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Traceability and Certification in Meat Supply Chains

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Food safety problems such as the BSE and dioxin crises focused attention on traceability systems and the certification of such systems. This study analyzes the status and perspectives of traceability systems and certification schemes, and reviews their potential costs and benefits. Results indicate that traceability and certification in meat supply chains comprise a very dynamic area with an increasing impact. Necessary transparency, control of livestock epidemics, increasing due diligence, and a declining role for governments are critical factors. Findings also reveal there is a general focus on the technical characteristics of traceability and certification, and there is a lack of economic considerations. Therefore, specific topics are emphasized for an economic research agenda, such as an analysis of the break-even point for the level of detail of traceability systems, the reconsideration of liability and recall insurance schemes, and regulatory incentives to motivate adoption by free-riders.

Key Words: certification, cost-benefit analysis, livestock production, supply chain, traceability

Food safety scandals such as the dioxin crisis in the Dutch poultry sector and the bovine spongiform encephalopathy (BSE) crisis in the beef sector in several European countries, initially in the United Kingdom, have heightened consumers' concerns about food safety. A major aspect of the scandals was that the contamination was not immediately detected. Furthermore, after detection, the exact source of contamination was difficult to identify within a reasonable time period. As a consequence, there was a distrust in the safety of the food still remaining in the food stores.

In January 2000, the European Commission (EC) outlined radical new principles for food safety in its "White Paper on Food Safety," and a few months later specified these principles in a proposal for new food safety hygiene rules. These rules (among other things) state that food safety is the primary responsibility of food producers.

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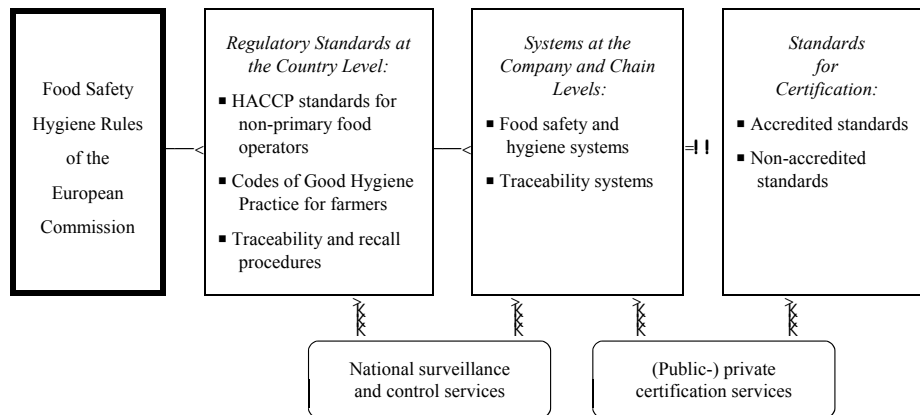


Figure 1. Relationship between the food safety hygiene rules and standards for certification

Linked to this responsibility is an obligation for non-primary food operators to implement Hazard Analysis and Critical Control Point (HACCP) systems and for farmers to implement sector-specific Codes of Good Hygiene Practice. Furthermore, the EC principles specify that all food and food ingredients should be traceable, and proper recall procedures should be in place for food that presents a serious risk for consumers' health.

The food safety hygiene rules do not mention the need for certification of "good manufacturing practices." Still, certification of the type of systems required by the hygiene rules is becoming increasingly important throughout supply chains. Figure 1 illustrates the relationship between the food safety hygiene rules issued by the European Commission and the (accredited) standards used for certification. As seen from figure 1 (from left to right), the food safety hygiene rules lead to regulatory standards at the country level for HACCP, codes of good hygiene, and traceability and recall procedures. Next, national standards are "translated" into food safety and hygiene systems and traceability systems at the company and chain levels. National surveillance and control services monitor whether the implemented systems fulfill the regulatory standards. In addition, (public-) private certification services can certify the systems using various accredited and non-accredited standards.

