

# UNDERSTANDING THE RETAIL SECTOR: TOWARDS TRACEABILITY IN THE MEAT PRODUCTION CHAIN<sup>1</sup>

**Brian Buhr**  
**Department of Applied Economics**  
**University of Minnesota**

## ABSTRACT

The traditional food supply chain is arranged as a complex array of producers, handlers, processors, manufacturers, distributors and retailers. As the food supply chain grew in complexity over time, little emphasis was placed on preserving information regarding the origin of raw materials and their transformation, often by multiple handlers, into consumer ready products. The 1990's saw an explosion of the desire for information beyond the retailer, as many foods' final traits are increasingly determined and controllable at the production or even genetic level. Often these traits are not readily observable to the final consumer and labeling or other assurances are necessary to provide this information to the final consumer. Further demands for traceability have arisen from concerns about food safety and more recently bio-terrorism. In both cases the primary economic objective of traceability is to appropriately capture value or assign costs. So far, the North American food system has relatively limited traceability of food products, particularly animal products. Meanwhile, several European countries have implemented animal product identification mechanisms. Historically, these were managed by costly batch processing methods that are not likely to be implemented in the large-scale, throughput-oriented supply chain in the U.S. However, the advent of information technology including electronic scanning devices and the Internet offer promising technological solutions for maintaining large-scale supply chain efficiency while maintaining product identity. In 2001, case studies including several European meat and poultry supply chains were completed. The objective was to identify incentives for adopting supply chain traceability, to understand the economic costs and benefits of these existing traceability systems and to assess their potential for application in North American meat and poultry supply chains. This paper focuses primarily on the economic issues identified and uses illustrations from the case studies to underpin these results.

## INTRODUCTION

Food safety issues in meat and livestock have come to the forefront in recent years with high profile incidences of contamination by *e. coli*, BSE, dioxin, hormones and antibiotics all contributing to a desire to find ways to improve quality control systems in the meat supply chain. In the U.S., the primary large-scale response has been to implement HACCP programs from slaughter to retail. However, in the case of BSE or hormone and antibiotic residue, the need for quality control programs extends farther back to feeding and management practices

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<sup>1</sup> For those interested in more details than space permits in this paper, a complete description and analysis of the cases is available from the author (formal publications are in progress, but it's too early at this stage to formally cite them). Simply send an e-mail with your request to Brian Buhr at [bbuhr@apec.umn.edu](mailto:bbuhr@apec.umn.edu).

on the farm or even feed manufacturing. Extending this to include the use of genetically modified feed ingredients, product integrity must be controlled at the crop production stage of the supply chain. As a result, there are increasing calls for meat supply chain traceability initiatives along with identity preservation of genetically modified crop products.

A few recent economic studies have addressed the physical or market side of the traceability issue. Liddell and Bailey (2000) examine the broader market implications of traceability by ranking the relative development of traceability systems in the U.S. to other competing countries in world markets. They suggest the U.S. lags behind in areas of both food safety and quality control, particularly when compared to European suppliers such as Denmark and the U.K. However, there is no information in the report regarding the actual types of quality control systems in place or their economic potential. Hooker, Nayga and Siebert (1999) examine the food safety activities in the beef industry and primarily focus on the results of surveys regarding the ability to implement food safety practices, including traceable supply chains. Most processors in the U.S. and Australia viewed it as feasible, but the particulars of how it might be implemented or the economic costs of implementation are not directly addressed. Bullock, Desquilbet and Nitsi (2000) consider the costs of identity preservation and segmentation of grains, but construct their economic results from an economic engineering perspective with no hard information on actual costs and potential benefits of implementation. Maltsbarger and Kalaitzandonakes (2000) take a similar approach with regard to grains and Hobbs (1996) develops an economic engineering approach to implementation of traceability in beef processing. Missing from all the previous work is a look into the actual economics and practices necessary to implement traceability.

