TRACEABILITY IS FREE

Competitive Advantage of Food Traceability to Value Chain Management

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ABSTRACT

The agri-food industry[1] competes on a global, consumer-driven stage. The success of a business relies on its ability not just to produce good, nutritious food; it relies on profiting from the ability to verify the value of food products to customers and consumers. Businesses must also possess the ability to improve *(at minimum retain)* their financial performance in a rapidly changing and highly competitive market.

As illustrated by the recent European "Horsegate" meat scandal, systems designed to enable businesses or sectors address situations that should not have arisen, by only tracking and tracing products, can never achieve the grandiose promises that often accompany the enormous sums invested in their development. As fraud and prior food safety/integrity occurrences also illustrate, there is a distinct limit to which legislation can increase the effectiveness of traceability systems that are not imbedded into enabling the development of more effective operations and business relationships along the value chain.

The primary objective of this paper is to illustrate that effective food traceability is an outcome of a disciplined, professionally managed approach to data gathering, retention, analysis, and collaboration, performed simultaneously at all points along the value chain. This approach enables the creation of financially and environmentally sustainable food businesses and value chains, through providing the opportunity to create and retain a unique competitive advantage. In so doing, it moves the discussion surrounding the role of traceability forward in the context of the 21st Century's global agri-food industry.

The paper illustrates why the ability to build economically and environmentally sustainable businesses (and the value chains which they together comprise) rests on implementing processes that reflect good manufacturing and food safety practices, where traceability is viewed as being the outcome of possessing an effective management system. It is not a separate entity.

In essence, therefore, much like the "quality is free" notion that drove improvements in automotive and aerospace industries, by enabling businesses to more effectively manage the determinants of success, the prosperity of agri-food businesses will rest on embedding traceability into their and their partners' value chain processes.

Opinions expressed in this document are those of the Value Chain Management Centre and SCS Consulting, and not necessarily those of Agriculture and Agri-Food Canada.

[1] The term "agri-food industry" in this paper encompasses the entire scope of operations performed in the production, processing, and marketing of food, from farm input suppliers through to retail and foodservice

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1 Introduction and Background

As the old adage goes: "you cannot manage what you cannot measure." It is the visibility provided by access to continual and measurable data, and what this enables businesses to achieve, that sets apart those who are applying traceability from a strategic perspective versus those who are not. Without an effective traceability system, businesses are unable to both track and trace products, and objectively measure the effectiveness of their operations.

Driven by increasingly sophisticated information and communication technologies (ICT), competitive advantage no longer comes simply from transforming one product into another, such as barley into beer, or wheat into bread, or a calf into beef. It comes from using the information produced from the transformation process to continually improve the effectiveness of the processes that businesses employ to transform inputs into a final product. When this approach is employed by an individual business, the benefits can be significant. When employed by businesses that together form a food value chain, the benefits can be enormous and very difficult for competitors to replicate.

While this fact-driven approach to decision making has to date been adopted by relatively few visionary leaders in the agricultural and food system, it is widespread in other industries. As with auto companies' practices, efficiencies in the food system will come not by cutting corners (which often leads to quality, food safety, and environmental issues); it will come by consistently executing the correct processes from farm to consumer.

This paper identifies and considers issues relevant to the role of traceability in the development of competitive and profitable businesses, and food value chains (or systems). It proposes that, contrary to popular opinion, traceability need not be simply an added cost of business. Instead, it is a beneficial outcome that occurs through the strategic application of ICT and disciplines very similar to those already being used as part of good manufacturing practices. Traceability is not a gift, but it can quite literally be free.

1.1 What is Traceability?

Although there are several perspectives on traceability, for the purposes of this paper, traceability is defined as the ability to follow an item, or a group of items — whether animal, plant, food product, or ingredient — from one point in the value chain to another, either backwards or forwards.

> *"Traceability systems are essentially record-keeping systems that are primarily used to help keep information related to products with different attributes separate from one another. When information about a particular attribute of a food product is recorded*

> *from creation through marketing, traceability for that attribute is established." (AAFC, 2007)*

Traceability has three key essential information components: identification of product attributes (critical to creating and capturing value), identification of premises (the parties and/or location), and identification of movement (tracking). Key data elements (KDEs) about the product must be collected at critical tracking events (CTEs) — usually a specific location associated with a movement or transformation — to ensure traceability is reliable. Substantial work has already been done by industry and international organizations to identify CTEs and associated KDEs.

1.2 Data Requirements

At a practical level, the data needed for food traceability within an individual business/ organization (so-called *internal traceability*) is built into operations and the business's processes and reporting systems. In other words, it is not separate from the work being done; it is a part of that work.

i. When a product is purchased, the vendor's lot or identifier is communicated to the business's management system (ERP or whatever is used) and the vendor lot identifier is retained until the product is completely used.

ii. An inventory control (materials management) system is used to keep vendor lot numbers (or other unique identifier) separate and accessible.

iii. An internal (quality) system creates and assigns a unique finished goods identifier to a manufactured product whenever a "critical event" occurs (more on this later).

iv. An internal system uses input/process/output identifiers to monitor performance and coordinate/manage continual improvement programs.

v. All finished goods transactions are recorded (no exceptions) in a way that retains the internal identifier as well as linkage to the raw material (vendor) identifier(s).