This study focuses on the right-hand side of figure 1, and more specifically on traceability and certification. The objectives are to analyze the status and perspectives of traceability systems and certification schemes, and to review their potential costs and benefits. In the following two sections, we describe purposes, requirements, status, and perspectives of traceability systems and certification schemes, respectively. An overview of producers' potential costs and benefits is then presented. Conclusions are given in the final section, as well as a detailed listing of important topics for consideration in the development of an economic research agenda in the field of traceability and certification in meat supply chains.

Traceability Systems

Definition, Purpose, and Requirements

A traceability system provides a set of data about the location of food and food ingredients along the supply chain. Data relate to both the “where” and “when” issues. There are various relevant elements. Tracing is the ability to trace food and food ingredients back along the supply chain, i.e., from the end user to the producer and even to the suppliers of the producer. Tracing is aimed at finding the history of a product, for example, to identify the source of contamination. Tracking refers to the ability to track food and food ingredients forward along the supply chain. Tracking can be used to find and recall products determined to present a serious risk to consumers’ health. Identity preservation is the set of measures taken to preserve and communicate the exact identity and source of food and food ingredients to the end user.

Traceability systems can be set up with different purposes in mind—for example, to *increase transparency* in the supply chain. More transparency, for instance, about the country of origin, is likely to increase consumers’ trust in food safety. In this respect, Gellynck and Verbeke (2001) found consumers especially value the functional attributes of traceability systems, such as the monitoring of chains and the opportunity to address individual chain participants’ responsibility in case of abuses.

A traceability system can also be implemented to *reduce the risk of liability claims*: a proper traceability system is a valuable tool for companies to counterattack liability claims and to recoup claims from other participants in the supply chain. In addition, traceability systems can be developed to *improve recall efficiency*. With an adequate system, the quality of recalls can be improved, thereby reducing costs and enhancing the image of the supply chain. Finally, traceability systems *enhance the control of livestock epidemics*, since the systems provide insight into animal movements between farms. A quick overview of these high-risk contacts is crucial in effectively controlling livestock epidemics such as foot-and-mouth disease.

For a traceability system to be adequate, a number of requirements must be met. First, all partners within the supply chain should be identifiable—including small producers and hobby farmers. The latter are especially important if the traceability system is used for the control of livestock epidemics (Disney et al., 2001). Also, there should be a unique animal identification system (McKean, 2001), usually aggregated to an identification system for batches of animals as soon as the processing level is reached. Furthermore, an adequate traceability system requires a credible and complete (in the sense of what has been agreed on) information transfer among all participants in the supply chain.

Current Status

Three different types of traceability systems can be distinguished, as outlined in figure 2. In system “A,” each link in the supply chain gets its relevant information from the previous link. The advantage of this type of system is that the amount of

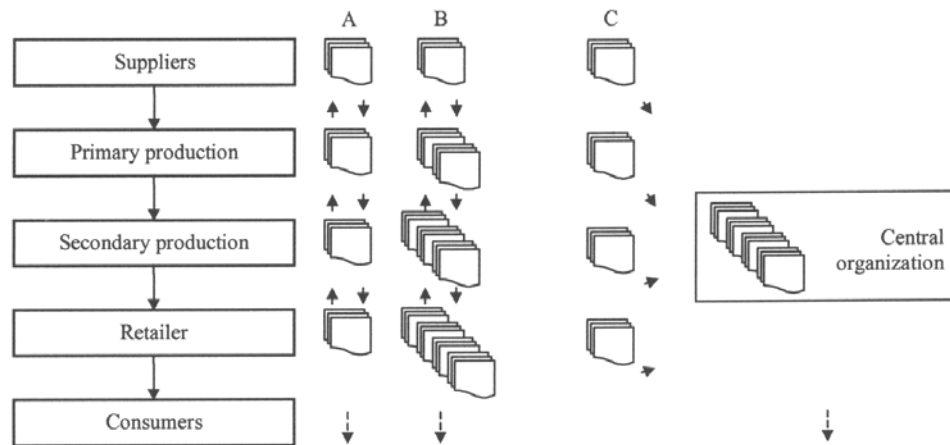


Figure 2. Traceability systems in supply chains

information to be communicated remains small, which reduces transaction costs. The disadvantage is that this system is largely based on trust; each link must trust the previous link on both the quantity and quality of the information passed. Furthermore, in case of an emergency, all links need perfect administration in order to act quickly.