Five European organizations were chosen for this investigation. Participants included a poultry production system (Label Rouge/Challans, France); an egg production system (KAT/Wiesengold, Germany), a salmon production system (Intentia/Nutreco, Norway), a veal production system (The VanDrie Group, The Netherlands) and a lamb, pork and beef supply chain (Scase-Intentia/Gilde, Norway). In examining these systems several supporting organizations were also visited, including the Poultry Livestock and Meat Board in The Netherlands, several governmental agencies in France, and Carrefour supermarkets in France. This enabled us to discuss the implications with other participants with whom the focal organizations interact. There are several other firms implementing traceability schemes in the E.U. such as Pingo Poultry (Nutreco), Danske Slagterier (Denmark) and Beltrace (Belgium). Our selection included those willing to graciously open their systems to our visits. The objectives of the site visits were to document the supply chain production protocols, examine alternative forms of governance structures for supply chain traceability and document methods of electronic traceability. This paper, however, focuses on the economic incentives and implications of adopting traceability in their supply chains. This includes a diverse set of issues, which I believe require careful consideration as similar systems are adapted to North American meat and poultry supply chains.

## **TRACEABILITY SYSTEMS ARCHITECTURE**

The general concept of traceability as implemented by the case study participants included

three components – 1) management of the physical supply chain, 2) management of the parallel information system to maintain traceability and 3) organizational structures to manage and implement the production and information systems. This section provides a description of these aspects. For the most part this section is ‘fact’ base with little discussion of the implications, but sets the stage for the economic issues raised.

### **Physical Production Systems**

In all cases we visited, the traceability systems extended from the feed manufacturing process through retail. Also, each case had unique production protocols that supported the development of particular consumer product attributes such as organic production, group housing, free range or antibiotic free. All were also clearly focused on the joint issue of food safety. The production protocols typically stipulated production inputs such as feeds, health treatments, and animal rearing methods (e.g., non-cage, group housing, free-range) and genetics. Production protocols were enforced at all stages of the production process. In many cases the key implication of this was the need to manage the production modules as batch processing systems to maintain product integrity. This “batch” system also improved the efficiency of the information system by creating larger lots to be tracked, rather than tracking individual animals. Still, all systems were able to trace individual animals or products as well. In cases where the supply chain members were independent but cooperatively organized, group boards usually established the protocols. In the vertically owned and contracted cases, protocols were simply mandated by management and implemented at the production level. Most operations were of relatively small scale, compared to North American production standards. For example poultry farms we visited had a maximum of 4,300 chickens per farm and the processing plant (mid-sized by their standards) slaughtered approximately 2,000 birds per hour.

Logistics management in production becomes a key enabler of traceability. Animal supplies, slaughter times and locations, feed deliveries and other aspects were all tightly coordinated because the supply chains were relatively closed. Animals must be identified when they are born, carefully tracked as they are moved between farms and then tracked at slaughter if they are to be identified by the final product. The most intensive points of logistics were at aggregation/dispersion points for inputs (e.g., feed plants with ingredient inputs and packing plants where carcasses are disassembled). Batch integrity quickly becomes an important production management tool by reducing the sheer number of observations (e.g., animals vs. pens vs. barns vs. farms). The more individual elements (e.g. animals) that could be treated identically the greater ease in managing production protocols. Hence, production methods often fit the scale of barns. It’s very much analogous to all-in-all-out production management already common in the swine industry in this regard.

### **Information Systems**

Information systems we observed ranged from relying heavily on paper and personal computers to fully web-integrated traceability systems. However, it is clear that all will evolve to incorporate the Internet in some form because of its inherent merits for creating large and centrally managed databases. There are two key components to the information

systems: the computer databases and applications themselves and the information hardware necessary to collect and record data. Weigh scales with data ports, visual carcass grading technologies which enabled capture of key carcass parameters, water monitoring devices for measuring mixing ratios of calf-milk replacer are all examples of data collection devices which greatly enhance the ability to capture production information which can be part of the traceability information system. These lower the costs of collection, improve accuracy and avoid the error of human input. At this point, processing plants (feed and meat/egg) had a much higher level of automated data collection hardware than did farms. This was particularly true in cases where the farms were mostly independent from the rest of the chain.

In addition to measurement devices, there must be methods to physically identify products. Interestingly, the everyday barcode was still the primary vehicle for labeling products. Two firms (Gilde and VanDrie) had experimented with implantable and radio frequency id's (RFID's), but found they were unreliable compared to inexpensive barcodes. The primary problem with implantable chips is that they migrated in the animal so they were difficult to find (and more importantly may have carried a food safety risk in themselves) and RFID's had production line difficulties in getting them to read properly. At farms, much of the information was still captured via human data entry from paper reports, and multiple copies of paper reports were kept on file at other participants locations or at enabling agencies.