When this model is expanded between multiple businesses, it enables *value chain traceability*. The success of value chain traceability depends on traceability systems being implemented in a disciplined manner along the entire value chain from farm to fork. This enables businesses to continually monitor the relationships that exist between these data components, to produce insights that enable businesses to manage their operations more effectively and objectively than otherwise possible.

For reasons cited in the remainder of the report, value chain traceability is fast becoming a determinant of businesses' sustainability. It enables companies to compete in unprecedented ways by providing a fact-based method of creating and defending competitive advantages.

2 The Benefits of Traceability

Many businesses continue to view the main value of traceability as being able to provide customers with reliable information and assurances about where their food came from and how it was produced. While this is the most readily identifiable benefit of traceability, it is not the most valuable benefit from a commercial perspective. This is partly because its value often comes from assisting businesses to manage a situation that should not have occurred, such as a food safety recall. That this benefit is easily attained by most businesses further lessens its value as a source of sustainable competitive advantage for businesses in today's increasingly global and hyper-competitive environment. Many government programs appear fixated on encouraging agri-food businesses to adopt traceability practices for this very reason.

2.1 Individual Businesses

Applied correctly, information and communication technology (ICT) in the form of traceability systems enables businesses to reduce risk and increase their long-term profitability. This directly stems from how the visibility provided by traceability systems enables businesses to utilize their assets more effectively and efficiently. The resulting visibility also enables businesses to make more informed management decisions, leading to increased market penetration and brand equity, and reduced operating costs.

The visibility that flows from having implemented effective traceability systems also enables agri-food businesses to better manage risks, through possessing the ability to implement verifiable safety and quality compliance programs and to quickly react to emergencies, recalls, and withdrawals. Effective traceability systems significantly reduce response times when an animal or a plant disease outbreak occurs, by providing more rapid access to relevant and reliable information that helps determine the source and location of implicated products.

Some national governments (for example: European Union, Japan, South Korea, New Zealand, and Australia) have already imposed traceability requirements as a risk mitigation tool to help protect public and animal/plant health. An examination of the food industry has shown that traceability can cut in half the scope of the recall; and in some cases, the recall scope has been lowered by more than 95% (Sparling & Sterling, 2005). As well as reducing the amount of wasted product, decreasing the scope of recalls can decrease the number of consumers affected and the negative impact of a recall on brand(s) equity.

Sparling and Sterling (2005) summarize this well:

> *"One can assess the benefit of improved recall and risk management by considering the reduction in recall scope, the frequency of different types of recalls, the market reaction to recalls and withdrawals, and the liability exposure of a firm. Each of these calculations will yield quantifiable business benefits to the organization."*

2.2 Enabling World Class Value Chain Management

Substantial and continual improvements in financial performance can only occur by having established closer coordinated operations across the functional departments operating within and between the businesses that together form a value chain. These improvements can best be attained by leveraging ICT and traceability systems to continually improve the performance of an entire value chain versus one business in isolation. The benefits provided by this level of visibility include the ability to establish sustainable competitive advantages that are very difficult (even impossible) for competitors to replicate.

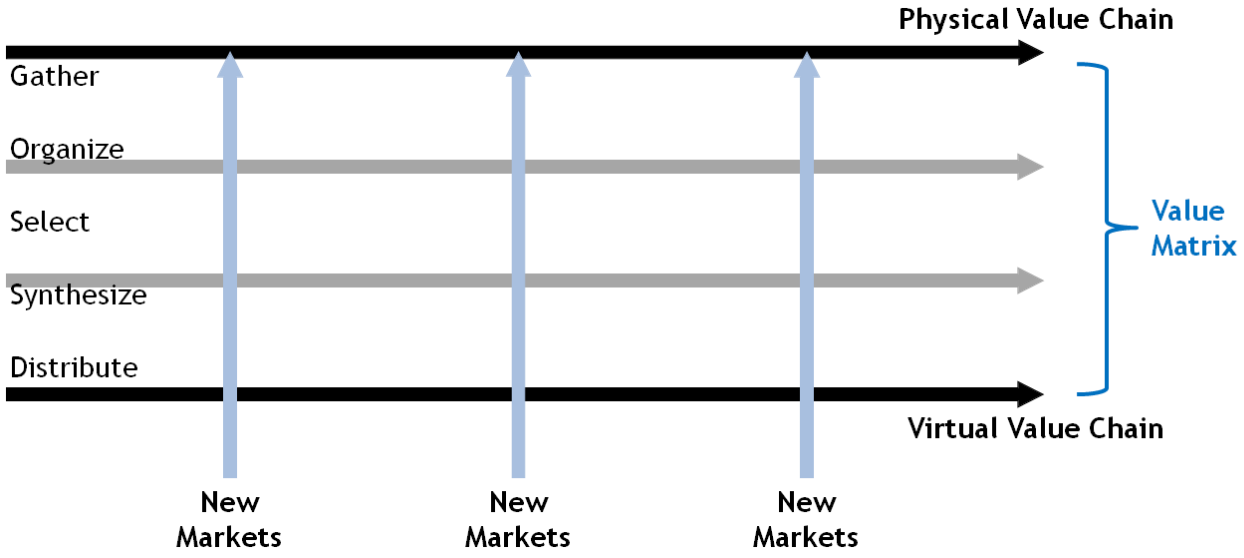
Recognition that ICT systems can be exploited to add value for the customer, while simultaneously reducing the costs of producing an end product or service, has revolutionized the role of ICT in organizations. It enables managers to move beyond having to view the value chain as a series of physical steps that systematically occur one after the other. Instead, they are able to systemically gather and analyze data that emanates continually from multiple points and multiple businesses situated along the value chain. This enables them to innovate in unprecedented ways.

