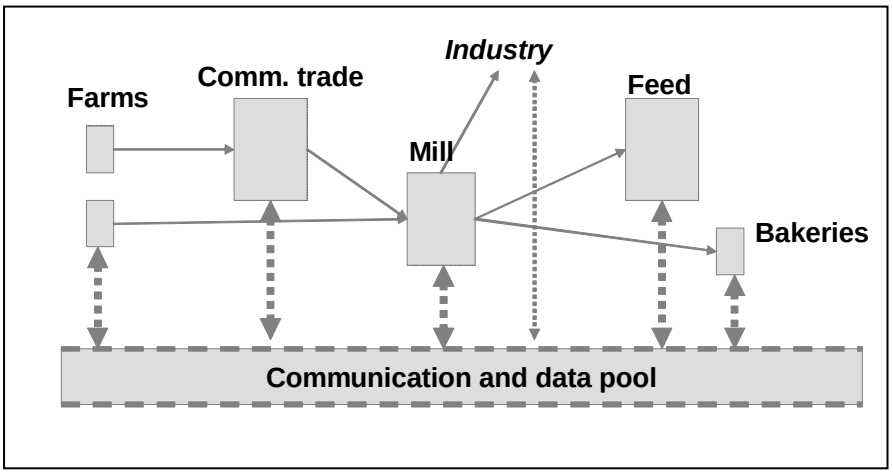

***Figure 6**. Sector-wide communication and data pool (example: grain chain)*

As a consequence, the information infrastructure could build on any of four organizational alternatives (Table 1).

***Table 1**. Information infrastructure alternatives*

	I: data pool communication	II: enterprise linkage
A: Trigger system	A-I	A-II
B: Rule system	B-I	B-II

The different information layers could follow different organizational approaches. Actual but not yet published developments focus on:

a. the organizational approach A-I for tracking and tracing purposes; and

b. the approach B-I for quality assurance communication.

The system alternatives A-II and B-II are reported from small groups of closely cooperating enterprises that directly link their ERP systems for data communication.

However, there is an additional alternative 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; 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 being implemented with a number of quality systems. An example is the Q&S system (Nienhoff 2004) (Figure 7).

ADDED VALUE OF NEW INFORMATION INFRASTRUCTURE

In judgments regarding the costs and benefits of the newly developing information infrastructure one needs to keep in mind that the existence of such an infrastructure would greatly facilitate the implementation of a variety of information services for business support.

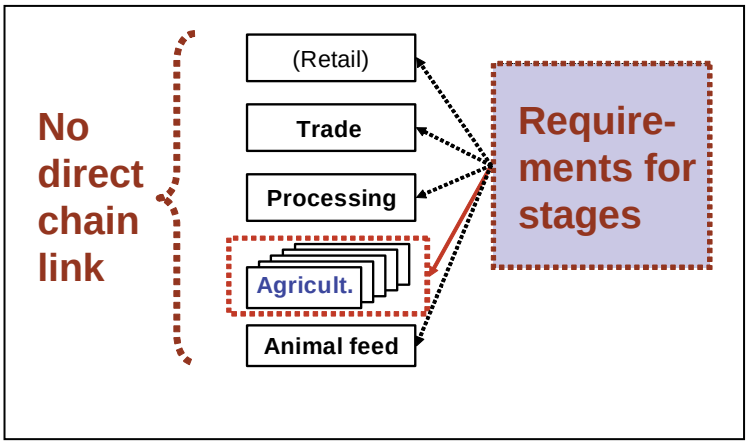

Figure 7. *Communication through certification regarding the fulfilment of requirements (see Schiefer 2004)*

Typical and basic examples include:

a. the organization of chain focused consulting services;
b. the communication of quality guarantees to consumers;
c. the establishment of a chain inventory management activity.

The new information layers provide the information basis for chain-focused consulting (extension) services regarding improvements in quality. As an example, the quality information layer could incorporate production information from farms as well as information from processing regarding the suitability of farm deliveries

etc. This information combined and related to external information from other sources might better enable consulting services to advice farms on changes in production processes.

The communication of quality guarantees to consumers beyond what is available on labels has gained interest with food enterprises. As a basic example, the ability to offer consumers a chance to check for themselves the origin of their products (e.g. farms) or a product's supply-chain path might become a competitive business advantage (see, e.g., Boeve 1999; Schiefer et al. 1999).

The establishment of a chain inventory management activity is a first step towards more sophisticated chain management initiatives that might utilize the new information infrastructure. Chain inventory management builds on the exchange of information on the availability of inventories at the various stages of the supply chain. As an example, a grain-processing enterprise might greatly benefit in its own production and sales' activities from information on grain inventories and their quality in its supplier farms.

All examples involve certain aspects of chain management for improved chain efficiency that depend on the availability of an information infrastructure. The quality interest, the chain management 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. These benefits combined are the long-term matching part for the costs of a sector-wide information infrastructure.

CONCLUSION

The need for new management approaches in food supply chains, especially regarding food safety guarantees and quality assurance activities, requires new initiatives in information management. At the core of interest is the need for new information layers that utilize enterprise information but focus on the communication between chains for quality assurance towards the consumer as the final customer and for improvements in risk management and tracking or tracing capability in case of problems in food safety or quality.

As some of these aspects have become legal requirements, the sector is forced to act. However, as the balance of costs and benefits for individual enterprises regarding general sector solutions might be low or even negative, it is suspected that solutions will have to build on a network of enterprise clusters of limited size that are easier to coordinate for utilizing some of the potential benefits of the new information layers that reach beyond basic legal requirements and might involve improvements in food quality, in tracking and tracing, and in chain efficiency.

Several projects not yet published in literature are under way. They might serve as a basis for a sector-wide network of clusters, a semi-optimal but feasible solution for meeting the sector's information management needs in the future.

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