In system "B," each link receives the relevant information from all former links. With these systems, the speed at which tracking and tracing can be handled is much higher than with systems of type "A." Moreover, because each link in the chain receives all other information, the information can be controlled for completeness. Also the chain's transparency seems larger than with system "A." A disadvantage of system "B" is that the amount of information to be transferred increases per link.

In the third type of system ("C"), each link of the supply chain provides the relevant information to a separate organization, which combines all the information for the entire supply chain. Such organization can resolve the matter of trust. Also, tracking and tracing can, in principle, be carried out very rapidly. Further, since the organization is dedicated to the system, the danger of the system not being well maintained because of lack of time or other resources is minimized. On the other hand, total costs may be larger.

An example of a traceability system of type "C" can be found in the European beef industry. Due to the BSE crisis, the beef industry put into place a basic version of a traceability system: each package of beef contains information about the country of origin of the animal, the country of growing, the country of slaughtering, and the country of butchering. To provide this information, individual countries have identification and registration (I&R) systems in place. In the Netherlands, for instance, each cow receives a unique life number at the moment of birth and two yellow ear tags on which this number is visible. The unique life number is registered in a central database together with some additional information, such as the unique farm code of the farm of birth. When the calf or cow leaves the farm, this transfer must be registered by both the delivering and the receiving party through the use of an automatic voice-dialing system. In this way, a cow can, in principle, be traced back

and tracked forward at any moment in time. In the United Kingdom, the eartags are combined with a cow passport, which accompanies the cow for his or her complete life (Pettitt, 2001). A similar system is in place for pigs, although they are not registered on an individual level, but on a batch level, using earmarks with the unique farm number.

Experiences during the 2001 foot-and-mouth disease crisis in the Netherlands served to illustrate that the I&R system for cattle was not (yet) foolproof, since not all cows appeared to be part of the system. Such gaps considerably delay the tracing and tracking of possibly infected contact herds. In contrast, the 2002 experience with the Medroxy Progesteron Acetate (MPA) crisis in Dutch pig feed confirmed that the traceability system in the pork chain worked well for tracking (and blocking) 26 Dutch pig farms who bought the particular feed. The system also performed well in tracing back to the source of contamination. Identifying the “source company,” however, was not sufficient for the blocked farmers to receive any compensation for their losses. Only a few examples are documented of experiences associated with tracing back the history of contaminated consumer goods. Alert systems generally tackle the problem at an earlier stage—but, repeatedly, not early enough to protect the public before they have consumed the contaminated product.

Future Perspectives

Technical developments are likely to improve compliance and usability of traceability systems. In the near future, the eartag system of different farm animals might be replaced by radio frequency identification devices (RFIDs) (Ribó et al., 2001). In the Netherlands, the feasibility of RFID systems is being investigated for cattle, pigs, goats, and sheep. A further (and already on a small scale applied) technique is the use of biological markers. Using DNA strains from individual animals, it becomes possible to trace back (combined) meat products to individual animals as long as the DNA structure has not been damaged due to treatment such as heat (Cunningham and Meghen, 2001). Immunological identification seems a promising technique to identify batches of smaller animals such as chickens. With this technique animals respond to treatment with some known protein. An advantage of techniques such as immunological identification and the use of DNA is that it is possible to assess the identity of (batches of) animals from any part of an animal’s carcass. Furthermore, the identity of animals cannot be altered through illegal handling by humans.

In addition to new techniques to advance traceability systems, we also expect some further applications. One might be the logistic slaughtering of animals based on historical data about the prevalence of microbiological contamination of the animals or farms—for instance, with respect to *Salmonella*. A further application includes more detailed assessments of animal breeding values based on information about the production and offspring of individual animals. Traceability systems may also be used in the future for the inclusion of extra information, e.g., with respect to the primary production circumstances (living conditions, use of medicines) of animals. Such additional information enhances product differentiation and branding.