As mentioned the information systems varied from personal computer based databases in the case of Challans (they are moving to web-based databases) to state of the art web-based systems illustrated by Gilde/Intentia/Scase, VanDrie and KAT. The personal computer based systems are very similar to existing swine record systems but included information on all stages of the supply chain. The obvious drawback of this is that while it was functional for maintaining traceability it was nowhere near real-time and not physically or remotely accessible by someone not on the computer. So while they did have traceability, it was not very transparent to those external to the system. The state of the art systems were real-time and transparent to anyone. In the cases of KAT and VanDrie they had consumer focused websites where the consumer could take the code number from their egg or package of veal, enter it into a website and actually see the farms and plants where the product originated and a limited set of information of the production protocols, any quality assurance tests which had been done and their results. For an illustration, visit VanDrie's customer website at <http://www.vealvision.com>.

The overarching goal for much of the computer industry and IT is the development of standardized system architectures including databases and interfaces. This systems compatibility has dramatic spillover benefits for traceability and business management as well. From our observations it appears that the system that is in the front-running position is a combination of enterprise resource planning systems combined with corporate level intranet modules which then interface with web-based information systems for transmitting data to other partners in the supply chain. Enterprise resource planning systems (ERP's) basically serve the role of capturing and managing operations and management data. For example, VanDrie had an ERP for its' feed manufacturing plant which was specific to feed processing. This ERP analyzed real-time ration formulation and then captured the data of the final batch that could then later be used to support traceability. This has the advantage of being highly

customized to the particular application (in this case milk replacer blending), but is secure because there is not outside access to the system. A subset of this data was uploaded to the VanDrie corporate intranet which simply is a server (database) which links computers within their operations (feed, farm, slaughter). The feed ingredient identification and any tests that were relevant to the farms or the slaughterer were uploaded to this intranet, making it available for tracing information. Similar activities are done at each stage of the production process (e.g., farms had veterinary certification and treatment records, the slaughter plant had carcass information, etc.). Of this universe of data from all stages of operation, only the subsets necessary for confirmation of traceability to outside parties (e.g., ear tag identification numbers, test results, prices, etc.) were added to the Internet database.

The merits of this information system are considerable in that it captures the efficiency of production management systems (ERPs), while enabling efficient transmission of information to upstream and downstream participants in the chain while maintaining security for the entity. The KAT organization and Gilde/Scase managed very similar information systems from an architectural standpoint. Clearly, the more efficiently data can be captured for input into the system the more valuable it becomes, so bridging the physical world and the digital world is an extremely important component of traceability. Note also that in many cases, the networked traceability systems doubled as sales planning systems. In the cases of Gilde, Label Rouge, and VanDrie, they all had mechanisms for retailers to place orders directly into their system and even provide pricing information so that the price labels could be directly applied at the plant. This has tremendous potential for creating dual traceability and supply chain management benefits.

One of the most striking insights from the traceability systems we observed is that while their goal seemed to revolve around a desire to improve information and create the ability to trace and preserve identity, there were two significant spillovers. First, it enabled dramatically improved collection of data about production processes which was then used for production management decisions, and secondly, it naturally led to improved supply chain coordination for other purposes such as pricing, ordering and aligning supply and demand. Much of the theme of the rest of the paper will include the theme that potentially the greatest impact of traceability is not the success of preserving the identity for products, but actually these spillovers into the areas of production management and supply chain management.

## **ECONOMIC TRADE-OFFS IN TRACEABILITY**

### **Branding, Consumer Demand and Traceability**

When we asked our case participants why they adopted traceability, the first response in every case was: “consumers demanded to know where their food came from and how it was produced.” Why consumers wanted to know this clearly had to do with historical food safety issues such as dioxin contamination, BSE in cattle, radiation contamination as well as increased demand for organic products or free range products. However, the participants consistently co-mingled these other product attributes with traceability. So, it was impossible to say whether consumers actually demanded traceability or if they actually demanded other product attributes (e.g., organic poultry) or some combination which is most likely. When we

speak of traceability in the physical sense of the control mechanisms and information systems to accomplish identity preservation, we also need to differentiate between this and HACCP procedures which also improve food safety. A prime example is the potential substitution of irradiation for traceability. What value does traceability have when irradiation breaks the chain of pathogens to that point? Traceability by itself may only improve food safety by enforcing truth telling and possibly by improving information on processes which contribute or detract from food safety.