The evolution of the Internet, "cloud computing," social networks, and ubiquitous access to technology through personal devices has hastened this change by enabling information to be gathered and analyzed cheaper, faster, and more accurately than ever before. This has created the ability to move beyond a value chain's physical limitations and becomes especially important for creating additional value for customers and consumers.

Clemons and Row (1991) and Rayport & Sviokla (1996) are among those who described why rapid improvements in ICT and data management enabled businesses to profit from improved procedures for gathering, analyzing, and utilizing information.

Figure 1 shows how managers can gain unprecedented insights about almost every aspect of a process by analyzing the virtual chain of information that flows from their physical operations. This enables them to clearly monitor and have more disciplined control over processes that they employ to create value for customers and consumers. This provides previously unattainable opportunities for businesses situated along the entire value chain to continually improve their performance.

Figure 1: Value Matrix – Rayport & Sviokla (1995)



Rayport and Sviokla (1994/95/96) identified three ways by which businesses can leverage virtual chains of information to reduce costs and increase revenues, resulting in the opportunity to acquire sustainable competitive advantage:

i. Mirroring

The informational value chain provides a platform on which processes that have previously occurred only in the physical world can be transferred to a digital format. This mirroring of the physical chain with data drives the opportunity for businesses to increase capacity and/or improve their economic returns, without needing to invest in costly physical infrastructure.

ii. Visibility

Visibility is at the heart of effective management. It enables businesses to continually increase the efficiency of their operations by having the ability to objectively monitor and measure the effectiveness of their operations over time, not just a particular point in time. Visibility, therefore, equates to reliable and traceable information, which can be used to attain tighter coordination within a food business, and between it and its suppliers and customers. This provides an array of previously unattainable opportunities.

iii. New Relationships

Traceability in this context enables businesses to form new forms of relationships with customers and suppliers. Today's interactive, customer-focused relationships could not exist

without web-enabled ICT systems and constant access to continual and measurable data. The development of relationships focused on developing increasingly sophisticated problem-solving skills and capabilities offers further opportunities to develop new customer and consumer oriented products and services. It also enables organizations to enter previously unattainable markets.

2.3 The Goals of Effective Traceability

For reasons cited above, effective traceability systems benefit businesses and entire sectors from a production, marketing, and value chain management perspective. The following benefits should be considered the goals of a well-designed traceability system (Samarasinghe et al., 2009).

- **Market benefits:** Traceability is essential to the survival of business in regulated markets. Food products need to be labelled or identified to facilitate their origins and contents to the consumer. This will become the norm in supermarkets as new traceability regulations are implemented.

- **Quality and safety management:** Businesses can use traceability to respond strategically to consumers' increasing concerns about the potential risks posed by a food safety issue or a product's integrity being compromised. Traceability is not food safety per se. An effective traceability system strengthens the food safety management capabilities of any business.

- **Reduced cost of production:** When traceability is viewed as an outcome of possessing an effective ICT system, businesses are able to monitor performance and communicate more effectively than otherwise possible. The involved businesses are able to make more informed management decisions, minimize the resources invested in non-value adding activities, and reduce waste efforts along the entire value chain. Harmonizing traceability systems and requirements also enables businesses to reduce their costs, often while simultaneously increasing revenue.

- **Product recall:** Product recalls tend to be bad news. But companies that successfully manage a recall can turn the bad news into a good news story by containing the crisis. A critical ingredient in effective management of a crisis is visibility — this means reliable and accurate information about a company's affected products and any associated food safety data. More than that, transparent traceability systems allow a company to provide the assurance needed to restore consumer and market confidence.

The next section builds upon the ideas presented above. It cites specific examples of where individual businesses and the value chains in which they operate have benefited financially from

imbedding traceability into their operations and processes. It then positions the benefits of traceability within an industry and wider socio-economic perspective.

