Traceability and Process Verification in the Canadian Beef Industry

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Executive Summary

Traceability and quality verification have become increasingly important in the beef sector. The Canadian beef industry has a well-established animal identification system that facilitates traceback through the farm to slaughter stages of the industry. This study explores the feasibility and implications of extending the current cattle identification system to a full chain traceability system from farm to retail. It explores the network effects and economic implications of combining traceability with more comprehensive process verification information management systems through an industry-wide information system versus a series of competing private sector supply chain initiatives. A comprehensive literature review, combined with interviews with key industry stakeholders and experts in Canada and the US, forms the basis of this analysis.

A commonly accepted definition of traceability has yet to emerge. There is an important distinction between identification, traceability and verification, as well as between tracking attributes (forwards) and tracing (backwards). 'Traceability' systems perform a diverse set of roles responding to private sector incentives to improve supply-side cost management and demand-side product differentiation, but also driven by public sector goals around reducing the social costs of food safety problems. Broadly defined, five roles for traceability (and quality verification) systems emerge: i) improved inventory and logistics management; ii) improved management of food recalls in the event of a food safety problem; iii) limiting the broader (public) impacts of food safety or herd health problems; iv) strengthening due diligence and liability incentives; v) demand-side incentives, including facilitating product differentiation strategies and providing stronger economic signals to producers

In Canada industry-wide traceability initiatives relevant to the beef industry include the Canadian Cattle Identification Agency (CCIA), the Canadian Livestock Identification Agency (CLIA) and Can-Trace. These programs are designed primarily to address a reactive traceability function – facilitating the traceback of animals or food products in the event of a food safety or herd health problem. The liability function is beginning to be addressed by CLIA and Can-Trace, as well as a number of private supply chain programs. The Can-Trace initiative also has potential additional functionality in terms of being a vehicle for improved logistics and inventory management within specific supply chains, particularly if duplicative or incompatible data systems are avoided through the establishment of a common data standard. For the most part, however, this is a purely private sector function, with private supply chain-based systems evolving in tandem with, and more often ahead of, the Can-Trace initiative.

It is the private sector supply chains and branded programs that have begun to address the quality verification function. Numerous branded programs in the US and, to a lesser extent Canada, undertake traceability for the purpose of production and process verification from farm to packer door. Private sector supply chain-based initiatives are obtaining premiums for products that address the demands by consumer market segments for specific food quality and safety attributes. Newer private sector investments have built traceability capabilities into the packing plant, although by-and-large individual animal ID is still not retained post-slaughter in most major packing plants. Production protocols provide a means by which specific quality attributes

are assured, with third party verification ranging from simple self-declaration to audited processes.

For traceability and quality verification systems to be effective and useful to the industry they must be **functional**, **reliable** and **credible**. The system must provide tangible and appropriate **incentives** for compliance to all parties involved. The technology exists to extend traceability beyond the point of slaughter. While technologically feasible, full traceability is often not economically feasible, and depends on the strength of demand from the marketplace for additional quality information. Traceability and quality verification systems that span several stages of the supply chain must also be credible. Independent third party monitoring lends credibility to quality and safety claims, for example, the USDA Process Verification program.

Network Economics provides additional insights into the comparison of industry-wide versus private supply chain initiatives as an approach to traceability and quality verification. Complementarity and compatibility of network components is essential for positive network externalities to exist. Private supply chain-based initiatives are complementary for those within the system but not necessarily compatible outside the program's network of users. Those in favour of an industry-wide system see value in the centralized storage of data and a single service provider for traceback and process information. A perceived advantage for producers from an industry-run CCIA data storage system compared with private sector initiatives includes the flexibility to establish multiple marketing relationships, thereby reducing the reliance on a single downstream buyer. On the other side of the debate, those opposed to a centralized system see it as a duplication of supply chain initiatives and well outside the boundaries of CCIA's initial mandate.

Some key conclusions include:

Regulatory developments: Development of programs by different levels and jurisdictions of governments could make it difficult to establish an integrated national program for traceability.

Technology: Industry consultations revealed that the technology exists to extend traceability along the supply chain to the retail sector and that it is being done on a small scale. The high speed of commerce of the beef industry in Canada creates a challenge for implementing farm to fork traceability. The current technology is better suited to lower cattle numbers and slower processing than exists in the industry at the present time. Again, the distinction between traceability information, food safety assurances and quality assurances bears emphasizing. If they exist, market premiums for assured quality attributes are likely to be quite different from simple traceability information. Traceability capability may instead lend credence to quality assurance claims.

From Reactive to Proactive: Industry and policy initiatives to date have been largely reactive: improving the ability to traceback animals in the event of disease problems. Proactive strategies to improve food safety and quality through industry-wide initiatives and/or through private sector supply chain strategies need further consideration. The role of incentives is a central consideration. The incentives to implement food safety and quality strategies through a supply

chain versus on an industry-wide basis will be quite different. Future research could examine the nature of the underlying supply chain relationships necessary to deliver credible quality and safety assurances as a proactive marketing and industry development strategy.

CCIA- Data Collection Vs. Information Verification:: There is reasonably high level of confidence that the existing cattle identification system is sufficient for addressing animal health and food safety concerns, while a recognition that what is considered "sufficient" in terms of information for the industry to function will change over time. Consumers are becoming more discerning and requiring more information about their food. In general, the information needs of various supply chain members are poorly understood with respect to traceability or quality verifications.

Traceability does not guarantee food safety, neither does it necessarily automatically enable quality assurances, but the traceability infrastructure can be a means of facilitating additional quality assurances. The line between the CCIA's responsibility and the realm of private sector firms is increasingly blurred. Beyond age verification, other quality attributes are the basis of competitive advantage among firms and will emerge through individual supply chain initiatives. It may be that a process verification program, similar in scope and objectives to the USDA programs, is warranted in Canada.

Understanding Consumers & the Role of Food Retailers: Industry representatives were unanimous in their belief that Canadian consumers have confidence in the safety of the Canadian food supply. While this may be true generally there remains a significant information gap in truly understanding what motivates and influences Canadian consumers. We also need a better understanding of the requirements of food retailers and the food service sector with respect to traceability and quality verification, and the implications for the relationships between these firms and their suppliers.

Animal identification and traceback from the slaughter plant is functioning effectively in the Canadian cattle sector. There is widespread recognition that the system could do more, but not universal agreement over whether it should do more. Nevertheless, product differentiation and competitive strategies that require longer term supply chain relationships between producers, feedlots and processors will be the source of brand advantage to alliances in the future.

Traceability and Process Verification in the Canadian Beef Industry

1. Introduction

Over a relatively short period of time, traceability (traceback) has entered the lexicon of the agriculture and food sector with a pervasiveness that is hard to ignore. The food retailing sector is adopting traceability requirements for its suppliers at a rapid pace; individual supply chain initiatives led by food processors, producer groups or entrepreneurial third parties are building traceability into a wider product branding strategy; in the livestock sector, agricultural producer organizations have introduced industry-wide animal identification and traceability initiatives; governments are variously encouraging, enabling or mandating traceability within their national food sectors. Canada is no exception to these trends. The Canadian cattle sector, in particular, has a well-established animal identification system that facilitates traceback through the farm to slaughter stages of the supply chain.

Traceback is only one potential function of the information infrastructure that comprises a 'traceability' system. Credible verification of quality attributes to downstream food firms or to consumers lies at the heart of successful product differentiation. As the beef industry seeks to differentiate products, build branded beef programs, and facilitate value chain alliances, a means to verify the presence of enhanced quality attributes becomes increasingly important. Verifying the presence of process attributes such as on-farm production methods related to animal welfare, the use of specific feeds, the production of 'natural' beef etc. requires new information flows along the supply chain. The credibility of quality claims, and the potential damage to industry-wide reputation of misleading quality or safety claims, requires an effective traceability and process verification system.

Clearly, traceability and quality verification are closely linked; however, they are not synonymous. Some traceback systems primarily offer a means to identify the source of contaminated food products or the movement history of potentially infected livestock efficiently and effectively but are not intended to provide quality assurances with respect to production methods. Similarly, some quality verification programs enable assurances with respect to a specific quality attribute (e.g. organic beef), without needing to identify the farm of origin. Nevertheless, inherent synergies exist in combining a traceback function with a quality verification capability within the same information infrastructure. Traceability can add credibility to a quality assurance guarantee. Yet traceability and quality verification remain separate functions, driven by different incentives, with different implications for private versus public costs and benefits.

The purpose of this study is to explore the issue of full-chain traceability and process verification in the Canadian beef sector, assessing the opportunities and constraints, relative advantages and disadvantages of combining these functions within one system versus several independent competing systems. The study has three main objectives:

1. To evaluate the feasibility and implications of extending the current cattle identification system to a full chain traceability system (i.e. beyond slaughter to downstream sectors of the beef industry).

2. To explore the potential 'network effects' of combining traceability/source verification with more comprehensive process verification information management systems, in the context of a national industry-wide information system or through competing private sector supply chain systems.

3. To draw insights from existing traceability and process verification systems/technologies currently in use in Canada and elsewhere.

To address these issues, the study examines the key functions of traceability and identifies the essential elements of an effective traceability system. A sample of the existing traceability and process verification systems and technologies currently used in Canada and elsewhere serves to illustrate the diversity of traceability and quality assurances programs in use or under development. A comparison of delivery through a national industry-wide system versus competing supply chain initiatives is an important consideration in this analysis and provides a constant theme throughout the report. The capability of an industry-wide system to effectively perform all the necessary functions of a traceability system, while preserving incentives for innovation and product differentiation, emerges as a key issue.

The report is organized as follows. A brief summary of the research methodology employed is provided in section 2. Section 3 presents a comprehensive discussion of the nature of 'traceability', its definition(s), roles and the implications of traceability for vertical supplier-buyer relationships in the agri-food sector; this discussion provides a context for the subsequent analysis. In section 4, various traceability initiatives, programs and systems are described, including sector-wide programs, supply chain-based systems, and third-party data management systems. Traceability initiatives in other countries are briefly reviewed. Section 5 presents a framework for assessing traceability and quality verification programs on the basis of their functionality, reliability and credibility, while section 6 provides insights from a Network Economics perspective. The report concludes with a summary of key findings, a discussion of the implications for the development of full chain traceability initiatives as well as combined traceability and process verification systems, and recommendations for further research.

2. Methodology

To provide a context and framework for the analysis a comprehensive literature review was completed. A synthesis of recent literature pertaining to traceability and quality verification highlights the private sector and public policy incentives for the development of traceability and quality verification systems. Insights from the Network externalities (economics) literature inform this perspective, i.e. are there sufficient network externalities from the existing industry-wide cattle traceability infrastructure that facilitate the inclusion of additional quality assurances in the existing data collection system?

Following a synthesis of key insights from the traceability and network externalities literature, information from semi-structured telephone interviews with key industry stakeholders, technology providers and experts in Canada and the US was used to examine the key research questions. Twelve in-depth interviews were conducted with cow/calf producers, industry technology providers, industry associations, and value chain specialists in Canada and the US.