In this context, branding can be thought of as a traditional form of traceability. By labeling it clearly identifies the seller to the buyer. This has two benefits: it allows the buyer to capture the value of their particular product by differentiating it to the consumer and it enforces truth telling or a form of reputational traceability in the sense the company and its' brand are held accountable for delivering what they say they will deliver – in the present case a safe and wholesome food product. Case study participants often viewed traceability as supporting branding by increasing consumer confidence in the production process. However, this could be obtained through effective control mechanisms without traceability in place. It also implies a potential failure in branding in that consumers do not trust the assurances provided by brands but seek to have the ability to examine those assurances themselves. Therefore, the current argument is that firms, and especially firms with consumer brands seek traceability to support their brand by tracking their suppliers. This is a very important distinction – consumers probably really don't care how their food got "safe", but they will penalize those with unsafe products. The branded firm will seek to push those penalties back to suppliers who might be the actual cause of any problems. Similarly, from a value perspective of firms in the supply chain without consumer brands, they are seeking to capture value from the downstream firm with the consumer brand. Hence, I argue that while traceability is often packaged as a consumer demand issue – it is at its' heart an intra-firm allocation issue. To the extent consumers view this as superior is likely a psychological benefit (not to minimize the fact this can have important marketing value). In the same sense, brands are eroded by 'mistakes', traceability will be eroded as a consumer value as there are 'mistakes' and may perhaps be more severely penalized for mistakes because of the implied integrity of traceability.

### **Food Safety and Value Capture**

All participants illustrated concerns regarding mitigating costs and improving food safety and capturing the value of product attributes which were often categorized as credence attributes. Credence attributes are simply those attributes which are only verified by assurances of the seller, many animal welfare issues (battery cages, free range, group housing, etc.) are undifferentiable to the consumer but for the claims and assurances of those using these production methods. This is in contrast to physical attributes (e.g., the color of the meat) which is easily observable and verified by the consumer. While capturing value through traceability is a one sided coin – firms benefit if they can capture value they have contributed to the final product, food safety is a two sided coin – on one hand creating superior food safety can be a value added attribute, at the same time it can result in high costs if not accomplished – hence having positive and negative consequences. Value capture is relatively straightforward and so emphasis in this paper is focused on the food safety issue.

The food safety implications of traceability are quite interesting. First, though it must again be emphasized that food safety issues for the firm can be controlled through HACCP processors or technologies (e.g., steam pasteurization, irradiation, worker and production line hygiene, etc.), while traceability largely involves information about these processes or products. Traceability has two components in its economic effects on food safety (1) it assists in identifying the origin of the food safety problem and (2) it likely reduces the costs of containing a food safety problem if it occurs. Navobi, the calf-milk replacer manufacturer, provided an excellent example of this point. Their veterinary services identified a salmonella problem in routine on farm testing. They immediately sampled feed batches at the farm and also were able through traceability databases to identify all possible other farms using feed from the same batches and which ingredients and their sources had gone into the suspected feed batches. Therefore, they were also immediately able to go back to plant records to cross-check feed testing which had occurred prior to its sale. They found that no feed was contaminated and that the salmonella had been introduced by other means on the farm. Without traceability they would have recalled all suspected feed immediately to reduce the risk of cross contamination to other farms, and likely wouldn't have been able to identify as quickly that the contamination had occurred on the farm versus at the manufacturing plant. They did an ex post assessment of the cost savings from traceability and estimated in this single instance it saved them over \$100,000 in recalls and recovery costs. What this example illustrates is that the value of traceability likely depends on the overall risk of contamination and the costs of testing or controlling for that risk, and also the overall potential costs for recall. The costs for recall also depend on how widely the product is distributed upon its release. In a relatively closed system such as VanDrie's feed manufacturing and calf feeding, the potential recall costs are small compared to potential recall costs for ground beef which can be distributed very widely and can even be used as ingredients in other manufactured food products. Proper valuation of traceability in any instance depends on the following issues 1) the accuracy of testing and sampling procedures for detecting contamination 2) the costs of sampling and testing or control (HACCP) procedures 3) the dispersion of the product once it leaves the control of the firm 4) the probability of contamination itself 5) the costs of recall and 6) any potential costs in terms of liability and reputational damage. What traceability likely contributes to these issues is that it reduces the costs of recovering from a food safety outbreak and to some extent may reduce the probability of outbreak by improving information within the process and enabling communication and identification of potential issues more quickly and efficiently among participants. To simplify this logic, think of it as the proverbial "ounce of prevention and a pound of cure". You can prevent outbreaks and food safety issues through preventative measures such as improved sampling, testing procedures and technologies, or you can reduce the "pounds" or costs of compensating should an incident occur. This recognizes the fact that given the biological nature of food safety issues, there is no "zero risk" state and that traceability has a contribution to make in improving response (hence lowering human health implications and costs) and helping improve communication.