3 Translating Concepts into Practice

3.1 Creating Superior Value for Customers and Consumers

The highly effective interactions that traceability systems enable to occur between physical and virtual food chains provides a powerful tool for driving and enabling innovation. It also creates the ability to manufacture, market, and distribute highly valued products and services. Once the necessary infrastructure is in place, organizations may implement food traceability relatively easily industry wide. This enables entire industries to use traceability systems to achieve far more than simply improve the monitoring and integration of value-adding steps along the physical value chain.

By transferring (mirroring) physical activities via the traceability (virtual) chain, opportunities are created to deliver new customer value on an unprecedented scale. This is especially true where the physical and informational value chains complement each other through related yet distinctly separate activities (Rayport & Sviokla, 1995/96). One example of this is where operating in the virtual world allows companies to establish closer links to customers and consumers, who in turn provide information that can be incorporated into physical products and services. The complementary chains offer superior value.

3.2 New Products and Processes

3.2.1 John West

John West (see sidebar below) is an excellent example of a seafood company that is leveraging information between its physical and virtual value chains to achieve competitive advantage. The company does this partly via a software application on its website, which encourages customer interaction through a simple inquiry about its canned products. (See sidebar explanation.)

The information John West records about its products allows the company to deliver additional consumer value. It provides the capability to improve decision making regarding new product development and operational efficiency, while it also enhances its customer service. The entire concept delivers competitive advantage while simultaneously strengthening customer loyalty.

3.2.2 Bama Group

Bama Group is a Norwegian business that annually distributes over 480,000 tonnes of highly perishable fruit and vegetables, processed products, and flowers to 15,000 customers. Its traceability system permits the precise management of temperatures and shipments along the entire value chain, resulting in improved quality and longer shelf life. Bama is also able to benchmark the performance of specific producers and products, identify trends or anomalies at any point along the value chain, and identify market opportunities with greater clarity and accuracy than previously possible.

This, combined with the ability to manage inventories more effectively and accurately than previously possible, enables Bama and its partners to save millions of dollars, while simultaneously lessening the value chain's environmental impact through reducing the food and other wastes that previously occurred.

John West is able to connect the physical world of its fish products with the virtual world of information that it already collects on its products as they move from harvest to store shelf. The company provides an application on its website that utilizes basic information that the consumer can access from codes on its packaged products.

The consumer first goes to the website at http://www.john-west.co.uk/.

Entering 'TUNA' from the drop-down list for FISH TYPE, the customer then specifies, for example, that 'SEYCHELLES' is the COUNTRY. An example of a product BARCODE number is 5000171033567, which can be entered manually or through a scanner at point-of-sale. Lastly, the product CAN CODE is entered (for example, 313).

Submitting this information then allows the application to access the data available for that specific product. The application returns information about the physical location and fishing vessel that caught the tuna as well as other information and cooking suggestions. The user interface is simple and easily altered to provide two-way communication capacity.

3.2.3 Blade Farming

Blade Farming is the UK's largest veal and beef initiative. It uses an integrated traceability system to continually monitor, coordinate, and improve operations from "gate to plate." Best practices are able to be identified, refined, and shared by objectively and simultaneously comparing the performance of individual producers and batches of animals as they move along the value chain. Metrics used to monitor animal and producer performance include feed conversion ratios, input costs, number and severity of health incidences, breed/genetics, daily growth rates, carcass composition, and eating quality.

This creates unprecedented insights, which provide participating producers and their strategic partners (incl. feed manufacturers, distributors, and retailers) with the ability to reduce costs

and increase revenue in ways which would not otherwise be possible. It includes reducing calf mortality rates less than 2 percent, and reducing veterinary / pharmaceutical costs by over 75 percent. It has also provided the ability to cost-effectively create value for customers by producing products best suited to the demands of specific end markets, versus forcing specific markets to accept what has already been produced for a generic customer. This has enabled customers to expand their market share, particularly among discerning and affluent clients who are willing to pay premiums for consistently high quality products. This ability to reduce costs and risks while simultaneously increase revenues has strengthened participants' business relationships, and fostered the enthusiasm and commitment that is critical to sustaining value chain initiatives and enabling sophisticated market-focused innovation.

3.2.4 Goat Genetics

The final example of the strategic use of traceability comes from Canada, where a goat farmer uses traceability to help better manage his business and capture greater value by differentiating his products in the market. This has also enabled him to secure new markets in ways that would otherwise not be possible. He considers the ability to comply with regulations as "just an added benefit."

His management and traceability processes begin by only purchasing purebred genetics with roots that trace back to breed origins in Switzerland and France. Only accepting genetics by way of frozen semen or embryos allows the herd to remain closed, which reduces variability and lowers the risk of disease from being introduced to the herd. It also enables him to monitor trends in performance and identify anomalies or opportunities considerably sooner than could be seen with the human eye. Each animal he raises is given a unique tattoo inside its ear which links to the RFID band on the foot, with data being uploaded to a computer. This information can also be accessed remotely. It also allows herd owners from around the world to monitor animals whose genetics they want to buy, and stay informed about animals they have already purchased, which are related to animals on his farm.