Where necessary, follow-up contact (by phone or email) with some interviewees occurred to explore emerging themes or clarify subsequent questions. Interview candidates were identified through discussions with industry leaders and stakeholders and through the literature review. Clearly this is not a random sample, nor is it intended to be, given the nature of this study: interviewees were selected based on their anticipated knowledge of the Canadian and US beef and cattle industry and to represent a spectrum of stakeholders and expert opinion.

Potential interviewees were contacted by e-mail or phone and invited to participate in the study. An introductory letter and interview consent form were forwarded to the participant prior to the interview. Those agreeing to participate were asked to return the signed consent form and were provided the opportunity to ask any questions about the interview process prior to starting the interview. When requested, the interview questions were sent to the interviewee prior to the interview for review. The *Semi-Structured Interview Guide*, found in the appendix, provides a guideline for the types of questions that were asked, although the topics and coverage varied depending on the role of the interviewee in the sector. Upon completion of the interview, the participant was sent a copy of the transcript of the interview and asked to review to ensure the transcript accurately reflected their comments[1]. The interview process provides information on the operation of existing systems, constraints to adoption, opportunities for product differentiation, and impacts on supply chain relationships.

3. The 'Why, How, What and Where' of Traceability

3.1 Traceability in the Food Industry

Traceability of food and food ingredients has garnered increasing attention from the agri-food industry, policymakers and consumers in recent years. The issues of food safety and food quality, along with the development of technologies to facilitate tracking and tracing, lie behind the interest in traceability. In Europe a series of high profile food safety crises (e.g. Bovine Spongiform Encephalopathy - BSE, *E .coli* 0157:H7, dioxin contamination of animal feed, etc.) heightened consumer concerns about food safety and galvanized both the food industry and policymakers into taking steps to prevent food safety problems from occurring and to facilitate a more effective means to trace the source of problems (see for example Meuwissen et al 2003; Buhr, 2003; Hobbs, 2004; Beulens et al, 2005). The lessons from that experience were not lost on policymakers and the livestock sector in other countries, including in Canada even prior to the discovery of BSE domestically.

Improved knowledge about the connection between diet and health, combined with rising standards of living and consumer expectations have led to growing demands on the food production system (Farm Foundation, 2006). In general, consumers have become more interested in where their food comes from and how it is produced, while the food industry has recognized the potential for product differentiation opportunities and management (production and logistical) efficiencies from improved information flow along supply chains. Consequently, many consumers are attracted to food products that offer specific assurances with respect to food quality (and sometimes, although les overtly, safety). Many of these quality attributes such as

[1] Interview participants were assured confidentiality, therefore individual interviewees are not identified in this report. The interview procedure complies with the requirements of the University of Saskatchewan Behavioural Research Ethics Board.

taste, tenderness, nutritional content, as well as process attributes such as hormone free, animal welfare, free range production, country of origin, source verification, etc. are not readily discernible at the point of purchase and are referred to as experience or credence attributes[2].

Similarly, consumers would not knowingly consume unsafe food. Food safety can be an experience attribute, or in many cases (e.g. BSE) a credence attribute. Information asymmetry characterizes the market for products with credence attributes, meaning that the seller has more information about true product quality than the buyer. When buyers cannot discern the true value of a product it is not possible for the producer of these goods to differentiate their products from those of lower or different quality and reap the economic gains for the high-quality products they produce (Golan et al., 2003). If product quality cannot be differentiated, firms do not have an incentive to produce higher quality goods. Gathering information about credence attributes increases transaction costs for firms in the supply chain. Information systems are needed to transfer information about these product attributes to downstream supply chain participants and consumers. Consumers obtain information about the credence attributes through labels and brands that accompany the product.

Reflecting the increased importance of the topic to the agri-food sector, traceability has been the subject of a rapidly growing body of analysis in the economics and business management literatures. It is clear, both from this literature and from a review of existing traceability initiatives, that the concept of 'traceability' is multidimensional. Traceability can be defined broadly or treated very narrowly; it is associated with a variety of potential functions and outcomes; it is perceived in some quarters as the responsibility of governments, while others consider it to be primarily a private sector issue; the drive for enhanced levels of traceability is credited alternately to consumers, the food industry, technology providers, and policymakers, singly or in combination. The multidimensional nature of traceability lies at the heart of the key questions posed in this study with respect to full chain traceability and quality verification options for the existing Canadian cattle identification system. For this reason, a discussion of the roles and functions of traceability is useful as a context for the subsequent analysis.

3.2 What is Traceability: In Search of a Definition

What do we mean by "traceability"? A commonly accepted definition of the term "traceability" has yet to emerge. Different definitions of "traceability" reflect the diverse set of roles that traceability systems can play, from simple traceback to quality verification, as discussed in the next section. It is worth highlighting a few key insights from the literature. The ISO 9000:2000 Quality Management standard takes a fairly general view of traceability as the ability to trace the history, application or location of a product or ingredient, including the processing history and the location of the product after delivery (Golan et al., 2004). The terms "identification", "traceability" and "verification" are often used interchangeably, when in fact they are quite different. It may be relatively easy to identify livestock (tags), but is often more difficult to

[2] The distinction between search, experience and credence product attributes is a useful way of conceptualizing product quality and the information challenges in conveying that quality to the end-user. Consumers can identify *search* attributes prior to purchase, e.g. the visible blemishes on a piece of fruit, but *experience* attributes can only be assessed after consumption, e.g. the tenderness of a steak. In the case of *credence* attributes, in the absence of labelling consumers are unable to detect or evaluate the attribute either before purchase through search activities or after consumption, e.g. farm of origin, feeding methods, animal welfare practices.

accomplish traceability, and even more difficult to verify identity, traceability and quality (Smith et al., 2005b). Several authors distinguish between tracking (following food and food ingredients forward to downstream buyers) and tracing (tracing food and food ingredients back to upstream suppliers) (Meuwiseen, 2004; Schwägele, 2005). The ability to track or trace food does not necessarily provide buyers (consumers) with information on how that food was produced or whether it is safe. Quality (or safety) assurances provide additional information.

Golan et al. (2003; 2004) provide a useful characterization of traceability systems in terms of their breadth, depth and precision. Breath refers to the amount of information recorded, e.g. cattle genetics, feeding regimes, progeny, etc. Depths refers to how far back or forward along the supply chain the system tracks (or traces). Depth will vary depending on the attribute of interest: whether it is necessary to trace back to the initial input (e.g. genetic line) or only to the feedlot, packer, etc. Precision is the degree of accuracy with which the system can pinpoint the movement of a specific product: is it possible to trace back a cut of beef to the animal, or is it sufficient to trace a batch of beef to a processing plant? The level of precision will vary depending on the attribute in question and the objective of the traceability system. It is evident that there are many different types of "traceability" system, varying in scope, purpose and design. For simplicity, this report uses the term "traceability" broadly to refer to systems that allow tracking, tracing and/or quality verification. We now turn to a closer consideration of the various functions of traceability systems.

3.3 Roles of Traceability Systems

Traceability systems perform a diverse set of roles responding to private sector incentives to improve supply-side cost management and demand-side product differentiation, but also driven by public sector goals around reducing the social costs of food safety problems. Broadly defined, five roles for traceability systems emerge: i) improved inventory and logistics management; ii) improved management of food recalls in the event of a food safety problem; iii) limiting the broader (public) impacts of food safety or herd health problems; iv) strengthening due diligence and liability incentives; v) demand-side incentives, including facilitating product differentiation strategies and providing economic signals to producers.

Individual firms have an incentive to adopt traceability systems to improve supply chain management, including cost savings from **improved logistics and inventory management**, increased transportation efficiency and accuracy, and savings in labour costs (Golan et al., 2004, Jones et al., 2005). Electronic systems for tracking and linking inventory, the purchase of inputs, production and distribution processes have become essential business tools in both the food and non-food sectors. Food retailers use electronic bar-coding and Radio Frequency Identification (RFID) technologies to manage inventory, increase on-shelf availability and improve customer service (Jones et al., 2005).

Following a food safety incident, accurate traceability systems enable firms to **manage food recalls more efficiently** by enabling potentially contaminated batches to be identified and located quickly, reducing the size and costs of a recall while containing the damage to brand name reputation (e.g. see Meuwissen et al., 2003; Hobbs, 2004; Hobbs et al., 2005; Smith et al., 2005a; Golan et al., 2004). Traceability systems with higher levels of precision allow more accurate recalls and are more valuable to firms where the costs of failure are high: e.g. perishable

products, products susceptible to contamination, high value products, and for firms with valuable investments in brand-name equity (Golan et al., 2004).

Traceability also serves broader public and industry-wide functions related to the presence of **information asymmetry and the potential for market failure in the delivery of safe food**. The ability to trace potentially contaminated products can reduce the number of people exposed to unsafe food. Societal costs from a food safety breach, including illness and premature death, medical costs and lost productivity, are reduced. From the perspective of the livestock industry as a whole, animal identification and traceability systems enabling accurate and timely identification of animal location, origin and movement enhance the control of livestock epidemics, reducing the financial impact (externalities) on producers with unaffected herds. Traceability in this context is reactive – limiting the scope and impact of a problem, and has been a key motivation for the introduction of industry-wide livestock identification and traceback systems (Hobbs, 2004; Hobbs et al., 2005).

Traceability may also **facilitate the allocation of liability** for food safety breaches. The ability to track products back along a supply chain allows civil and statutory liability for food safety problems to be more easily established, and provides an additional incentive for firms to practice due diligence (Hobbs, 2004; Hobbs, 2006; Golan et al., 2004). The ability to demonstrate due diligence in meeting statutory requirements is central to a defence against strict statutory liability. A good example of the effects of a change in statutory liability rules is the introduction of the 1990 Food Safety Act in the UK. The Act was notable for extending legal liability throughout the food chain, including food retailers. The change in regulatory liability encouraged retailers to focus on their supply chain relationships and highlighted the need for greater traceability within food supply chains so as to facilitate monitoring of upstream suppliers.

Firms are also subject to civil liability (sometimes known as contractual or tort liability) which results from negligence in the production, preparation or handling of food, or from the misrepresentation of products, and can result in an injured party pursuing a legal claim for compensation. In the case of both statutory or civil liability, legal proof of responsibility is necessary for liability to be an effective incentive for firms to produce safe food. Traceability can be a key component of this proof. Nevertheless, proving liability is often difficult in practice, given the challenges in determining who is at fault in complex multi-layered food supply chains; this weakens the liability incentive for delivering safe food (Buzby and Frenzen, 1999; Hobbs, 2006).

Concern over liability appears to have inhibited the acceptance and adoption of voluntary traceability systems among producer groups in some countries, including the USA (Souza-Monteiro and Caswell, 2004). Despite this apparent reluctance, a persuasive counter-argument holds that, for firms/farms who practice due diligence, traceability systems can in fact *reduce* their liability by enabling producers and agri-food firms to demonstrate that they were not the source of a problem (Meuwissen et al., 2003; Smith et al., 2005a). Seen in this light, industry-wide traceability systems help producers who have adopted improved livestock management practices (incurring additional costs in doing so) isolate themselves from free-riders who fail to invest in preventative measures.