Certification Schemes

Definition, Purpose, and Requirements

We define certification as follows: Certification is the (voluntary) assessment and approval by a (accredited) party on a (accredited) standard. As this definition suggests, “certification” is a very broadly used term. However, it certainly involves an assessment and an approval of some standard. The “approval of good practice” distinguishes certification from the activities by national surveillance and control services (figure 1), which do not go any further than evaluating if implemented systems at the company and chain levels fulfill the regulatory standards.

Certification is, in general, voluntary. However, there are also cases in which it is “quasi-voluntary”—for example, if it is a customer’s requirement or if there are price disadvantages from not participating in a certification scheme (Payne et al., 1999; Bredahl et al., 2001). Also, risk financing organizations, such as banks and insurance companies, may require some form of certification in their underwriting policy (Bullens, van Asseldonk, and Meuwissen, 2002; Skees, Botts, and Zeuli, 2002). In relation to the certifying party and the standard used for certification, it can be stated that if an accredited standard is used, the certification procedure needs to be carried out by an accredited party (Tanner, 2000). All other types of standards can be certified by either accredited parties, (other) third parties, such as product boards and interest groups, or customers (also called “second parties”).

Figure 3 gives an overview of the various certifying and certifiable parties in meat supply chains. The dashed line linking “accredited party” with “other third party” and “second party” refers to the fact that an accredited party can be employed by any other party to carry out certification audits.

The purpose of certification is to reach a defined performance and to make this known to stakeholders. Stakeholders may include consumers, (other) customers, governments, risk financing parties (such as banks and insurance companies), and society as a whole. Also, the company itself can be a stakeholder, since certification of food safety and traceability systems gives organizations a tangible approval of good practice and a tool for a due diligence defense in the case of product safety (see, e.g., Buzby and Frenzen, 1999; Henson and Holt, 2000).

For stakeholders to regard certification as a valuable tool, they must trust the certification scheme as well as the certifying party. Further, there should be regular tests or audits (usually specified in the certification scheme) to verify whether the certified party still achieves the agreed performance level.

Current Status

Many certification schemes fit within the context of the food safety hygiene rules noted in figure 1. Table 1 lists a number of examples for meat supply chains, including the scope of schemes and, for accredited standards, the underlying International Standardization Organization (ISO) and European Norm (EN) guidelines.

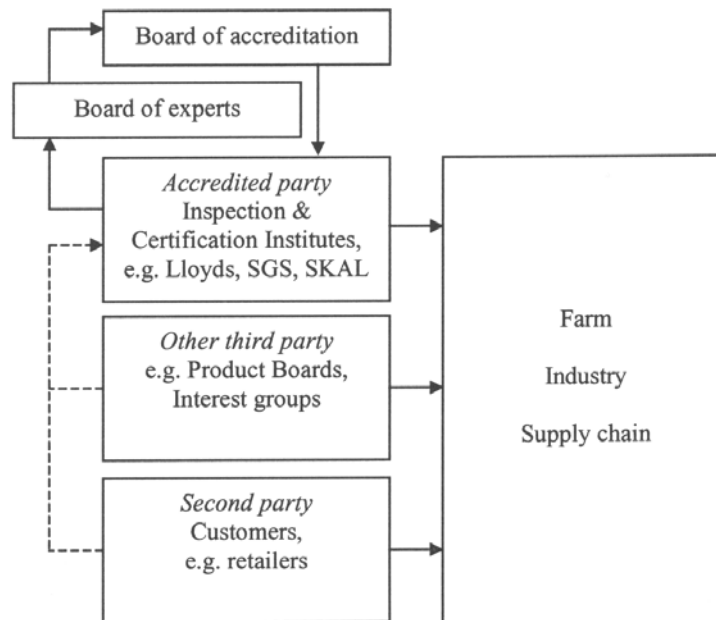


Figure 3. Certifying parties (left) and certifiable parties (right) in meat supply chains

As for the accredited standards, schemes linked to ISO39/EN45004, such as BRC-issue 2 (table 1), are *inspection* schemes, based on a checklist, and are in principle only valid on the day of inspection. ISO65/EN45011-based schemes, such as EKO, are *product* certification schemes in which processes as well as products are tested on specified standards. They enable visible claims on the end product, such as the EKO label. Certification schemes based on ISO62/EN45012, such as ISO 9001:2000, are *system* certification schemes in which system requirements are used to evaluate complete management systems.