Webcams have been installed in various locations across the goat farm so that customers, or stakeholders who demand full disclosure, can monitor animals as they move through the barn, feeding, and milking station. The animal security code is taken at key points and labelled for milk to be sold as a differentiated product. End consumers can also develop a "relationship" with the farm, to see the animals from which they have bought milk products.

3.3 Health and Safety

The agri-food sector and public health are becoming increasingly intertwined. The agriculture community, as the key source of food, has a critical role to play in maintaining the health of people and the environment, and can help reduce burgeoning health-care costs. Indeed, both

human health and the agriculture and food industry stand to benefit greatly from an integrated food strategy enabled through effective traceability (Sparling, 2010). This raises possibilities and also poses many questions. One is: What impact does traceability have on public trust in food and on public health issues?

In the past two decades, foodborne diseases have emerged as an important and growing public health and economic issue. Contamination of foodstuffs by micro-organisms (e.g., bacteria, fungi, parasites, and viruses), chemicals (e.g., food additives, pesticides, and veterinary drugs), toxins, and allergens can occur at any stage of the process from primary production to food preparation. In addition, food contamination may occur through environmental pollution (air, water, and soil).

Foodborne diseases, which are usually acute in nature (self-limiting and short duration), are now a significant concern for governments and industry, especially in terms of economic impact and social disruption. Several factors contribute to this situation:

- Globalization of the world's food supply and the fluidity of worldwide shipments of fresh and frozen food;
- Identification of new bio-agents that cause life-threatening conditions;
- Traditional agents that were not a previous concern are increasingly associated with foods (e.g. *Salmonella* and *Escherichia coli* on ready-to-eat salads packaged and distributed internationally);
- Migrant populations demanding their traditional foods in their country of settlement;
- Increasing number of outbreaks of foodborne diseases being reported; and
- Impact of foodborne disease on young children, the aging population and immunocompromised people.

Betsy Donald, in her 2009 paper for the Martin Prosperity Institute, provided a succinct summary of some driving forces behind changes in the agriculture and food industry as consumers seek assurances and superior value:

> *"Phenomena like food scares, declining rural communities, rising cultural awareness, and growing public unease around the social and ecological attributes of food are having the effect of motivating more people to eat 'quality' foods. Quality, of course, means something different to everyone. For the quality-seeking consumer of a specific ethnic product, quality may be defined as the ability to find an 'authentic' product from their homeland; for another, it may be about consumer products grown locally; for another, it may be about buying products free from certain allergens, synthetic additives, pesticides or herbicides regardless of the source. Knowledgeable consumers are searching for*

> *something different from what has traditionally been available from mainstream producers, processors or retailers."*

In the near future, foodborne illnesses are expected to become an even greater problem. This is because existing pathogens are increasingly resistant to drugs, new pathogens are emerging, and because of the continuing globalization of the food supply. Scanlan et al. describe the extent of this in their 2011 paper: they estimated that foods consumed in the US were contaminated with 31 known agents of foodborne disease, causing 9.4 million illnesses, 55,961 hospitalizations, and 1,351 deaths each year. Norovirus caused the most illnesses; nontyphoidal *Salmonella* spp., norovirus, *Campylobacter* spp., and *T. gondii* caused the most hospitalizations; and nontyphoidal *Salmonella* spp., *T. gondii*, *L. monocytogenes*, and norovirus caused the most deaths. Health Canada has estimated the impact of acute foodborne illness on Canadians (Health Canada, 2008) between 11-13 million cases of gastro-intestinal illness per year and estimated at over $1 billion a year in direct healthcare costs and indirect losses in productivity.

These cost estimates are modest. They fail to include unidentified pathogens, the travel cost to obtain medical care, time lost from work caring for the sick, or the cost of chronic complications (such as the reactive arthritis associated with *Salmonella*). Moreover, these estimates do not include resultant costs imposed on the food industry or public health system as a whole.

3.4 Traceability and Industry Welfare

Reliable and readily accessible traceability information for agriculture and food benefits industry and governments as well as consumers. Establishing a value chain traceability system is a strategy that governments and industry should use to win the confidence of consumers and address requirements posed by international trade agreements.

Science-based traceability provides reliable and relevant product information and documentation, which are required by Canadian and international food safety standards. The benefits to agriculture and food businesses go beyond the conventional goal of complying with legal requirements. A number of studies have been undertaken in various jurisdictions to determine the impact of traceability (Dagenais, 2009). Conclusions regarding the value of traceability from a trade and economic development standpoint include

- Lowering costs in managing disease outbreaks (during a FMD outbreak, traceability could reduce costs in Canada by $21 billion),
- Reducing and containing impacts of zoonotic diseases (that can be transmitted from animals to humans),
- Contributing to maintaining/regaining markets ,

- Reducing costs in administering Animal Health Programs,
- Enhancing animal welfare by locating animals during natural disaster, and
- Decreasing the risk of unfounded liability claims by documenting who is *not* part of the problem.