A final set of roles for traceability systems reflects **demand-side incentives**, including reducing information costs for consumers, implementing product differentiation strategies, and providing more accurate economic signals to producers (Meuwissen et al., 2003; Buhr, 2003; Hobbs, 2004; Smith et al, 2005b; Golan et al., 2004). Traceability systems that incorporate proactive quality verification or assurances reduce information costs for consumers through labelling the presence of credence attributes (e.g. animal husbandry methods, use of pesticides, country of origin, information on labour standards, the use of non-GMO inputs, etc.). In this context, traceability increases transparency in the supply chain, reassuring consumers and engendering trust. Traceability facilitates the product differentiation and value-added marketing strategies of individual firms or supply chains. The ability to provide consumers with information on the source of products and key product ingredients lends credibility to quality verifications and has been an important incentive for the adoption of private supply chain-based traceability and quality verification systems in Europe and Japan (Buhr, 2003; Hobbs, 2006; Clemens, 2003a). Traceability can improve pricing efficiency within a supply chain by providing more accurate price signals to producers on the product qualities valued by the end user (Smith et al., 2005a).

Traceability systems incorporating quality verifications are not always intended to provide detailed information directly to final consumers. In some cases quality (farm) assurance programs are aimed primarily at downstream food retailers; the traceability information may not even be labelled at the consumer level. In these cases traceability serves to reduce information asymmetry *within* a supply chain, lowering information and monitoring costs for downstream food processors and retailers (Buhr, 2003; Hobbs, 1996; Northen, 2000). Traceability systems therefore have important implications for vertical coordination and the structure of supply chain relationships.

3.4 Implications for Supply Chain Relationships

As information on the origin of food and food inputs and the nature of production processes becomes more important due to changing consumer preferences and/or regulatory pressures, the transaction costs of arms-length spot market transactions increases. Quite simply, it becomes technologically challenging and extremely costly to ensure traceability through a series of relatively anonymous spot market transactions between multiple buyers and multiple sellers, dealing in aggregated and blended commodities. Under these circumstances, contracts and closer supply chain relationships facilitate traceability and identity preservation (Hobbs, 1996; Buhr, 2003).

The Transaction Cost and Agency literatures provide insights into the implications of traceability for vertical co-ordination. Firms incur search costs in identifying reliable suppliers and incur monitoring costs in ensuring that inputs meet their quality and safety requirements. Anonymity in the supply chain increases search and monitoring costs and raises the likelihood of opportunistic behaviour and moral hazard (Amanor-Boadu and Starbird, 2005). Agency costs arise in the presence of incomplete contracts when the principal (downstream food firm) cannot fully observe the actions of the agent (upstream supplier). Traceability systems help reduce agency (transaction) costs by facilitating monitoring and providing incentives for compliance with production protocols. This has been called the ‘motivational’ aspect of the traceability problem; overcoming the motivational problem requires that traceability and quality verification systems are reliable and credible (Peupert and Theuvsen, 2003).

Does traceability encourage closer vertical coordination or does it instead facilitate arms length transactions? One view holds that the perceived need for traceability has encouraged closer vertical co-ordination in agri-food supply chains; this has been particularly evident in the UK beef sector (Hobbs, 1996). Interestingly, an alternative perspective holds that (industry-wide) traceability systems reduce the need for closer vertical co-ordination by improving the transfer of information, thereby facilitating traceability between arms-lengths transactions (Peupert and Theuvsen, 2003; Sodano and Verneau, 2004). These views are not necessarily inconsistent, and reflect the wide scope and diversity of traceability initiatives and their different stages of development. In the absence of an industry-wide traceability infrastructure we expect firms to initiate closer supply chain relationships as a result of higher transaction costs arising from information asymmetry with respect to downstream suppliers. However, if an industry-wide traceability system is available (e.g. a livestock identification and traceability system), and if this system provides sufficient information to downstream buyers, is reliable and credible, closer supply chain co-ordination may not be needed to deliver that information. Nevertheless, where firms are assuring specific quality attributes targeted to niche markets as part of a product differentiation strategy, the incentive to develop a private sector supply chain based quality verification system is likely to remain.

As a backdrop to the evolution of traceability and quality verification systems there exists the ongoing trend of consolidation in both the production and processing sectors of the livestock industry as firms strive to achieve economies of scale and improve efficiency. Contracts and other market co-ordination mechanisms are becoming increasingly important in reducing the cost of buying and selling goods, securing market access, improving information exchange among trading partners, and facilitating traceability for the purpose of branded programs, food safety, biosecurity and improved operating efficiency (Farm Foundation, 2006). Some observers contend that commodity production will continue to dominate the livestock market (Farm Foundation, 2006). Where producers are selling to auction markets or directly to feedlots there is often no information on carcass quality flowing back. Only when producers have closer supply chain relationships with packers and processors does traceability provide two-way information flow. Where these closer supply chain relationships exist and include primary producers, traceback can be used to provide feedback on carcass quality for the purpose of improving production efficiency and meat quality. Examples of traceback programs with broader information goals are discussed in section 4.5. Before we turn to a discussion of specific traceability initiatives, our discussion of the role of traceability systems concludes with a consideration of the implications for consumer confidence.

3.5 Implications for Consumer Confidence

Observers anticipate that consumers will be increasingly intolerant of food safety failures (Farm Foundation, 2006). Although in reality traceability does not assure food safety, traceability of process and production attributes is often a proxy for food safety in product selection by consumers. The perceived link between traceability and confidence in food safety has not been lost on food retailers. A senior representative of the fast food company McDonald's recently described traceback of beef as the foundation of the food industry that depends totally on the trust of consumers for its future (Brindal, 2006). A lack of, or imperfect information can degrade consumer confidence and trust in the quality of the food system (Farm Foundation, 2006). One

of the current challenges of the food system is providing large amounts of information in a format that is digestible by consumers. When there is the possibility of partial disclosure or deception, the incentives to establish a traceability system may be reduced because widespread deception makes consumers doubt the truth of claims made by all producers (Golan et al., 2003). The sources of information that consumers utilize and have confidence in are an important consideration when developing traceability and process verification systems and programs.

Consumer trust in government to regulate food safety varies significantly between countries (see for example, Gellynck and Verbeke, 2001; Hobbs, et al., 2005; Dickinson and Bailey, 2002; Farm Foundation, 2004). In the EU food safety incidents destroyed public trust in the ability of the food safety regulatory system to protect consumers, resulting in a total revamping, deepening and tightening of food safety and traceability regulations in an attempt to regain public confidence. In some EU countries, private companies and associations addressed diminished consumer confidence in government assurances by developing branded meat products accompanied by private certification related to food safety and quality assurance (Liddell and Bailey, 2001). In contrast, the recent BSE cases in the US and Canada appear to have done little to shake consumer confidence in the safety of the food supply. There appears to be a reasonably high level of trust among US and Canadian consumers in their governments' abilities to provide information about food safety (Hobbs, 2003; Farm Foundation, 2006).

While food safety is likely a basic expectation of all consumers, traceability alone does little to reduce consumer information asymmetry with respect to credence attributes. Traceability bundled with quality assurances has more value for consumers. Similarly, consumer research has suggested that quality assurances are likely to have more credibility, and therefore be of more value to consumers, when backed by a traceability capability; this may be the case even if consumers are not provided with the traceability information directly (Hobbs et al., 2005). Knowing that the product is traceable is sufficient to engender trust. In this respect, traceability information, information on origin (geographical indicators) and credible quality assurance standards (certification) can be effective extrinsic quality cues in the consumer decision-making process (Northen, 2000). The key word is 'credible'. If quality assurances are not credible, or if a plethora of different quality assurance logos exist in an industry, leading to confusion among consumers, the assurances will be ineffective as quality cues. It has been noted that lack of adequate oversight, including questions over the effectiveness and integrity of on-farm inspections plagued UK farm (quality) assurance programs in the 1990s, leading to a serious loss of credibility and the need to re-vamp and re-launch these programs (Northen, 2000) Working with the UK government in the wake of the BSE crisis, the UK meat industry introduced the Assured British Meat (ABM) program in an attempt to counter confusion over the emergence of multiple quality assurance programs.

4. Traceability and Quality Verification Systems

Given the diverse set of functions that traceability and quality verification systems can perform, it is no surprise that traceability initiatives exist at different levels of the livestock sector across various countries. In general, it is useful to distinguish between industry-wide traceability initiatives, and individual supply chain-focused initiatives. In Canada industry-wide initiatives relevant to the beef industry include the Canadian Cattle Identification Agency (CCIA), the Canadian Livestock Identification Agency (CLIA) and Can-Trace. These programs are designed

primarily to address the reactive traceability function – facilitating the traceback of animals or food products in the event of a food safety or herd health problem – and are described below.

4.1 Canadian Cattle Identification Agency

The CCIA houses a national mandatory cattle identification program; it is an industry-led non-profit organization established to ensure cattle identification and traceback for the purpose of animal disease control and food safety from the producer through to packing plant in the Canadian beef sector. The program began in 2001 on a voluntary basis, becoming a regulatory requirement in 2002 and is now well-established. The CCIA is a subsidiary of the Canadian Cattlemen's Association, operated at arms-length under a separate board of directors and staff. The program is currently operational for cattle, bison and sheep. A federal government agency, the Canadian Food Inspection Agency (CFIA) enforces the national mandatory animal ID program, with penalties for non-compliance. The Canadian Cattle Identification program administered by CCIA requires individual identification of cattle moving outside the herd of origin. Radio Frequency Identification (RFID) ear tags with a unique identification number purchased from an authorized dealer must be attached to each animal. The tags are linked to the herd of origin through the mailing address of the producer (Scott Wolfe Management Inc., 2005).

The original mandate of CCIA was the provision of information (primarily to CFIA) to assist in tracing cattle from the packing plant to the farm of origin in the event of a herd health or food safety problem. This mandate has since expanded to include voluntary collection of birth dates for the purpose of age verification. Birth date information for individual cattle is available to individuals/firms authorized (validated) on the CCIA database, but no additional information (e.g. herd of origin) is released Age verification is one of several new directions introduced or under development by CCIA. In January 2006 the CCIA released an enhanced database (Canadian Livestock Tracking System). Within this revamped infrastructure functionality is included for account management, premise ID, animal movement and sighting and age verification; planned initiatives include value added quality assurances and group lot identification (CCIA, 2006a; 2006b). Currently producers can provide land location of their premises on a voluntary basis, which will enable CCIA to create a premise ID. Producers are able to access the CCIA database directly to submit premise information and obtain a premise ID.

4.2 Canadian Livestock Identification Agency

The CLIA was formed in 2005 as a partnership between various sectors of the Canadian livestock industry and the Federal and provincial governments to provide a vehicle for the development and implementation of a national multi-species animal traceability system for Canada (CLIA, 2005). CLIA is concerned with traceability of live animals for the purpose of disease control, while Can-Trace (described below) is primarily concerned with food safety for all food products from "farm to fork". The purpose of CLIA is to contain and eliminate reportable animal diseases, maximize food safety, and deliver food quality. The CLIA is responsible for overseeing the development of species-specific identification and traceability programs that can meet the data requirements of a national traceability system and provide support services related to these programs and system for all livestock and food animal industries. This system is being developed to support the financial viability of Canada's livestock industries by minimizing the impact of domestic and foreign animal disease outbreaks and food

safety crises, supporting domestic and export market access, and improving industry competitiveness. There are three components to the planned reporting system: (1) animal identification (individual or group depending on species); (2) premise identification and registration of sites; (3)animal movements into and within Canada and live exports of animals out of Canada (CLIA, 2005).