Because product and system certification schemes do not use straightforward checklists, individual auditors' interpretations become increasingly important with these types of schemes. For instance, the EKO certification scheme for livestock production states that "pig breeding systems should allow sows direct access to the soil ... except where bad weather or unsuitable soil conditions make housing preferable." An auditor must judge whether the housing circumstances at a farm fulfill these requirements. Under the HACCP criteria, it is required to "identify hazards" and to "carry out risk analyses." Controls developed by the national Board of Accreditation must be carefully crafted to prevent large interpretation differences between individual auditors, both in a national and an international context.

From the listing of non-accredited standards in table 1, "Retailer 'X' approved pork supplier" illustrates the potentially large number of standards needing to be met by supply chain participants. However, instead of introducing such customer-specific standards, most customers adhere to the standards already implemented and monitored.

Table 1. Examples of Certification Schemes in Meat Supply Chains, Their Scope, and Underlying ISO/EN Guidelines

Standards	Scope	ISO/EN
Accredited Standards:		
BRC-issue 2 (British Retail Consortium) ^a	Suppliers of retailer branded food	39/45004
EUREP-GAP (Good Agricultural Practices) ^b	Farm	65/45011
Sector-specific Codes of Good Hygiene Practice	Small- and medium-sized enterprises	65/45011
EKO (organic)	Chain	65/45011
IP (Identity Preserved)	Chain	65/45011
Q+S (Quality and Safety System), Germany	Chain	65/45011
SQF (Safe Quality Food)	Chain	65/45011
HACCP criteria, Netherlands ^c	Any chain participant	62/45012
ISO 9001:2000 on quality	Any chain participant	62/45012
ISO 14001 on environmental issues	Any chain participant	62/45012
OHSAS 18001 on occupational health and safety	Any chain participant	62/45012
HALAL (Islamic)	Chain	62/45012
Non-Accredited Standards:		
"Retailer 'X' approved pork supplier"	Processing companies	NA
GMP+ (Good Manufacturing Practices), Netherlands	Feed companies	NA
KKM (Chain Control Milk), Netherlands	Chain	NA
IKB (Integrated Chain Control), Netherlands	Chain	NA
Label Rouge, France	Chain	NA
British Farm Standard, United Kingdom	Chain	NA
QSG (Danish Quality Guarantee), Denmark	Chain	NA

Notes: ISO = International Standardization Organization; EN = European Norm; ISO39/EN45004, ISO65/EN45011, and ISO62/EN45012 are comprised of inspection schemes, product certification schemes, and system certification schemes, respectively; and NA = not applicable.

^a The most recent version of BRC, i.e., BRC-issue 3 (April 2002) can only be accredited under ISO65/EN45011.

^b EUREP-GAP "livestock" is under development, so officially not yet accredited.

^c The HACCP criteria ("Criteria for the Assessment of an Operational HACCP System") are certifiable under the Dutch Board of Accreditation. A worldwide certification scheme of HACCP is in progress (i.e., ISO22000).

With regard to certifying supply chains, table 1 lists a number of examples both under the accredited and the non-accredited standards. For the accredited standards, chain certification implies that each chain participant acquires the certification scheme under consideration. For instance, under the Islamic HALAL scheme, each participant in the chain is certified HALAL. For the non-accredited standards, chain certification generally implies that there are specific requirements for subsequent stages in the chain. For example, with the Netherlands' Integrated Chain Control (IKB) scheme, farmers may only acquire feed from "Good Manufacturing Practices" (GMP+) feed companies, veterinary services from "Good Veterinary Practices" (GVP) veterinarians, and animals should be slaughtered in "IKB complying slaughterhouses."