The previous discussion ignores the "allocation" problem. The current issue with many food safety issues is that the restaurant or grocery store who last handles the product before consumption is the initial focal point for identifying the problem and also for resolving it and potentially bearing the liability costs. Similar allocation problems may exist at all stages of

the chain. In this case, traceability plays an important role in both allocating costs once an outbreak may have occurred, but probably also inherently improves it because firms are more likely to implement control procedures knowing that their probability of being held liable and identified are much greater. This is a similar argument on the value-added side of the issue.

### **Retailers and Traceability**

Although our focus during the case visits was not on retailers; given the consumer, branding, value added, food safety and logistics issues involved in traceability it's not surprising that retailers are the nexus where traceability comes together. In particular, grocers and even restaurants view fresh meat and produce as the final strategic niche in which they can differentiate themselves to consumers (vs. WalMartization). However, retailers find themselves in a strategic conundrum in the nexus between food safety, value added and traceability. On the positive side, traceability enhances their ability to offer value added products such as improved safety or organic products as it helps them assure that the attributes claimed are accurate. Also, traceability naturally fits into major retail initiatives of ECR (efficient consumer response) and CPFR (continuous planning, forecasting and replenishment) where information systems and standardization for logistics are critical to success and an area in which meat products (with variable weights and cutting differences) largely defy systems applied to dry goods. As we'll see shortly for the rest of the production chain, traceability also enables retailers to avoid the "liability by association" problems they face in anonymous supply chains. The negative side is that traceability, if left to manufacturers and producers, leads to more value and more responsibility being shifted to the manufacturers and suppliers. In all the traceability cases we observed the manufacturer or producer branded the product and assured traceability using a case ready product. This is positive for retailers' logistics management and in store processing and fabrication and liability perspective. But it potentially destroys their ability to strategically differentiate themselves from competitors who will carry the same brands, traceability claims and products provided by manufacturers. In fact from a manufacturer's perspective the broader the retail base the better. So, retailers move more towards WalMart's competitive advantage of simply selling shelf space and least cost logistics management with traceability shifted to manufacturers. What is retail's response? What will likely emerge are "store or chain" based traceability systems where closely aligned production systems originate at the retailer and are linked through the manufacturer to producers. This is the only mechanism by which stores can maintain strategic competitiveness in this arena and explains why Marks & Spencer has aggressively promoted traceability in the UK and is also an incentive for Safeway foods in the U.S. to have invested in Future Beef with a concept of supply chain traceability.

### **Firm Specific Production Economics**

As implied in earlier discussions, traceability often has production benefits from improved information and control of production even though traceability has generally been couched as a supply chain management issue. In large part this stems from the incorporation of ERP systems at the firm level that inherently improved data collection, as well as analysis, diagnosis and response of potential production issues.

Perhaps Gilde Norge, the Norwegian slaughtering plant, provided the best illustration. In implementing traceability, they incorporated a visual grading system. In this system, the carcass is photographed on the line and a computer program immediately uses the image to construct parameters on the size of the carcass. This information is instantaneously compared to previous carcass yields from similar carcasses already in the database. This information is passed to terminals along the line, which show appropriate cuts to be made in subsequent fabrication to maximize the yields of the carcass. As the carcass is fabricated data is captured on the actual yields of the fabricated cuts and compared to the predicted values prior to fabrication. This ongoing real-time analysis of carcass cutouts aids in quality control and improves yields. In fact, at the end of each week the workers on the line are evaluated based on the data collected on their cutting efficiency and abilities to meet expected cutout yields with actual yields. They attributed this continuous improvement as adding 5-10% to their final meat yields.