The CLIA will develop and maintain a multi-species database for livestock identification, traceability and livestock premise identification. The agency has a mandate to establish national standards and minimum criteria for identification and traceability of species in Canada and provide a mechanism for discussion and policy development related to livestock identification and traceability as it pertains to animal health management emergencies and food safety. Currently the CLIA's mandate is to provide resources and programs to support the implementation of data collection and communications between systems, including how, when and why data is collected and exchanged. Individual species associations will be responsible for developing and administering their own national identification programs that feed into the multi-species database to be administered by the CLIA.

The CLIA has three levels of membership: Livestock Members, one from each species sector is entitled to one vote on the Board of Directors; Associate Members, representing stakeholder organizations who have voting or non-voting privileges at the discretion of the Board; and Government Members, representing federal and provincial government ministries who are non-voting (CLIA, 2005). Currently membership includes Equine Canada, Canadian Pork Council, Canadian Sheep Federation, Canadian Bison Association, Canadian Cattle Identification Agency, National Livestock Identification for Dairy, Canadian National Goat Federation, Canadian Veterinary Medical Association, Canadian Meat council, Agri-Traceabilite Quebec, Can-Trace, Canadian Animal Health Coalition, Canadian Food Inspection Agency, Agriculture and Agri-food Canada, all Provincial and Territorial Ministries (signatories to the Agricultural Policy Framework). Membership is voluntary and the Agency is currently encouraging participation in the CLIA by other species organizations with priority given to those governed by the Health of Animals Regulations, followed by others included in Statistics Canada Census of Agriculture and Aquaculture.

The Health of Animals Regulations authorizes mandatory individual identification through tagging of all animals of the bison, bovine and ovine species prior to leaving the farm-of-origin, or upon importation into Canada. Other livestock are not currently included in mandatory identification. Quebec has mandatory identification of bovine and ovine species to be completed within 7 days of birth for bovines and 30 days of birth for ovines, or upon leaving the farm-of-origin if this comes first. Quebec also mandates the reporting of movement between farms/production sites identified by site number. The Current Health of Animals Regulations do not have a mechanism for authorizing mandatory identification or registration of livestock premises, making it necessary to begin with voluntary participation. However if the system is to be effective for disease prevention and containment, observers contend that full coverage is essential and will require a mandatory identification system supported by an effective regulatory framework (Scott Wolfe Management Inc., 2005).

4.3 Can-Trace

Can-Trace is an initiative involving the Federal government, the food industry, standards organizations and consumer groups in Canada with the objective of developing traceability standards for all Canadian food products. Starting in 2003, Can-Trace began developing a voluntary whole-chain standard for traceability in Canada. Under this initiative it is envisioned that there will be a voluntary exchange of data between food chain participants with a minimum, standard data set of information being passed "one-up-one-down" between food production sites. A multi-stakeholder Steering Committee involving the food industry oversees the development of the standards. The objective is to establish a commercial data collection system, with Can-Trace providing minimum data element standards rather than a full traceability program. Issues of integration and implementation for full-chain traceability still need to be addressed, including technology solutions and the sharing of data between existing and developing systems. The sharing of data between systems is key to ensuring that the livestock sector is able to benefit from potential marketing advantages that may arise from a full-chain traceability system. Unlike the CLIA traceability initiative, Can-Trace will not require a data repository because the data will remain with the supplier who shares it one-up-one-down with trading partners. Each supply chain member must ensure the integrity of their own data and Can-Trace will not be conducting audits, as implementing the standards is intended to be market-driven and voluntary. To-date Can-Trace has developed draft Canadian Food Traceability Data Standards, competed pilot studies in the pork, beef and produce industries, developed a decision-support tool to assist businesses to assess the cost and benefits of implementing traceability, and completed a series of assessments related to technology, multi-ingredient products and small businesses (Can-Trace, 2005; 2006).

All three industry or sector-wide initiatives (CCIA, CLIA, Can-Trace) primarily address the reactive functions of a traceability system: reducing recall costs for firms and minimizing the wider societal and industry impacts of food safety or herd health problems. The liability function is beginning to be addressed by CLIA and Can-Trace, as well as a number of private supply chain programs (discussed below). The Can-Trace initiative also has potential additional functionality in terms of being a vehicle for improved logistics and inventory management within specific supply chains, particularly if duplicative or incompatible data systems are avoided through the establishment of a common data standard. For the most part, however, this is a purely private sector function, with private supply chain-based systems evolving in tandem with, and more often ahead of, the Can-Trace initiative. Before discussing private sector supply chain-based traceability and quality verification initiatives, we provide a brief overview of traceability initiatives in other countries.

4.4 Traceability Programs in Other Countries

USA

The US is a significant trading partner for the Canadian beef industry, easily representing Canada's largest export market for beef. Many observers have noted that the beef industry exhibits high levels of north-south integration, such that developments affecting traceability in the US are of relevance to the Canadian livestock sector. The US is developing a national tracking system for livestock with the objective of containing a disease outbreak within 48 hours (Scott Wolfe Management Inc., 2005). As currently envisioned, the USDA will enter into agreements with private organizations that will administer databases where program information

will be housed. Data will include: individual animal or group identification; premise location; and date of entry to that premise. Federal and state animal health officials will have the right to query private database systems during any disease investigation (Bell, 2006). Unlike Canada, which took a national umbrella approach to developing a cattle identification and traceability system, in the US individual states are responsible for registering the premises. Wisconsin currently has the most comprehensive and advanced program in the US with animal registration nearing completion and premise registration mandatory. Penalties for noncompliance in this state are up to US$5000 (Scott Wolfe Management Inc., 2005). Nationally, the Animal Trace Processing System, which is scheduled to be in place by 2007, will be initially voluntary but will become mandatory with comprehensive recording of movements required by 2009 (Bell, 2006).

Turning to process verification, on a national level the US has established both the USDA Process Verified Program (PVP) and Quality System Assessment Program (QSA) to ensure the credibility and authenticity of the process claims being made about beef products. Some countries require US beef exporters to be accredited under a USDA Export Verification program; for which the USDA requires exporters to have PVP and QSA programs in place. The USDA has established product and process specifications that meet the requirements of each export market. For example, beef exported to Japan under an approved QSA program for the USDA Export Verification Program must be derived from cattle less than 20 months of age at time of slaughter and must be traceable to live animal production records (USDA, 2005). Private companies are approved by the USDA to advise firms on developing their own PVP and QSA programs that comply with USDA requirements. The USDA must approve all companies wanting to be certified under the program. Smaller firms can be certified indirectly under a company that has approval if they are willing to adopt the systems and protocols set out by the approved entity. Audits are used to ensure compliance with program requirements. PVP requires extensive documentation of procedures and records. QSA programs do not require as many records and procedures as the PVP. Processors and packers tend to utilize the PVP whereas the QSA is more appropriate for the feedlot sector.

Japan

Japan has a comprehensive mandatory national traceability and process verification system for beef and pork. In 2002, the Law Relating to Special BSE Countermeasures came into force, implementing mandatory traceback for cattle from the packing plant to the feedlot. This was followed in 2003 with legislation requiring traceability information from the packer to the retail outlet for all beef muscle meats, effective December 2004. Ground beef, processed products and offals are exempt (Clemens, 2003b). Retailers must display the cattle ID or lot number on beef products. In some cases, meat counter computer access to the Internet allows consumers to obtain information on beef and pork products by entering the ID number on the retail package.

A new Japan Agricultural Standard (JAS) was introduced in June 2003 to certify the traceability of imported beef (Clemens, 2003b). JAS certification is voluntary and also available for the domestic beef sector. Both traceability information and information on feeds and pharmaceuticals used in producing the animal is required for certification under the JAS standard. Required information includes: date of birth; gender; name of cattle owner or caretaker and the date they acquired the animal; date that feeding was initiated and address of the facility where feeding occurred; date of slaughter; breed of cattle; telephone number of manager; name, address and phone number of slaughter facility; list of feeds used; and medicine administered.

Individual animal information is required but when it is difficult to identify individual animals, such as with ground meat, lot information is acceptable, with meat from no more than 20 animals mixed together. Meat processors must store DNA samples; random testing at the wholesale and retail level will be introduced to ensure the validity of the system (Scott Wolfe Management Inc., 2005). The program is administered by the Ministry of Agriculture, Forestry and Fisheries through the Individual Livestock Data Control Center. Producers must by law be certified to produce under JAS. The Japanese government is considering extending these standards to other foods including, vegetables and rice.

EU

In the European Union, traceability has been enshrined in a number of regulatory initiatives, beginning with a requirement for mandatory cattle identification and traceability labelling for beef products in 1997. Broader legislation was subsequently introduced across all sectors of the food industry, including specific requirements with respect to traceability (General Food Law 178/2002). The 1997 beef labelling legislation[3] required Member States to develop national cattle identification and registration systems; it also required beef products to be labelled with a traceability number identifying origin, including where the animals from which the meat was derived were born, reared, slaughtered and processed. Rules governing voluntary labelling of additional information (e.g. production information, animal welfare information, etc.) were also a component of the beef labelling legislation. Each Member State government is responsible for establishing its own cattle identification system, enforcement regulations, penalties for non-compliance, and approval of ear tags.

Animals born after December 31 1997, or traded within the EU community after this date, are tagged with identification numbers. Passports are issued within 14 days of birth notification. Two working days are given to prove identity, after which an animal must be destroyed. The bovine identification system includes ear tags, identity cards, on-farm herd registers and computerized database containing full information on animal identity and location. The EU has no mandate to set up or control databases within individual countries, such that compatibility of individual Member States databases is an issue. The ability to validate data on animal movements is considered to be a concern with the present system given the large number of animal movements that occur (Scott Wolfe Management Inc., 2005).

The EU has continued to refine and revise its food safety legislation, introducing the General Food Law in 2002. While broad in scope, the General Food Law has important implications for traceability across the entire food industry, requiring upstream and downstream traceability through each adjacent stage of a supply chain. The one-up, one-down approach is intended to facilitate full chain traceability from input suppliers, through primary producers, food processors, distributors and retailers) (Hobbs, 2006; Schwägele, 2005).

Although private sector supply chain-based traceability initiatives are emerging at a rapid pace in many countries, including across Europe and North America, a distinguishing feature of the European approach is the adoption of mandatory regulatory requirements for traceability. This is notably different from the approach taken in the US, which has eschewed direct regulatory intervention in favour of private sector traceability initiatives. In Europe the incentives for

[3] Regulation No. 820/97 subsequently amended by Regulation EC 1760/2000

regulatory intervention were primarily related to crisis management and the restoration of consumer confidence following a number of high profile food safety scares. In contrast, in the US, Canada and Australia the policy focus has been on risk management and the prevention of trade-threatening food safety issues.

Nevertheless, the EU presents an interesting dichotomy. At one level, we observe over-arching regulatory intervention in the form of mandatory traceability requirements, but traceability requirements that are not overly prescriptive (i.e. mandating the traceability outcome, but not the method by which traceability should be achieved). Distinct from simple traceback, however, quality verification systems in the EU have emerged and been most successful when housed within the private sector.