Standards are not always country specific. For instance, it is possible for a German dairy farmer to produce under "Chain Control Milk" (KKM) standards in order to deliver milk to a Dutch dairy processing company. Likewise, a Dutch pig farmer can

be “Quality and Safety” (Q+S) certified and deliver to a German slaughterhouse. The Q+S certificate will be issued under the German Board of Accreditation. Similarly (as an extreme example), if an Australian slaughterhouse is seeking to be certified against the Dutch HACCP criteria, the certification process can be carried out by Dutch auditors under the auspices of the Dutch Board of Accreditation.

Based on a review of the various certification schemes detailed in table 1, clearly the issue of certification is a very dynamic area. Standards constantly evolve. For instance, the British Retail Consortium (BRC) standard is moving from an ISO39/EN45004 to an ISO65/EN45011 scheme. Also, EUREP-GAP—“Good Agricultural Practices,” originally introduced for fresh produce—is now being developed for live-stock. Similarly, standards such as KKM and IKB undergo annual updates. Furthermore, beginning in 2003, GMP+ audits in feed companies are no longer carried out by the product board for feed, but by accredited parties.

Also, for reasons of credibility, supply chains increasingly endeavor to base certification on accredited standards. In this respect, product-market organizations appear promising. Such organizations provide a less expensive method for supply chains consisting of multiple small entities (as is the case for the majority of meat supply chains in Europe) to collectively attain accredited certification, in contrast to certification of each small unit individually. Schemes based on ISO65/EN45011 fit within this context. The “product-market organization vehicle” is illustrated in figure 4.

Accredited certification of a product-market organization has a number of characteristics. First, there is one chain director—for instance, a slaughterhouse, or possibly an individual farmer. Second, the certification scheme is issued to the chain director for the full scope of the chain. Third, chain participants are monitored by the chain director and sampled by the certification institute. Although promising, accredited product-market organizations have yet to be successfully implemented in meat supply chains. A recent initiative in the Dutch poultry chain with a slaughterhouse as chain director did not succeed, mainly because farmers were afraid of too much control by the slaughterhouse.

Future Perspectives

Elaborating on current developments, we argue that the importance of certification will continue to strengthen. Governments increasingly shift responsibilities to companies under the initial assumption that certified products, processes, and systems are in conformity with regulatory standards. In practice, standards used for certification go beyond the legislative provisions. Certification will also become more important as due diligence becomes increasingly vital, not only with regard to food safety issues, but also in the field of livestock epidemics.

Furthermore, we expect the role of retail organizations will increase, leading to standards such as EUREP-GAP (“Good Agricultural Practices”), introduced by the European retailers’ organization. Benchmark models such as the Global Food Safety Initiative (GFSI), established by the International Food Business Forum, assist in *standardizing the standards*—contributing to the effort to manage the increasing number of standards and certification schemes.

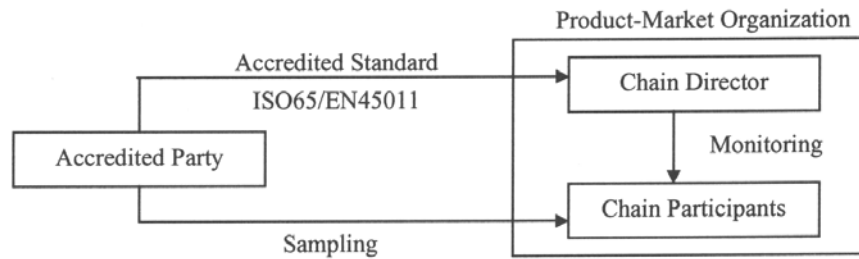


Figure 4. Accredited certification of a product-market organization

Costs and Benefits

Table 2 provides an overview of producers' costs and benefits associated with food safety and hygiene systems, traceability systems, and the certification of these systems. The table does not distinguish between the various types of systems and certification schemes.

Most items in table 2 are fairly straightforward. Specific attention, however, should be paid to the costs and benefits noted for certification. Often these costs and benefits are commingled with those of the systems themselves. The three benefits denoted with a question mark—the positive effect on trade, the enhanced license to produce, and the price premium—are discussed below in more detail. The magnitude of these aspects is debatable.