At the peak of the BSE crisis in 2003 and 2004, the economic cost to the Canadian cattle industry was estimated at $11 million per day. The accumulated impact has been estimated at between $9 and $11 billion; and 10 years later the beef industry is still recovering its production levels to those prior to 2003. If another BSE-like crisis were to occur, it would have devastating consequences for the industry. Not only would it affect domestic demand and food prices, but more than likely it would severely restrict export opportunities for Canadian cattle and threaten up to 50 percent of Canadian production capacity. Enabling greater industry-wide innovation and more effective disease control are just two reasons why Canada's beef industry could benefit from a fully integrated and mandatory traceability system, such as Australia's National Livestock Information System (NLIS).

The benefits of commercial industry taking the lead in establishing more effective traceability systems, versus governments simply imposing more rigorous legislation, are increasingly obvious and global in scope. Internationally, new regulations on food authenticity, traceability, and nutritional labelling are being drafted and imposed. In Europe, regulations are already being revisited, thanks to a recent spate of weak control problems associated with food (such as, horsemeat contamination in beef products), animal feed, and animal diseases. European consumers are continuing to crusade to restrict production and use of foods and feed ingredients derived through biotechnology. Consumers are demanding that food and food ingredients be identified clearly. Similar concerns are being voiced in Canada and the US, as regulators begin to address new regulations that will make traceability mandatory.

The food industry, for its part, has developed systems and standards aimed at ensuring food safety. These include chemical, mechanical, and biological inspection of final products, and the use of safety control mechanisms, such as Hazard Analysis and Critical Control Point (HACCP). These safety control systems are not in themselves traceability systems. However, the implementation of traceability dovetails with the existing practices and processes used to support compliance with food safety standards.

4 The Cost of Traceability

4.1 Business Costs of Traceability

According to the Institute of Food Technologists (2009), the costs of implementing and maintaining the capacity to identify the source of inputs/ingredients for all products, to track product transformation within the facility, and to identify the location and time of shipment for all products, can be significant. Key data elements (KDEs) must be collected at critical tracking events (CTEs) to ensure traceability is reliable. Substantial work has already been done by industry groups and international organizations to identify CTEs and the associated KDEs. These are the building blocks of the data needed for traceability to work.

However, in many cases the resources required to acquire and maintain equipment dedicated to information management, product labelling, and information sharing are already being borne by businesses as part of their routine operating costs.

Critical Traceability Events are transactions that occur at significant points along the value chain. For example, CTEs include shipment, receipt, transformation, depletion, and disposal activities.

Key Data Elements are attributes of a product that are significant to identifying a unique quality of a product. For example, KDEs can include source party, target party, premises/location, lot or batch identifier, quantity, etc.

While perhaps not traceability per se, a key point many businesses miss about traceability is that many of the processes, systems, and practices (and actual data recorded) are already in place for food safety and good production efficiency, and can be exploited for traceability. Traceability often simply requires accessing, and using differently, what is already available. While software and hardware may be required to facilitate a value chain traceability system, particularly for companies that currently have only manual (paper-based) systems, excellent, cost-effective products and on-line services have already been developed.

A variety of factors impacts the cost of implementing a food traceability system. These factors include the size of the company and its technological sophistication, the adaptability of existing tracking and record keeping processes within the company, and the relative competitiveness of the company. The availability of existing technologies from commercial vendors will also affect costs, especially if they cannot adapt to existing systems and business practices.

Costs may also vary depending on the nature of the food product, including the harvest and packing location, how product is packed and shipped, its perishability, and whether it is used in further processed product. An effective traceability system must be successful at the firm level and compatible with the value chain. For these reasons, an often overlooked cost is the lack of standards and the impact on individual businesses.

All of the businesses mentioned in this report (and countless others around the world) are gaining substantial financial benefits from implementing traceability as part of a wider strategy. Implementing traceability for traceability's sake can often be just a cost. Yet, when it is part of a value-driven business strategy, it is effectively free due to the added benefits it brings.

Manual record keeping invariably incurs hidden costs: there is increased likelihood of inaccuracies due to human error, increased rework associated with fixing mistakes, and lost opportunities from not having rapid access to reliable and relevant data required to make informed management decisions. Therefore, the greatest cost incurred by businesses can stem from not having implemented effective information management systems at all.

Until now, larger companies could justify investment in more automated systems by distributing their costs over larger volumes. Smaller companies did not have this option, that is, until the power of the Internet and the web-enabled application concept of "Software as a Service" (SaaS) (Webopedia, 2008).

The SaaS solution provider owns and maintains the software applications and the computers on which they run, and the user typically pays a "subscription fee" to access the software over the Internet. In addition to the subscription fee, the user only requires an Internet connection and a browser to run the application. Total costs are pooled and distributed over a large number of users/customers, so that total per user cost is far less than a standalone system.

This is an especially attractive model for small- to mid-size companies. How much is "far less" per user? Full featured warehouse management, traceability, production planning, and labelling systems are available starting at $125 per user per month. Just a labelling system might cost about $50 a month. Even once expensive RFID solutions are available at affordable fees.