4.5 Supply Chain-based Traceability Initiatives

As the discussion in section 3 indicated, there are several market-driven incentives for the establishment of traceability initiatives within individual supply chains, including supply-side motivations related to more efficient supply chain and inventory management, and demand-side motivations related to product differentiation strategies through production and process verification. This section prevents a brief overview of traceability and quality verification initiatives within a supply chain context, and discusses some case study examples.

Numerous branded programs in the US and, to a lesser extent Canada, undertake traceability for the purpose of production and process verification from farm to packer door. In the US there are over 90 USDA-recognized alliances that carry out source verification. It is worth noting that source verification does not necessarily imply the ability to trace back to an individual animal ID. An interview with a supply chain expert confirmed that most of the major packers in Canada and the US are not currently doing individual animal ID. Cargill is reported to be doing individual ID for their branded products, while National Beef, a rancher-owned US beef processor, is retaining animal ID on a relatively large scale. National Beef openly differentiates its product on the basis of food safety, emphasizing the BioLogic Food Safety Program used in its processing plant. The company offers a number of branded beef products differentiated on the basis of specific breeds and production practices (NatureSource™ Natural Angus Beef, Naturewell™ Natural Beef, Certified Premium Beef™, Black Angus Beef™, Black Canyon® Angus Beef , Certified Hereford Beef®, Certified Angus Beef®, Certified Angus Beef® Prime) (National Beef, 2006).

Industry sources indicate that Packerland Packing, a vertically integrated meat processing plant in the US owned by Smithfield Beef Group, has the capability to do traceability and uses it for some customers. Swift & Company, a US beef and pork processor that offers natural source and age verified beef products in a range of branded product lines, is believed to be in the process of installing traceability capability in their plants. Tracking individual cuts across the packing floor is difficult given the speed and type of technology currently being used in the processing plants. Shift ID, which means that the meat is tracked to a specific shift in the packing plant, is being done but individual animal ID has not been crossing the floor of the large-scale plants. Further case study descriptions of supply chain-based traceability and quality assurance programs are provided in the shaded boxes.

Case Study Example: Rancher's Beef

Rancher's Beef is a relatively new Canadian venture, a vertically integrated beef company based in Alberta. The company has recently built a new beef processing facility near Calgary, which will focus on processing cattle under 20 months aimed at the Japanese and other S.E.Asian markets. This is a medium-sized plant that can process up to 800 animals per day. There are currently 48 investors, but with two major investors owning one-third each of the company. One of the major investors is Sunterra, a vertically integrated food company producing, processing and retailing beef, pork and lamb products. Industry sources indicated that Rancher's Beef is capable of traceability from the farm to the box of primal cuts. The company has both tracking and tracing capabilities, owning both the two feedlots it works with and contracting with its 48 producer investors to provide the balance of the cattle needed for their program, although animals may also be sourced from the open market where necessary. The processing plant is RFID-compatible, with the animal ID information from the RFID tag scanned into a plate on the roller so that the carcass retains its identity after slaughter. Box ID, rather than individual animal ID is possible where the primal cuts in a box can be traced to a specific group of animals. Conceptually this is similar to the box ID-oriented tracking and tracing systems introduced in Danish pork processing plants in the 1990s (for a discussion see Hobbs et al. 1998). Eventually it is expected that process information will be collected, so that carcass quality can be linked back to individual producers, enabling Rancher's Beef to match the requirements of an individual market to the type of animals produced by specific suppliers.

Case Study Example: Highland Premium Alberta Beef Alliance

Highland Premium Alberta Beef Alliance features a beef feedlot (Highland Feeders Ltd) in a value-chain alliance with a processor, cow-calf producers and a computer technology firm. The alliance uses an information-based quality control system to link producers, feedlot, processor and retailers for the purpose of preserving quality attributes throughout the supply chain. The Alliance has developed a complete traceability and source verification system that utilizes ear tags to track each animal from herd of origin to the processor. Several products, including hormone free, antibiotic and hormone free, and Alberta Beef are produced through the Alliance. High-quality natural beef is sold under the branded label of Spring Creek Premium Natural Beef. Segregated processing ensures compliance with the guarantees on the product label. Producers are required to implement a record keeping system and to adhere to specific feed and health protocols based on the requirements of the alliance program in which the cattle are to participate. Producers pay a participation fee of $5 per head to cover the cost of the tag and obtaining data back on the quality of individual animals; they are encouraged to retain ownership through to processing to realize the greatest value. Affidavits and audits are used to ensure compliance; the program is certified under the Canadian Food Inspection Agency which conducts its own random audits of the system. Production efficiencies and market access are the benefits promoted to producers. Branded products have been marketed at around a 20% premium over retail commodity beef products and industry sources indicated that producers on average receive a premium of about 15% above the live weight market price.

Blurring the line between private supply chain initiatives and industry-level programs are quality assurance programs championed by producer associations involving certification of specified production processes and branding, but which do not necessarily restrict producers to operating

within a single supply chain tied to a specific retailer. One example is Nebraska Corn Fed Beef (NCFB).

Case Study Example: Nebraska Corn Fed Beef (NCFB)
Nebraska Corn Fed Beef is a non-profit organization established by the Nebraska Cattlemen's Association for the purpose of providing source-verified value-added beef. Ear tags are used to track individual animal data and tie the information to the producer. NCFB owns only the brand name and producers and feedlots must be certified to participate in the program that requires specific feed, health and management protocols. Producers and feedlots must keep detailed and accurate production records to ensure both source and processes can be verified; they sign affidavits indicating the cattle have met all program requirements. Random audits are conducted to ensure compliance with the program. Swift and Company provides the processing. NCFB product is processed separately in a special shift, with NCFB staff present to ensure the transfer of data and to verify the product belongs to the NCFB program. Retailers and distributors purchase licenses for the right to distribute Nebraska Corn Fed Beef. Licensing fees are redistributed to producers through incentives and premiums offered by the program. Grid-based premiums are also available to producers. Industry sources indicate that product is usually sold at about a 15% premium over commodity beef at the retail level.

Large retailers, including Wal-Mart and McDonald's, are requiring that beef suppliers provide source verification for all meat purchased (Farm Foundation, 2006; Brindal, 2006). Sometimes major retailers have proprietary in-house programs for traceability and quality verification with which suppliers must comply. These companies are looking for accountability from suppliers to reassure their customers about the quality and safety of their meat products. Building and maintaining a high level of consumer trust is critical for these food companies.

Confidentiality and anonymity are sensitive issues for the beef industry as systems are developed that can identify individual suppliers. Among some producers there is concern that anonymity will be lost and liability for food incidents will rest with the primary supplier. In the US many producers are concerned about the government having more information about suppliers and some believe this is an unnecessary invasion of privacy. Contrasting this is a strong belief among some industry leaders that producers need to collectively "get over" the confidentiality issue and start sharing more information for the purpose of improving product quality and the credibility of the industry as a whole. Belk et al. (2003) suggest that liability is actually reduced when downstream supply chain participants make use of information about quality and food safety that has been provided by producers. When producers participate in the provision of quality and food safety information it demonstrates concern and due diligence related to their role in the provision of safe food. Liability rules differ between legal jurisdictions; an objective source of information on the question of producer liability – whether traceability systems increase or reduce liability, how and why – could help address producer concerns and enable more informed participation decisions on the part of producers. It is clear that buyers expect accountability and that traceability capability is becoming increasingly important to international market access.

Until now, the focus of the industry and governments has primarily been on the reactive and liability functions of a traceability system. The recent BSE crisis and the spectre of other livestock diseases such as Foot and Mouth disease have made governments conscious of the need

for a quick reaction in the event of a food safety or animal disease incident. A recent analysis of the opportunities and constraints of the North America livestock industry posits that consumers in both the United States and Canada have tended to exhibit relatively high levels of confidence in the safety of their own food supply system (Farm Foundation, 2006). Indeed, this view was prevalent among most industry stakeholders consulted during the interview process for this study, along with a conviction that there is currently little need to improve the present system in terms of traceback. Industry participants were more interested in proactive food safety initiatives for the purpose of improving the overall image of the industry and the gathering of information that will contribute to improving the quality of the beef produced in Canada.

As the examples discussed in this section illustrate, it is private sector supply chains and branded programs that have begun to address the quality verification function. Supply chain-based programs are obtaining premiums for products that respond to the demand for specific food quality and safety attributes among consumer market segments. Some consumers appear willing to pay more for information on a variety of process attributes, including feeding programs, antibiotic and hormone-free, organic and animal welfare (Farm Foundation, 2005; Hobbs, 2003). The same systems that transfer information to downstream buyers can often also be used to channel information back to producers on carcass quality for the purpose of improving production processes. This information exchange is possible through supply chain alliances where trading partners work closely with one another in trust-based relationships to collectively improve the product they sell.

4.6 Combining Traceability and Quality Verification: The Role of Third Parties

Numerous companies offer data collection, storage, transfer and reporting services to the beef industry. A number of individuals interviewed for this study expressed the view that many of these companies over-promise in terms of their capabilities and often under-deliver. There appear to be very few companies that can provide all data requirements for a combined traceability and quality verification system. One industry expert had recently evaluated software systems for the purpose of traceability and found that, even among the top 30, not all of these programs were capable of all the functions necessary for production and process verification.

Examples of the different services provided to the industry are given in the shaded boxes below. Three companies providing different types and levels of service are included for illustrative purposes. IMI Global, based in Platte City Missouri, has worked with some of the largest agricultural organizations in the US. Pardalis is a web-based data storage service based in Stillwater Oklahoma. Viewtrak is a Canadian information technology company located in Edmonton, Alberta that is providing information collection, storage and reporting services to the cattle industry.

Case Study Example: IMI Global Information Systems

IMI Global is a large US data service company working with the livestock industry (www.imiglobal.com). The company was started in 1995 and began by undertaking custom applications to gather critical information for alliances in the beef industry and reporting this information back to the client. Services included data collection, transfer and reporting. The company eventually identified a need for stand-alone applications for data collection and has since added verification systems. All of the company's products and services are process verified and it is approved to advise businesses on the development of USDA approved Process Verified Programs. This designation makes it possible for producers to become certified as process verified under IMI Global. The producer uses IMI Global's systems/technology, adopts the protocols and procedures set out by the company and follows specific documentation and record keeping requirements. The web-based system can be used or smaller producers can submit manual records. Audits are conducted by IMI Global to ensure compliance with the program's requirements. IMI Global has developed an off-site supplier evaluation program that is USDA-approved and has a patent pending. The program is used to audit cow/calf operators enrolled in the Process Verification Program through IMI. Producers submit their information electronically or by fax, providing birth records to support their claims regarding the age of their cattle. This information is reviewed by the auditor, who then phones the producer and asks a series of questions to verify the information is accurate. Feedlots receive on-site audits.

Case Study Example: Pardalis

Pardalis is a recently developed data storage and sharing system operating in the US (www.pardalis.com). The unique feature of this system is that the company has developed the technology to keep the information confidential. There is no network administrator and each producer's data is stored separately and accessible only by the producer and those with whom he or she chooses to share it; however this system is strictly data storage. The services of other data companies would be needed to collect the information, verify the data, and to provide data manipulation and reporting.