In principle, the effect on trade is positive since food safety and hygiene systems and traceability systems are indicators of the quality and background of a product. Certification further facilitates the communication about the product. Nevertheless, the effect on trade can be negative if trading partners do not trust each other's systems and certificates and use them to set up trade barriers. There will be fewer problems related to trust if accredited standards and accredited certification institutes are involved.

"Enhanced license to produce" is the second benefit denoted with a question mark. While stating that this "license" is enhanced by introducing the types of systems and schemes under consideration is probably true, the question is *for how long*? As soon as the public is accustomed to the upgraded market, new requirements are likely to be introduced. Discussions addressing the "license to produce" became topical in countries such as Germany and the Netherlands, following epidemics of BSE, foot-and-mouth disease, classical swine fever, and avian influenza.

Finally, uncertainty is also involved with the benefit to producers of consumers paying a price premium for food safety-related systems and certification schemes. In general, food safety is perceived as important, at least in developed countries (Unnevehr, 2000). Moreover, consumers have frequently indicated they are willing to pay a higher price for safer food (see, e.g., Henson, 1996). However, actual buying decisions show it is mostly economic convenience that matters, not the presence

Table 2. Potential Costs and Benefits of Food Safety and Hygiene Systems, Traceability Systems, and Certification for Producers in Meat Supply Chains

Food Safety & Hygiene Systems	Traceability Systems	Certification
— POTENTIAL COSTS —		
<ul style="list-style-type: none"> ■ Implementation: <ul style="list-style-type: none"> – Development – Training – Capital purchases ■ Maintenance: <ul style="list-style-type: none"> – Verification and validation – Record keeping – Enhanced operational processes 	<ul style="list-style-type: none"> ■ Implementation: <ul style="list-style-type: none"> – Transforming processes – Less flexibility – Automation – Extra storage, production materials, personnel, and documentation ■ Maintenance: <ul style="list-style-type: none"> – Audits 	<ul style="list-style-type: none"> ■ Implementation: <ul style="list-style-type: none"> – Audits ■ Maintenance: <ul style="list-style-type: none"> – Audits
— POTENTIAL BENEFITS —		
<ul style="list-style-type: none"> ■ Improved internal efficiency through more explicitness about tasks, responsibilities, and authorities of employees ■ Less failure costs, i.e., recall, closure, scrap, and liability costs ■ Positive effect on trade (?) ■ Enhanced license to produce (?) ■ Price premium (?) 	<ul style="list-style-type: none"> ■ Increased transparency ■ Reduced risk of liability claims ■ More effective recalls ■ More effective logistics ■ Enhanced control of livestock epidemics ■ Positive effect on trade (?) ■ Enhanced license to produce (?) ■ Price premium (?) 	<ul style="list-style-type: none"> ■ Reduced transaction costs from supplier identification, contract negotiation, verification, and enforcement ■ Enhanced access to insurance and finance ■ Effectuated due diligence ■ Positive effect on trade (?) ■ Enhanced license to produce (?) ■ Price premium (?)

Various Sources (among others): Caswell and Hooker, 1996; Roberts, Buzby, and Ollinger, 1996; Bredahl and Holleran, 1997; Crutchfield et al., 1997; Early and Shepperd, 1997; Jensen, Unnevehr, and Gómez, 1998; Jensen and Unnevehr, 1999; Golan et al., 2000; Henson and Holt, 2000; Unnevehr, 2000; Bredahl et al., 2001; and Bullens, van Asseldonk, and Meuwissen, 2002.

of some label (Blend and van Ravenswaay, 1999; Vastola, 1997). Implemented systems and certification schemes are generally perceived as part of the license to produce, notwithstanding the existence of niche markets.

In addition to the debatable magnitude of some specific aspects, a relevant consideration in estimating the size of all costs and benefits listed in table 2 is the definition of the reference point, or the “without project alternative” (Belli et al., 2001). A primary aspect of this consideration relates to the type of systems already in place. For instance, additional costs and benefits of implementing a HACCP system can be expected to be lower if there is already some sector hygiene code in place. Also, other characteristics of the meat supply chain, such as the structure of the chain, will affect the size of costs and benefits (Golan et al., 2000). For example, implementing a traceability system in an integrated chain, such as the veal chain in the Netherlands, will be less costly than implementing a similar system in a patchy and dispersed chain such as the Dutch dairy cattle sector. A further relevant aspect is the size of farms and industries involved. Costs are likely to be nonlinear; specifically, there is a possible comparative disadvantage for small- and medium-sized enterprises [as also noted by Unnevehr and Jensen (1999), and by Taylor (2001)].