Similarly, in all cases, strict controls on feed use and scheduling of delivery of animals naturally led to improved production management for growth efficiency and certainly enabled benchmarking of farms within the production system as was the case with Label Rouge in Challans. Each grower received a quarterly report of their relative efficiency compared to other growers within the syndicate.

Traceability has a multifaceted economic impact on firms and the supply chain. The key point is that there are potentially real economic cost and management benefits at the firm level at the same time that it improves coordination and allocation of values and costs in the supply chain. At this point, we have successfully identified the key tradeoffs. Further empirical work needs to be done to provide a clearer picture of whether traceability has net benefits to firms and the supply chain.

### **Governance and Structural Change Issues**

Traceability in general has implications for the structure of the supply chain and how firms organize. In general, there are two aspects of this governance and structure 1) the organization and structure of the firms themselves and 2) the organization of the controlling agencies and auditing firms. In all of the cases we observed the chains incorporating traceability were very tightly coordinated. The VanDrie group and Nutreco were completely vertically integrated except for growers which were sometimes contract growers and sometimes owned production units. Gilde and Wiesengold were cooperatives, but growers were tightly coordinated through contractual membership into the supply chain. Lable Rouge was organized as “syndicates” with feed companies, growers and plants pre-approved for membership, but products within the syndicate could be transferred among alternative members. In all cases we observed the overall production chains were relatively small compared to North American commercial production standards. The key issue with size and structure is the scale compatibility between stages of production which enables traceability. In other words, it generally took a relatively small number of growers to satisfy the demands of processing plants or to absorb the supply of feed plants. The primary scale incompatibilities in the North American supply chain may very well be that our processing plants and feed manufacturing plants are of such a scale that it presents coordination problems with the large number of

growers needed to manage traceability in the supply chain. Obviously, the fewer operations which need to be traced the more easily traceability can be implemented. In fact, VanDrie had difficulty coordinating their conventional beef operations for traceability because it required over 500 growers versus the 100 growers who were supplying their veal operations. One hypothesis is that traceability may have diseconomies of scale in that it is more cost efficient and operationally efficient on a smaller scale than non-traceable commodity production.

In the case of Label Rouge and Wiesengold, there were “control agencies”. The control agencies (KAT in the case of Wiesengold and Sylac in the case of Challans/Label Rouge) were responsible for managing records, establishing production protocols and standards, arranging for auditing and maintaining the databases supporting traceability. In other cases, the controls were internal. Auditing agencies were always external to avoid conflict of interest in application of production standards and traceability. Label Rouge also had extensive government involvement in managing the system. The Ministry of Agriculture and the Ministry of Finance had roles in developing and approving standards, establishing labeling requirements, and in preventing fraud. No other system had direct government involvement although government policies on traceability and food safety often influenced their decision to implement traceability or how it was implemented. KAT as an independent controlling agency offers a good example of how production protocols and participation is managed. KAT was developed by the European Poultry, Egg and Game Association. It developed the traceability information system and also manages the control processes and data collection. However, outside auditing agencies perform system checks to assure compliance with their protocols. Members such as Wiesengold propose standards (such as feeding, medication, and other production protocols) which distinguish their supply chain. Producer members can then approve or reject these standards. Once approved, all members are audited, including processors, farms and feed suppliers if appropriate. Audits are often done on a monthly, quarterly or annual basis or around production flows of the system such as when animals are ready for slaughter or when new animals are brought into the system. Members pay a fee for the audits and for being members of the control group. Members who do not comply are removed from the system. This is very important as they recognize their vulnerability to lapses in quality control.

It will generally be true that intensive traceability as we observed would require very tightly coordinated supply chains. How this coordination is achieved will also be important. The cooperative forms all recognized two potential problems 1) it was difficult to get membership buy-in to new protocols which may require increased investment since the members were otherwise autonomous 2) the first issue may affect their ability to be responsive to changing demands or new innovations. It appears that full integration has merits in both of these instances, where protocols can be updated and enforced at will. Secondly, it is clear that traceability has implications for size compatibility among participants in the supply chain. It appears that very large plants with a large number of suppliers or buyers will have difficulty managing traceability – it is simply a numbers game and as numbers increase logistics and control become more expensive. Information technologies are successful at reducing the costs of managing large numbers of records, but the requirement of control, auditing and verification is still largely a hands on process which gets more costly as scale increases.