Case Study Example: ViewTrak

Viewtrak provides information services to cow/calf producers, feedlots, auction markets and packing/processing facilities using its Beeftrak systems (www.viewtrak.com). The company has thousands of producers using the system across North America, as well as a number of small to medium size feedlots. Within the last year there has been a significant increase in the number of clients because of the need for age verification. Most of the Canadian slaughter facilities are using the system, with the exception of IBP and Cargill which are large enough to have their own software systems. The company claims it is currently the primary supplier of software to the livestock auction industry in North America. Company officials believe the system is appealing because of the low capital investment and security of data residing on a web-based system.

The company offers a web-based system that provides information for primary producers and feedlots. For the cow/calf producer there are 48 data fields related to all aspects of animal management. Animal ID numbers and date of birth information can be forwarded by Viewtrak to CCIA upon the producer's request. The production and process information can be made available to buyers at the request of the producer. After the sale, the producer can continue to access any additional information about the animal (carcass quality if available) for the purpose of improving production practices. Once sold, the new owner can access the information if the appropriate fee is paid. Feedlots can check for individual birth dates. The feedlot can add management and health information for improved animal management and marketing opportunities. Data on animals bought from an auction market or producer can be transferred electronically before the animals arrive, aiding in sorting and management, and making it possible to segregate animals with marketable information. Auction markets can collect information on the animals received and use it to improve the selling price of cattle when buyers pay premiums for specific information such as age verification. For processors the system can aid in recording the retirement of tags and automatically processing CCIA tags, plus generate birth certificates through the web-based application.

Of course, there are many other third party firms offering data collection, information sharing and quality verification services. These three examples were chosen to illustrate the range of activities performed by this sector. Data collection and verification services are transaction cost reducing: downstream firms face lower ex ante search costs and ex post monitoring costs if they can obtain age and quality verification information from a reliable source. Third party information conduits therefore facilitate spot market transactions between multiple producers, feedlots and downstream buyers. Yet it is worth noting that the larger packers in Canada have tended to vertically integrate through this function, using in-house systems of data management and quality verification for the cattle that they purchase. This may reflect economies of scale in the technology and the need to create proprietary quality verification systems as a component of product differentiation, or it may simply reflect the state of flux within this sector as firms explore ways of creating credible information verification systems either in-house or through out-sourcing at different stages of the supply chain.

5. Framework for Analysis: Elements of Effective Traceability Systems

For traceability systems to be effective and useful to the industry they must be functional, reliable and credible (Farm Foundation, 2006), as well as provide effective incentives to the appropriate supply chain members Traceability systems need to be functional, meaning they must be workable in their application. Implementation must be possible within the current industry structure otherwise changes need to occur if the program is to succeed. The program must be reliable. The outcomes of the program must be both accurate and consistent. Traceability programs must be credible with all stakeholders involved, including consumers. If the program is not designed such that it is credible with all parties it will be ineffective regardless of its functionality and reliability. Equally important, the system must provide tangible and appropriate incentives for compliance to all parties involved. These elements can be used to evaluate the anticipated effectiveness of current and proposed industry traceability programs.

Functional: There is evidence from the literature (Arana et al., 2002; Smith and Saunders, 2005; Smith et al., 2005a) and from the interviews with technology experts that full traceability is technologically feasible. RFID, DNA, retinal scanning and testing for the presence/evidence of certain animal treatments and feed regimes make it possible to verify not only age and source but process attributes. Companies are experimenting with the use of retinal scanning combined with trolley-tracking, archives of tissue samples, and coded boxes to aid in the tracing of meat (Smith et al., 2005b).

For traceability programs to be credible it must be possible to verify that the valued attributes have been preserved within the system. Technologies exist that make it possible to obtain information on animal species, origin, age, authenticity, composition and production systems, including feed (Schwägele, 2005). Proteins, fatty acids and DNA based methods have been used to identify species. The geographical origin of certain plant and animal materials can be "fingerprinted". Authenticity, geographic origin and the detection of fraud can be effectively determined by combining electrophoretic, chromatographic and molecular biological methods with other chemical and physical procedures. Tracing production processes and changes during storage can be done through a number of technologies including DNA, electrophoresis, immunological methods, high pressure liquid chromatography, lipid based methods, IR and NMR spectroscopy, and electron microscopy. Immunosensors measure target compounds and pesticide and veterinary drug residue. Electronic data management of this information can be achieved using bar codes and radio frequency tags (Schwägele, 2005).

While the technology exists for full traceability, whether its application in the beef industry is economically feasible is a subject of much debate among industry experts. Many industry observers believe that the current technology is not capable of capturing the necessary information at the current speed of commerce in the Canadian beef industry. RFID and other technologies used to track live animals at the point of sale, or during movement between facilities/owners, have limited radio frequency, requiring relatively close contact with the animals and the ability to move livestock in a single file through the chutes during processing. RFID tags have failed to read properly but the animals with defective tags are not easily identified when moving cattle through a chute in numbers. At the packing plant, the speed of conveyor belts makes it difficult to retain the identity of individual animals. Individual animal identification technology requires slower movement and processing of animals to be effective.

Nevertheless, these technological problems are not insurmountable, and indeed new processing facilities can be designed with tracking capability built into the operating environment (as is the case with Rancher's Beef).

Technological feasibility is only half the story. For implementation, the traceability system must also be economically feasible. Indeed full, complete and absolute traceability of *all* food products, food ingredients and food attributes through *all* stages of the food supply chain is probably an unattainable goal (Golan et al., 2003; 2004). While theoretically feasible for some product attributes (e.g. through the use of DNA technology), in practice the economic costs of implementing full, complete and absolute traceability down to the level of all food ingredients and attributes render it extremely unlikely. Even DNA technology will not provide information on housing standards for calves or the labour standards for packing plant workers. Only if the economic incentives are sufficiently strong in terms of a demand from the marketplace for this information will it be economically feasible to implement more complex systems of traceability coupled with quality verification.

Turning to the second element of a successful traceability system: any traceability program or system must be **reliable** in the outcomes it produces. The program must consistently meet the standards set, delivering reliable quality outcomes to meet stakeholders' needs and expectations. Audits and certification processes are necessary to ensure a program is reliable. Third party verification has a key role to play in this regard, and is discussed in more detail below. Reliability is closely tied to **credibility**. If the system does not provide reliable results it will not be credible. Compliance with the standards set for the program is essential if the program is to be credible with stakeholders and the general public. An example of a program in which affidavits, auditing and record-keeping play key roles in ensuring credibility is provided in the text box below.

Case Study Example: Laura's Lean Beef
Laura's Lean Beef is a private company marketing natural, lean beef products. Product sold under the branded program meets USDA requirements for natural as well as being free of growth hormones and antibiotics. Products are source and process verified to support these claims. Affidavits must be signed by producers indicating compliance with all required feed and health protocols. Feedlots are certified to ensure compliance with the program; they must also sign affidavits. Producers contract with the company to raise cattle for the program; the company purchases the cattle at the time of processing. Producers are required to keep detailed records of production processes and treatments to ensure compliance; audits are undertaken on a continuous basis to verify the information. The USDA has the ability to conduct inspections of producers, feedlots and processors and test for any prohibited inputs. Premiums are available to the producer through a grid system and bonuses are paid for enrolment in the program.

A common view among industry representatives consulted for this study was that the collection of process information should be voluntary. Voluntary compliance will allow the market to dictate what information producers provide by offering the appropriate incentives for compliance. There was a clear message that if the market is asking for the information, and there are market incentives associated with providing it, producers will comply. However, voluntary compliance can lead to market "confusion" when segregation of product is not undertaken or

possible, in other words, if there is a market failure. Information related to process attributes must be communicated with all downstream supply chain participants if market incentives are to be realized. Without segregation, inconsistencies in the quality attributes of meat products available to consumers can lead to a lack of trust and have negative implications for the entire industry.

The feed ban in Canada offers an example of the problems that can arise when there is ineffective enforcement of a food safety-related regulation, leading to lack of compliance and later credibility problems. In 1997 the CFIA introduced new regulations for cattle feed to limit the spread of BSE through cattle feed in response to international standards. The feed ban prohibits the use of protein-based materials, including meat and bone meal taken from specific mammals, to be fed to ruminants such as cattle. Following the first few cases of BSE detected in the Canadian cattle herd, public reassurances from both the Canadian government and the cattle industry emphasized the additional protection provided by the 1997 feed ban. In more recent BSE cases, it appears that cattle born after the ban came into effect have tested positive for BSE (as has also been the case in other countries, and should have been expected). The reality is that initially poor compliance and weak enforcement of the ban likely resulted in feeding of banned material after this date. Most consumers were probably unaware that the ban did not have 100% compliance and were thus reassured that all animals born after this date would not have been exposed to potentially contaminated feed. Clearly this is not necessarily the case. Mixed messages over the efficacy of disease prevention measures, or failure to adequately enforce new food safety or herd health rules, can swiftly undermine consumer confidence. Enhancements to the ban were announced by CFIA in June 2006 (CFIA, 2006c). The most important change is the prohibition of certain tissue, referred to as specified risk material, from *all* livestock feed, pet food and fertilizer.

When premiums are offered for the provision of information, or conversely discounts are received for the absence of certain attributes or information, there are incentives to free-ride if audits or verification programs are not in place. One US source indicated that when the USDA first put in place processes to ensure compliance with EU requirements that US beef was ‘hormone-free’, affidavits by producers was used to verify this information. The result was that with access to this export market being tied to a specific attribute (free of growth promoting hormones) there was an incentive to provide false information about the use of growth-promoting hormones to gain access to these markets. Eventually “cheating” occurred and, during an audit of the system, the EU found that some US beef exports to the EU came from cattle that had been exposed to growth-promotants. This had negative implications for the entire US beef industry and for trade relations with the EU. Access to specific export markets where importers have specific regulatory demands now requires compliance with USDA Export Verification programs; for example, the No-Hormone Treated cattle program is now an official Export Verification program for the EU market. The introduction of official verification programs was particularly important in securing access to export markets for US beef in the wake of the US BSE cases. Under the USDA Export Verification programs firms must document their compliance with the requirements of the importing country (e.g. age verification, exclusion of specified risk materials such as spinal column, etc.). These programs involve not only strict requirements but also audit and certification processes verifying that quality standards are met.

An important distinction should be made between safety and quality verifications. When access to international markets hinges on exporters complying with an importer's food safety standards, mandatory export certification programs have an important role to play in protecting the reputation of the industry as a whole. The USDA Export Verification programs perform this role. However, interestingly the USDA Process Verification Programs go one step further, providing a framework for verifying quality management processes within a firm or supply chain alliance. These of course are voluntary and non-prescriptive: firms must document the "who, what, where and how" of assuring quality in conformance with ISO quality management standards, but the USDA program does not itself define the meat quality parameters. Thus, individual firms or supply chains can have their own unique differentiated branded quality system approved under the USDA process verification program. The USDA seal of approval provides credibility to the firm's quality management system. As we have already seen, credibility is a critical dimension of any quality verification program.