Conclusions and Suggested Economic Research Agenda

From this study, we conclude that traceability and certification comprise a very dynamic area in which new techniques are being introduced and standards rapidly evolve. Furthermore, the impact of traceability and certification is expected to increase—at the company and farm levels, the chain level, and for society as a whole. Necessary transparency, control of livestock epidemics, increasing due diligence, and withdrawing governments are leading contributors in this trend.

However, our findings also suggest that developments are more often guided by technical prospects than by economic considerations, which may lead to an undesirable allocation of resources. We therefore suggest the following topics of emphasis in developing an economic research agenda (presented in arbitrary order).

- *Break-even Point of Traceability.* In an economic design of a traceability system, one should question the desired level of detail of the system; i.e., is it efficient to be focused on a system “as detailed as possible” or is there some break-even point? Relevant issues are whether it is necessary to be able to trace back to individual animals, or is tracing back to the herd level sufficient? Furthermore, is it necessary to track forward to all individual customers who received specific products, or would it be adequate to work with day and batch codes so that products can be recalled at a higher level?
- *Acceptable Level of Risk in Traceability.* A further consideration relates to the acceptable level of risk of traceability systems. “Acceptable level of risk” is a common term in food safety systems, but apparently not in traceability systems. The main question here is whether supply chains need to be able to track and recall all products in one way or the other, or whether they could, for instance, rely on some alert system at the end of the chain.
- *Participation in Traceability Systems, I.* Whether efforts in traceability systems reach the desired level of performance largely depends on the participation of the entire supply chain. However, an often-used argument not to participate is: “We suffer the costs while others capture the benefits.” A more profound insight into the distribution of costs, and especially the multiple benefits of traceability systems, may stimulate more (committed) participation (see Verbeke, 2001).
- *Participation in Traceability Systems, II.* A quantitative insight into the costs and benefits of traceability still may not prompt farmers to participate. Farmers face potentially high claims from larger companies downstream in the chain while they have only limited financial means themselves to counterattack such claims. There may be a reluctance to participate when there is a risk of cross-contamination during processing. Better tools for due diligence, for instance through product-market organizations, may resolve this impasse. Special attention should be paid to hobby farmers. Hobby farmers can considerably influence the introduction and spread of livestock epidemics and the speed at which epidemics can be controlled. These farmers, however, are generally not participants in traceability and certification programs, and likely are not affected by economic incentives such as a lower price for their products if certain requirements are not fulfilled.

- *Participation in Traceability Systems, III.* Still, there may be a problem of free-riders, throughout the chain. More insight is needed into the legal opportunities to effectively deter these individuals, not only after widespread food safety scandals or livestock epidemics, but also in a preventive manner.
- *Reconsideration of Insurance.* Traceability systems and certification schemes cannot exclude every risk. There is still the human factor, the possible introduction of new hazards, and the risky and fraudulent behavior of some individuals, as evidenced during the dioxin and MPA crises. In coping with these uncertainties, it may be more efficient to buy insurance than to attempt to further optimize certification and monitoring programs (see Skees, Botts, and Zeuli, 2002). The high-level certification schemes and traceability systems currently in place have likely encouraged the feasibility of improved liability and recall insurance products.
- *Communication with Consumers.* Various analyses have found that consumers' willingness to pay for safer food is not straightforward. However, the problem may be one of communication. Key research questions in this regard might include: What information should be presented on the label (for example, "HACCP" or "guaranteed safe," "from Umbria," or "fulfills our national standards")? Are consumers able to distinguish between various labels (content and appearance)? Are there alternative ways of communication (see Frewer, 2000)? What is the interaction with other issues of the license to produce, such as environmental aspects and animal welfare? With more insight into these questions, chain participants may be able to establish price premiums not limited only to niche markets.

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