Given the politically charged notion of “independence” at least in the U.S. agricultural sector, it is our contention that traceability at this point probably favors vertically integrated operations. Canada may have a slight advantage in their history of cooperative marketing boards and pooling similar to what is observed frequently in Europe.

### **Public Policy and Public Health**

2001 was a horrific year for conducting case studies in Europe. When we proposed the research, we were focused on what now appear trivial issues of supply chain efficiency and the role of information systems. As the year progressed, the outbreak of foot and mouth disease in the UK, the events of September 11, and subsequent anthrax terrorism in the U.S. had a direct bearing on our ability to do the research, but also on the implications of our research. Traceability has direct implications on the ability to contain both natural outbreaks of devastating diseases such as foot and mouth disease, but also on the ability to respond to and contain potential food borne bio-terrorism events. While much of this paper considers the implications on firms, in this new world, traceability is a public health and policy issue. Since we did not specifically consider the issues of the public costs of disease outbreaks (e.g., in the UK, the military was involved in quarantine, containment and clean up and disposal) it’s difficult to estimate what the potential benefits of animal identification and tracking systems might be but it’s safe to say from the UK experience that they total in the millions. Similarly, with bio-terrorism, the rapid identification and sourcing of pathogens can potentially save lives and even assist in bringing culprits to justice. At this point, suffice it to say traceability will be a component of public policy regarding food safety and health. The important question is again “how much traceability is enough”. Animal identification and tracking would seem to be a minimal set of traceability. Again, the interesting trade-off in the meat chain is the fact that there are intervention strategies such as irradiation which may have more merit than traceability. However, these tradeoffs need to be examined. Developing national systems on the order of the VanDrie Group’s intensity would likely be extremely burdensome from a cost perspective. Similarly, doing nothing likely exposes us to extreme public health and economic risks. Interestingly, the U.S. was opposed to the EU regulations requiring animal identification and tracking which became mandatory in January 2002 in August of last year because the U.S. felt it represented a trade barrier. Now, similar identification is being proposed in U.S. legislation (H.R. 3448).

### **CONCLUSIONS**

This paper has raised several issues which require further empirical investigation. However, the data from our visits also provides some guidance for some relatively confident conclusions. First, it is clear that electronic information systems greatly improve the potential for identify preservation, management of the supply chain and firm level management. Second, it is very likely that traceability will lead to more closely coordinated supply chains. Whether these can be cooperatively managed or if vertical ownership is more efficient is an empirical question. Third, traceability can improve the allocation of economic values, but the empirical question is does integration do the same thing and to what extent does integration become more valuable because of traceability and the ability to increase the control of a

broader asset base. Fourth, it is very likely that new government policies as adopted in Europe will mandate or require some form of traceability. Finally, producers must begin to consider how they can capture and control their own information to improve the value of traceability for their own situation.

Given recent events, the relevant question is actually one of “how much traceability is *enough* traceability?” For example, without any additional investment in the U.S. meat supply chains, animals likely can be traced from packing plants back to individual finishing farms by using existing business documents such as invoices, shipping or weight tickets and other similar documentation. Lot or batch numbers can also be used to trace most meat products back to plant of origin and even with a reasonable level of confidence to the date they were manufactured and therefore narrow the window of possible sources of contamination. Is that enough? Would we also like to be able to trace the feed batches? Would we also like to know before actual entrance into the meat chain what other farms may have been supplied this feed? This is the central policy and business issue in traceability, particularly when considering food safety issues. How much is enough depends on the costs of tracing products, the potential costs if a contaminating event occurs and the potential costs of recall or discovery if a contaminating event occurs. These costs in turn are affected by the likelihood of a food safety event occurring and also the ability to control this likelihood given quality control strategies (e.g., feed testing at the farm) and the ability to intervene (e.g., irradiating for biological pathogens). This complex set of trade-offs is basically what defines how much is enough. So far, relatively little information exists on the empirical value of these trade-offs.

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