Given the decentralized nature of the beef industry, enforcing compliance with new rules and verifying mandatory information requirements remain challenges. The US beef industry has moved toward information verification through third party on-site audits (Cattlenetwork, 2006). A 2003 US survey of consumers suggested that 60 percent of respondents preferred the government to certify the origin of meat products, while 20.8 percent preferred third-party independent certifiers (Farm Foundation, 2006). Demand for cattle with specific marketable attributes produced under private sector process verified programs is growing. Is this inconsistent with the finding that US consumers prefer to trust their government as a certifier of origin? The answer is "no", on two counts. First, the distinction between safety and quality assurances bears repeating: consumers may trust a higher authority to provide safety assurances, while being more comfortable with firm-level assurances with respect to (non-safety) quality attributes. After all, branded products dominate consumer food and non-food markets, and brands are a classic method of private sector quality differentiation. Second, as noted above, third party quality verification through an independent government agency is not inconsistent with the growth of private sector process verification programs: that is precisely the role played by the USDA Process Verification Program, enabling competing private sector firms to market their products with the USDA seal of approval.

Consumer and industry confidence in any information system is key. The credibility of a traceability or process verification system is vital. Many of those interviewed believe that third party auditing and certification is important to the credibility of any traceability program. The cost of gathering and auditing information is a significant concern for industry stakeholders. If additional mandatory information gathering is required many believe that producers will not be willing to accept the administrative costs associated with the collection and verification of this information without the appropriate financial incentives. The closer vertical coordination and trust-based relationships found in the private supply chain initiatives are more effective than government programs for the purpose of monitoring and verifying information and offer premiums to supply chain participants providing the information.

In Canada, the issue of voluntary versus mandatory age verification is currently being debated. Japan, an important export market, requires age verification for all beef imports; many international trading partners are proposing age-verification as a prerequisite for imports (CCIA,

2006). Some interviewees believed this should be mandatory to ensure future market access and make Canada a preferred source of beef for international markets. Others argued that private supply chain initiatives are providing this information as markets require – and are willing to pay for – it such that voluntary age verification is sufficient. At present age verification information is being collected voluntarily through self-declaration by CCIA and by private sector marketing initiatives. Producers are required to keep written records of the birth in the event of an on-farm audit by a CFIA inspector to verify the accuracy of the information. The Alberta government has proposed introducing mandatory age verification for all cattle under 30 months to be slaughtered in Alberta, beginning in April 2007. If this does occur, there will need to be a means of guaranteeing the information is correct to ensure the program is credible. If free-rider problems arise with this system and false information is provided to gain premiums or avoid penalties the system will not be reliable or credible. Verification methods must be credible with industry participants to ensure compliance, and credible with buyers to be effective in providing market value.

Appropriate market incentives are necessary for primary producers and other supply chain members to collect and relay additional quality information. Any information system must offer the appropriate incentives to achieve participation and compliance. Most individuals interviewed believe the private sector is best suited to undertake the collection and use of process information. Information only adds value for supply chain participants when it can be marketed or used to create market opportunities. Producers need to have access to private marketing initiatives to create value from the information they gather. When animals are sold through the commodity market to a feedlot the transfer of information becomes more complex and premiums are reduced. Most industry experts interviewed believe the market should drive the decision to collect and provide additional production and processing information.

There was a concern among a few interviewees that the voluntary provision of additional information will accelerate the demand for more information by consumers. This view is often couched in terms of the perceived risk that industry-wide provision of information would “turn premiums into discounts”. However, this view is by no means universal. The issue of age verification is an interesting example of the fierce debate over information collection for the purpose of industry-wide market access versus private market initiative. Supporters of mandatory age verification believe that this information is vital for industry development and access to export markets, arguing that the industry as a whole benefits from the provision of this information. They argue that age verification provides access to specific export markets, such as Japan and improves the overall image of the Canadian industry with respect to high standards for food safety and quality. Opponents of mandatory age verification argue that industry-wide provision of this information simply takes away the ability of private supply chain initiatives to get market value (premiums) in return for the provision of this information. They argue that once a critical mass of producers are providing the information, premiums for those providing age verification will turn to discounts for those that do not.

The current Canadian animal ID program administered by CCIA is considered by most stakeholders consulted to be functional, reliable and credible for the purpose of animal identification. The system has been tested by the recent BSE cases, proving to be effective in identifying the source of the problem and capable of dealing with the crisis in a timely manner.

Industry stakeholders in general believe that the current system addresses the industry's needs in terms of traceback for food safety problems and animal disease given (in their opinion) the low probability of such events occurring.

The proposed CLIA initiative that will expand ID to all livestock, as well as include premise ID and tracking animal movement, was not regarded by most interviewees as functional. Voluntary compliance is anticipated to result in limited participation leading to an incomplete system. If the proposed movement tracking system is implemented, including tracking of all animal movements and co-mingling on a premises, compliance is expected to be patchy and incomplete. Enforcement could be difficult given the large number of cow/calf producers. Many of those interviewed believe that, although it is possible to track all movements of animals from herd of origin to slaughter, it would be administratively overwhelming as currently proposed. Producers, feedlots, and auction houses are unlikely to record the movement of animals from pen to pen. If compliance is a problem, the system would not be reliable or credible with the industry and with consumers. Several of those interviewed believe the government and the industry need to be careful not to promise standards which they cannot deliver, pointing to the potentially damaging negative consequences (loss of confidence by trading partners or loss of market access) for the industry from failing to provide promised food safety standards.

Private supply chain initiatives have been successful in making full chain traceability functional on a small-scale because of closer contract and trust-based relationships between alliance partners. Segregation, certification and traceability are central to branded programs and require closer relationships where coordination mechanisms exist that can achieve these objectives. Private supply chains have been successful in establishing reliable traceability systems because of their ability to monitor compliance through contracts and other managed supply chain relationships.

6. Network Effects

Network Economics provides some additional insights into the comparison of industry-wide versus private supply chain initiatives as an approach to traceability and quality verification. Network Economics examines how network externalities arise when the utility a user derives from consumption of a good increases with the number of users consuming the good. Direct (positive) externalities arise through a direct effect of the number of users on the quality or value of the product (Katz and Shapiro, 1985). The classic example is a telephone service (Economides, 1996). Each additional user of the system increases the value or utility of the system by all existing users because it offers access to one more individual by all of the users. Indirect externalities occur when additional users of a product or service create increased demand that results in more products available for sale to all users (Katz and Shapiro, 1985). Computers and computer software are a classic example (Katz and Shapiro, 1985). The more people who choose a certain type of computer such as a Microsoft Windows PC or Apple, the more incentive there is for software providers to develop their software to be compatible with these systems. An individual purchaser of a Microsoft Windows computer benefits indirectly by other people purchasing the same kind of computer because the software options available to that individual are increased.

Complementarity and compatibility of network components is essential for positive network externalities to exist (Economides, 1996). Complementarity refers to the essential nature of the relationship between network components. Each network relationship, service or product is unique and essential to the function of the network. For example the connection between each individual user and the telephone service operator is the same type of service but unique in the sense that it provides a connection and service to a certain individual and essential in that all users are needed for the network to have value. Compatibility means that the components must be able to work together if they are to be part of the same network. Network components that are compatible allow the users of the components to be part of the same network. If the users of one telephone service could not talk with the users of another service the two systems would be mutually exclusive and the users of each service would have networks limited to those using the same service and excluding those from all other services (Katz and Shapiro, 1985). The fact that different telephone providers use systems that are compatible with each other means their customers can access each other and are therefore part of the same network.

The network approach can be applied to an assessment of supply chain versus industry-wide information systems. Private supply chain-based initiatives are complementary for those within the system but not necessarily compatible outside the program's network of users. Firms participating in a private supply chain that is gathering quality verification information can exchange information. These relationships are linear, or closed, among supply chain participants and do not allow for a competitive market if these firms/farms are not free to exchange information with outside industry players. Market power issues within these vertical relationships may become a concern. Trading partners are defined by those who have the technology and compatibility with the data system. Nevertheless, from a marketing perspective, this helps build a competitive advantage for the supply chain alliance.

Interestingly, there are options for producers to retain data ownership and marketing flexibility outside of private alliance programs. IMI Global offers a stand alone application to producers that has data collection and storage capabilities and the ability to have their production methods certified under the IMI Global Process Verification Program. Potentially this system circumvents the compatibility issue. The company believes the result of providing a stand-alone system where producers retain ownership of the information outside of an alliance has been more price discovery and freedom to choose marketing relationships.

In comparison, if an industry-wide data collection service was used, to which all supply chain members and stakeholders (producers, data collection agencies, information service providers, feedlots, processors, retailers) provided and accessed information, there would network externality advantages from the use of a common technology. As the size of the "network" increases, the number of trading partners becomes greater and the market more competitive. With an industry-wide system, lower transaction costs mean that markets may be more accessible for lower volume trading partners with fewer transactions. Processors may be willing to buy cattle with additional quality attributes from smaller producers if the quality data can be extrapolated easily from a centralized system.

Those in favour of an industry-wide system see value in the centralized storage of data and a single service provider for traceback and process information. A perceived advantage for

producers from an industry-run CCIA data storage system compared with private sector initiatives includes the flexibility to establish multiple marketing relationships, thereby reducing the reliance on a single downstream buyer. Furthermore, a single access point is created for downstream companies utilizing the data. Currently those assisting individual producers in obtaining carcass information believe one of the greatest difficulties is contacting the appropriate packers and then getting these firms to provide the information, especially when volumes are relatively small. If this information was centrally housed service providers would access the information on individual animals using the ID number and be able to report this information to producers in a more cost effective manner. Proponents of an industry-wide approach argue that there are potentially important efficiencies through the exchange of information via a centralized system.

On the other side of the debate, those opposed to a centralized system see it as a duplication of existing supply chain initiatives and well outside the boundaries of CCIA's initial mandate. While industry-wide market access issues such as animal ID are considered to be within the mandate of CCIA, any involvement in marketing is not. Golan et al. (2003) argues that a government–mandated traceability system that forces one template onto all firms could be costly and inefficient. They argue that private sector firms utilize a wide variety of sophisticated systems. Some interviewees for this study believe (rightly or wrongly) that the CCIA has not proved itself able to provide the necessary customer service support that would be needed if further data collection and dissemination activities were to be undertaken. As indicated earlier, information adds value for supply chain participants when it can be marketed or used to create market opportunities. Service providers must be capable of providing the necessary additional quality information so that supply chain participants can leverage this information for economic gains. The interviews revealed that, although a centralized industry-wide system might add value as a data collection agency, private information service providers are considered a more reliable source for utilizing that information. Private companies are considered to be more business and service oriented and therefore a more trusted source for helping supply chain partners use and market the information collected.

Industry consultations revealed a concern that an industry-wide information network would make market intelligence accessible to competitors. There was a fear that, just as information flows between supply chain members, it may be possible for third parties to extrapolate information about the marketable data users are getting from the centralized system. Clearly, credible assurances of confidentiality need to accompany the technology that assures privacy and security of information. There is a sense that private companies would be giving up some control and ownership over the data they use and that this would weaken their competitive advantage. It is apparent that questions over industry confidence in a national database to house market data would need to be addressed for such a system to be viable.