A good "from any point to every point" traceability system can process data retrieval for real or "mock" recalls in seconds and instantly identify and document all the shipments, receipts, customers, vendors, and products involved (Miller, 2009).

Users have reported that the entire annual cost of their systems were paid for from the labour savings they received from not having to manually collect, organize, read, review, and summarize their traceability data. The benefit of increased customer confidence, while certainly more abstract, is also of value.

As value chains have grown complex and more interconnected, and food products more globally sourced, we have seen that, in the absence of good traceability, failure of even one member of a chain can severely damage many stakeholders. Brand owners have never been in a more vulnerable position.

Fortunately, cost-effective solutions now exist to allow even smaller manufacturers and packagers to quickly implement the most stringent of announced traceability and labelling requirements. Technological innovations are occurring rapidly and the benefits of electronic data collection and storage should be weighed against the additional costs of providing a traceability system (IFT, 2009).

Here, therefore, the opportunity for technology firms, the market for developing equipment, services, and software to help a broad base of agriculture and food businesses from the farm all the way to the store shelf, is substantial. The challenge will be how to capture that opportunity in a way that serves the largest number of stakeholders at a manageable cost of ownership and operation.

4.2 Economic Development and Trade Costs – The Case for Standards

When a company's only reason for implementing a traceability program is to meet regulatory (recall) requirements, it is not surprising that the costs incurred will often be viewed as a burden with little perceived payback. However, like other process improvement investments, traceability provides benefits that extend beyond simply meeting regulatory demands (Sparling & Sterling, 2005). The challenge is that governments and legislators have commonly failed in their responsibility to form the architectural infrastructure required for establishing effective and affordable traceability systems that businesses can use to increase their profitability, and entire sectors can use to sustain their long-term competitiveness.

Standards for data interoperability and systems interoperability are nearly non-existent in the agriculture and food industry. As a result, fragmented and widely disparate information management systems simply cannot work together to support the simplest of commercial transactions. And as a consequence, each step of the chain invests in its own technology and systems at a significant cost, which is exacerbated by imposing incompatible requirements on others in the chain. The equivalent scenario for trains existed in the 19th century, when numerous different rail track gauges were used sometimes even within single countries.

Each company faces a different set of costs depending on its circumstances. To estimate industry level costs of a traceability requirement, it is necessary to develop a set of representative companies that generally cover the range of possible circumstances. For each type of representative company, the existing system and required changes could be described, and an assumption regarding the typical product volume could be assigned. Then, using data collected through discussions with technology providers and companies, a company-level cost estimate could be developed for each type of representative company (IFT, 2009).

Industry needs effective traceability standards to speed adoption and implementation. The cost of government's and industry's failure to develop and use industry standards and protocols for

data and communications in the US packaged consumer goods industry has been estimated in the billions of dollars per year. Why does the agriculture and food industry think it is different? And why are they not addressing this issue?

These discussions need to occur and an appropriate mechanism must be developed to facilitate an ongoing dialogue about systems interoperability. Without such it will be difficult for agri-food businesses to embed traceability into their operations to the same extent as has occurred in other industries. Therefore, particularly as incidences such as "Horsegate" prove the potential ineffectiveness of legislation for enhancing traceability practices, improving system interoperability is the foremost challenge facing governments today.

5 Concluding Observations

The primary objective of this paper is to illustrate that effective food traceability can be considered as free. It is not a gift, but it is an outcome of a disciplined, professionally managed approach to data gathering, retention, analysis, and collaboration — particularly when embedded in the processes and operations that businesses employ to create and capture value.

We conclude by stating our observations from having studied traceability systems in operation around the world, and by determining that the agri-food food industry trails other industries regarding the extent to which ICT based traceability is used strategically to generate long-term economic and financial success.

5.1 General Observations

1. Traceability is a key tool in enabling effective risk management in all industries, from commercial and government regulatory perspectives.
2. Traceability is vital to the future success of the agri-food industry. Combined, food safety, animal health management and traceability can substantially improve the industry's approach to managing public health, food emergencies, disease, and operating costs.
3. The agriculture and food industry has done itself a disservice by separating traceability from the broader management systems upon which the financial livelihood of any business depends.
4. Traceability helps protect animal health, public health, and food safety. During an emergency, traceability systems can reduce response time significantly.
5. Traceability systems are increasingly a requirement for conducting international trade.

6. The challenge is balancing the costs and benefits of traceability throughout the agriculture and food value chain. Potential benefits will invariably outweigh the costs when tallied for an entire chain, but may not for each part of the chain.

7. The growing trend in development of exotic and novel foods, or genetically modified foods, adds to consumer concerns and the need for effective traceability.

8. Maintaining the security of the food supply is a shared responsibility among government, industry, and consumers. Large retailers are pressuring suppliers to have traceability for their products (McDonalds, Wal-Mart, Loblaw, etc.).

9. Outreach and education is essential. Traceability systems are most effective when the entire value chain participates in a system. Outreach and promotion efforts must be part of the system's maintenance and operation.

5.2 Public Policy Observations

1. Governments are well placed to work with industry groups to coordinate the regulatory and non-regulatory incentives required to create a fully compliant system, and facilitate dialogue between food chain stakeholders.

2. The agriculture and food industry and governments share common needs to protect public health and the well-being of the food system. Mandatory traceability is an appropriate policy response to these needs.

3. Governments want to limit the extent to which public funds are used to impose mandatory traceability. At the same time, they must balance this desire against the potential costs of helping a seriously damaged industry or sector recover from an emergency such as an infectious disease outbreak.

4. The role of exhibiting the leadership required to produce effective traceability systems lies with industry, because industry has the needed resources, experience, and capabilities.

5. Public funding for traceability in food value chains is important, especially for smaller stakeholders. Much of current funding is used in the development of a plethora of different systems and tools without first establishing the basics, such as ensuring interoperability via effective data sharing standards, and uniform technical requirements.

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7 APPENDIX: Brief History of Traceability in Canada[2]

Livestock traceability initiatives began in Canada in 1990, with the creation of the National Advisory Board on Animal Identification, which was later transformed into the Livestock Identification Working Group. In 1998, the Canadian Cattle Identification Agency (CCIA) was created to coordinate the cattle sector's identification initiatives. Federal funding supported the building of that system. Industry commitment continues to support its maintenance and operation. In 2001, Quebec became the first province to formally legislate its commitment to traceability with the creation of Agri-Traçabilité Québec (ATQ), a not-for-profit industry-government partnership with a mandate to lead provincial agricultural traceability initiatives and systems. Quebec created a comprehensive regulatory framework for animal identification, premises identification, and animal movement recording first for cattle (2002), then for sheep (2004).

The creation of CCIA and ATQ were prescient events for Canada's agri-food industry. At the time, the crises overseas in the UK and other EU countries drove changes. European and UK industries were devastated by the economic, political, and consumer confidence issues emanating from BSE and Foot and Mouth Disease. The value of uniquely identified and readily traceable animals was made very clear — and shortfalls in the existing system were visible globally. The value of traceability systems in Canada would soon start to be understood. The Canadian government, under the authority of the Health of Animals Act, introduced regulations for national cattle and bison identification in 2001 and for sheep in 2004.

In 2003, the Agricultural Policy Framework (APF) signalled the importance of traceability to federal and provincial governments and solidified program funding to continue to advance traceability for national agriculture and agri-food organizations. In 2003 Can-Trace and in 2005 the Canadian Livestock Identification Agency (CLIA) were created. Both were the first multi-sectoral/multi-commodity initiatives designed to lead development of common national standards.

In 2005, the federal, provincial and territorial (FPT) governments formally recognized the unique opportunity to use traceability information systems for many applications, the benefits derived from traceability both for public and private good, and the importance of a coordinated, industry/government approach by creating a FPT Traceability Task Team (TTT).

In 2002 the Ontario On-Farm Food Safety Initiative began, and in 2003 a strategic steering group recommended a strategy to achieve a shared vision, including a traceability component, which was intended to proactively strengthen on an on-going basis the on-farm component of the

[2] With excerpts from *Towards a National Agriculture and Food Traceability System*, Agriculture and Agri-food Canada, 2006

Ontario Food Safety System. The joint industry/government strategy that was recommended was to establish two oversight bodies, comprising leaders from commodity groups, industry and government. The intent was to provide direction to project teams and facilitate the development of on-farm food safety and traceability initiatives. One recommendation was to create a coalition for on-farm food safety.

The other was to create a Traceability Task Force that would: (1) identify Ontario agri-food premises within a national framework, and (2) develop a provincial traceability node for crops and livestock. The Traceability Task Force engaged both government and industry leaders through the course of 2004 and 2005. The result of that effort was the Ontario Traceability Task Force report in October 2005, which recommended the creation of an Ontario Agri-food Premises Registry (OAPR) and a provincial “node” with an operating mandate and authority to lead traceability initiatives for the province.

An Industry-Government Advisory Committee (IGAC) was established in 2005 as an advisory body to lead the development and implementation of the National Agriculture and Food Traceability System (NAFTS). The IGAC is a forum for industry and governments to collaborate on traceability and comprises 22 industry members and another 15 representing FPT governments.

IGAC's vision is for industry and government to create a structure for a NAFTS, beginning with livestock and poultry, which will help prepare for and respond to crises, including outbreaks of animal disease and food safety emergencies. It will also help enhance industry's competitiveness and ability to retain or capture market opportunities.

In early March 2006, OnTrace Agri-food Traceability was incorporated, and a few weeks later, the Ontario Government provided a one-time grant of $10 million for an Ontario premises registry system to assist the province's agri-food industry to strengthen emergency management and capitalize on market opportunities.

In the summer of 2009, FPT ministers committed to a 2011 target date for the implementation of a mandatory national system for livestock. While progress has been made, the 2011 target has long passed and few provinces have developed the foundation of a multi-species, multi-commodity premises identification systems necessary, much less created a national animal identification system for all livestock. IGAC continues to meet twice yearly.