Establishing a voluntary centralized system for quality verification information assumes that there are sufficient network externalities and economies of scope to sustain the system. Network externalities exist if everyone benefits from the addition of one more user, while economies of scope are derived from the range of quality attributes and type of information included, i.e. if two attributes can be included in an integrated quality verification system at a lower average cost than it would cost two separate verification systems to provide this information. Although many

of those interviewed do not believe the industry has advanced to where this is economically viable, they believe that it may do so in the future. If such a system were to exist, it would require CCIA begin looking at how to make it functional, reliable and credible while not jeopardizing the market incentives that currently exist for production and process information. Data collection and information provision represents one important aspect of an industry-wide system for provision of quality information. The other aspect is the verification component. Who would verify the accuracy of the information provided in a central database? The US Process Verification Program provides one possible model: where standards for the detailed recording of process information and audit and verification systems are approved by the USDA, with firms accredited to certify under the USDA program.

7. Conclusions

This study has examined the prospects for full chain traceability and process verification in the Canadian beef sector. A thorough review of the literature and in-depth interviews with industry stakeholders and experts enabled an examination of the implications of extending the current cattle identification system beyond slaughter to a full chain traceability system, together with the potential to combine traceability or source verification functions with more comprehensive process verification information management systems. Insights from existing traceability and process verification systems inform the analysis. The report concludes with a summary of key insights, and recommendations for further research.

Regulatory developments: Canada is already experiencing the development of independent traceability systems that move beyond simple cattle traceback. Quebec has established provincial legislation requiring farm-of-origin information as well as reporting of movement through site numbers. Ontario has established a task force to develop a premise registry and traceability system, and PEI has begun registering all major livestock and poultry operations (CLIA, 2005). Development of programs by different levels and jurisdictions of governments could make it difficult to establish an integrated national program. Observers contend that, in the EU, movement control is severely flawed because of a lack of agreed upon standards for data reporting, the fragmented approach to the evolution of legislation and the independent development of the supporting national systems (McGrann and Wiseman, 2001). Uncoordinated legislative programs appear to have given very little consideration to data sharing between systems. Canada can learn from this experience by working on coordination and compatibility prior to system development. The existing CCIA cattle identification and traceability system provides an important level of national integration within the cattle sector from farm to point of slaughter.

Technology: Industry consultations revealed that the technology exists to extend traceability along the supply chain to the retail sector and that it is being done on a small scale. The high speed of commerce of the beef industry in Canada creates a challenge for implementing farm to fork traceability. The current technology is better suited to lower cattle numbers and slower processing than exists in the industry at the present time. Advanced testing methods are available that can verify the existence of many production and process attributes. However the cost and time to complete this kind of testing has relegated this kind of verification to experimental labs and niche market supply chains where premiums are sufficient to warrant the additional steps. If they exist, market premiums for assured quality attributes are likely to be quite different from

simple traceability information. Traceability capability may instead lend credence to quality assurance claims.

Moving from the Reactive to the Proactive: Industry and policy initiatives to date have been largely reactive: improving the ability to traceback animals in the event of (relatively low probability) disease problems. The industry consultations undertaken through this project revealed support for a proactive approach to safety and quality. Industry stakeholders are concerned that any traceability and process verification be functional (cost effective and manageable for industry participants), reliable such that it consistently delivers the intended results, and credible with industry stakeholders. The reputation of the industry is at risk should these programs not be reliable.

Proactive strategies to improve food safety and quality through industry-wide initiatives and/or through private sector supply chain strategies need further consideration. The role of incentives cannot be over-emphasized. The incentives to implement food safety and quality strategies through a supply chain versus on an industry-wide basis may be quite different. Incentives can be positive (e.g. price premiums, market access, stable business relationships) or negative (price discounts, loss of market share, penalties for non-compliance). Effective incentives (premiums for compliance or penalties for non-compliance) must exist for all supply chain members, such that free-rider problems and cheating do not occur. Closed supply chains for managing products differentiated by specific quality attributes have implications for the balance of market power and for price discovery. Trust becomes an important element of these supply chain relationships. Future research could examine the nature of the underlying supply chain relationships necessary to deliver credible quality and safety assurances as a proactive marketing and industry development strategy.

CCIA – Data Collection Vs Information Verification: The interviews revealed a reasonably high level of satisfaction with the current CCIA system in terms of the establishment of an effective animal ID system, and a general perception that the current system is sufficient for addressing animal health and food safety concerns. However, many of those interviewed acknowledge that what is considered "sufficient" in terms of information for the industry to function will grow over time. Consumers are becoming more discerning and requiring more information about the food they buy and consume. Age verification is considered by many to be essential for market access and is anticipated to be the next non-negotiable information requirement that will be needed for the industry to remain competitive in international markets.

In general, the information needs of various supply chain members are poorly understood with respect to traceability or quality verifications. The industry consultations revealed a dichotomy of viewpoints: some believed that there is value in sharing carcass information with producers with the objective of improving quality, while others disagreed. Sharing production information (e.g. vaccines administered) has the potential to deliver cost savings but verification is important since there are incentives to misrepresent this information. Timeliness of (verified) information provision contributes to supply chain efficiencies. For example, chute-side live access to the CCIA cattle identification information could improve the ability of processors to use the information (e.g. age verification) for sorting cattle. If the buyer cannot verify the information at the time of purchase this uncertainty will be reflected in a lower offer price for the cattle. The

costs and benefits of improving access to the existing traceability and age verification information bear further investigation.

By and large, stakeholders recognized the value in having a central authority, such as the CCIA, set standards for the 'mandatory' information needed to sustain access to export markets. Negative externalities arising from animal disease outbreaks can be widespread, reverberating across the entire cattle industry. Clearly therefore, an industry-wide traceback information system was needed, and an effective system has been put in place. Regulatory requirements for access to international markets (e.g. age verification) expand the role of an industry-wide information system but also introduce the need for independent verification. To achieve this, the CCIA must ensure that the systems it develops are functional, reliable and credible with all industry stakeholders. If these key elements are not met there will be compliance issues and the effectiveness of the system will be compromised, jeopardizing the integrity of the industry with detrimental effects for access to export markets.

Industry consultations revealed considerably less agreement as to the role of CCIA in process verification initiatives. Insights from Network Economics suggest there could be positive externalities associated with an industry-wide process verification system, provided that such a system does not dilute the commercial incentives for engaging in quality differentiation. Creating a system that all stakeholders trust would be essential. Without industry confidence and trust, such a system would have little value. Compatibility and complementarities within and between data collection and verification systems creates network externalities that provide an incentive for producers, feedlots and packers to join a system. It may be that a process verification program, similar in scope and objectives to the USDA program, is warranted in Canada. If so, whether the CCIA, a federal government agency, or independent third parties would be the appropriate vehicles to verify quality programs is a question for future analysis

Understanding Consumers & the Role of Food Retailers: Industry representatives were unanimous in their belief that Canadian consumers have confidence in the safety of the Canadian food supply. While this may be true generally, there remains a significant information gap in truly understanding what motivates and influences Canadian consumers. How do consumers evaluate quality: what is the role of a brand versus a quality assurance mark and whom do consumers trust for providing credible quality assurances? Much of the attention to date has focused on traceability and quality programs at the producer, feedlot and processor stages of the beef industry. We need a better understanding of the requirements of food retailers and the food service sector with respect to traceability and quality verification, and the implications for the relationships between these firms and their suppliers. Future research could address this information gap in the Canadian context.

In conclusion, animal identification and traceback from the slaughter plant is functioning effectively in the Canadian cattle sector. There is widespread recognition that the system could do more, but not universal agreement over whether it should do more. Over the past year, the CCIA has introduced new functionality in the form of voluntary age verification. While it is true that some private sector players had put in place age verification processes and were using this to

gain a marketing edge, it is also the case that competitive advantage is often fleeting and that firms need to continue to innovate to stay ahead. Thus, while age verification may have created a temporary edge in some markets, it is by no means a difficult or particularly unique differentiation strategy: given the appropriate infrastructure, age verification is not hard to achieve. Instead, product differentiation and competitive strategies that are harder to emulate and that require longer term supply chain relationships between producers, feedlots, and processors will be the source of brand advantage to alliances in the future.

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9. Appendix

Semi-Structured Interview Guide

The following questions were used to guide the interview process, providing a guideline for the discussion. Since not all questions were relevant to all situations, the interview varied depending on the role of the interviewee in the sector

Are you currently involved in a supply chain alliance? Does it involve a form of traceability?

Are you using a software program or working with a data collection company that gathers traceability or production information?

Who owns the information?

Who has access?

Confidentiality?

What value do you feel you get from using the system?

Has it provided access to markets that would otherwise not be possible?

How long have you been with your current information provider? Have you ever tried another system? If so why did you change?

Is the information transferable to another system (if a producer leaves does he take his data with him and in what format?).

Has the provider achieved what they said they would?

Who is paying for information and what information are they getting

Do you think the current CCIA traceability system is sufficient for the purpose of animal health and food safety concerns? What if any changes would you like to see made to the current system?

Do you currently have any problems complying with the current CCIA traceability system?

Are you familiar with the Canadian Livestock Identification Agency and its mandate to ensure a national animal traceability system is developed for Canada? What is your opinion of this initiative?

Do you think there is interest in extending the traceability system beyond slaughter? Have you been involved with any traceability and/or process verification initiatives beyond the CCIA system?

To what extent do you consider full 'gate to plate' traceability within the Canadian cattle industry to be economically and technologically feasible? What are the key barriers (technological and economic)? Would a system that included process verification differ? How/why?

Are you familiar with the Can-Trace initiative? How do you think it will impact the beef industry?

Should the existing CCIA system be combined with data management systems allowing supply chain participants to share information on production methods with the entire industry? Do you think separate systems administered by the CCIA would be more beneficial? Do you think this would enhance the international competitiveness of the Canadian Beef industry?

What kind of information would you like to see collected through a process verification system?

What kind of technology (web-based, phone, paper, electronic file) do you anticipate might be used in developing an industry wide full supply chain traceability system? Do you think this technology is the most appropriate or are there alternatives that should be considered?

Alternatively, should individual firms/supply chains establish their own identification and verification information systems?

What problems do you see in implementing/maintaining the additional record-keeping associated with a process verification program?

Do you think Canadian consumers are willing to pay a premium for additional information about the beef products they purchase (age, production processes, feed, breed)? Is this market sufficiently large to warrant a centralized CCIA-based process verification system?

How would it impact your operation if additional information regarding production methods such as feed, supplements, needles, illnesses, etc. was required to sell cattle in the commodity market?

What do you think is the best way to get industry compliance with a traceability system? A process verification system?

If such a full supply chain traceability/process verification system was put in place what kind of monitoring of this system would be required for it to have credibility with all industry participants (from producer to consumer) and compliance by participants? What agency should be responsible for monitoring/verifying the information (government, CCIA, third party, Industry associations)?

What role if any do you think the government (Federal? Provincial?) should play in further development/implementation of a traceability and/or process verification system for the cattle/beef industry?

What do you think the industry's (as a whole) goals should be in terms of traceability?

Are you aware of any traceability/process verification initiatives that are occurring in the industry?

Are you aware of any developments in the US related to traceability? Do you see Canadian and US initiatives needing to interact or coordinate in the future? Is there potentially a need for cross-border traceability and process verification systems?