Livestock Identification: Lessons for the U.S. Beef Industry from the Australian System

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ABSTRACT. An array of concerns about animal health, potential bio-terrorism, food safety, international trade, consumer demand for credence attributes, and improving supply chain management are igniting unprecedented change in the international meat and livestock market. One noteworthy development is accelerated advancement of national individual animal identification programs. This study reviews how these systems work and what motivates animal traceback system implementation. A case study approach is used to overview an extensive system currently being used and developed in Australia. Based upon the Australian experience, we present recommendations for pending U.S. animal identification systems.

KEYWORDS. Animal identification, Australia, credence attributes, food safety, individual ID, meat markets, traceability

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INTRODUCTION

International meat and livestock markets are experiencing unprecedented change. Concerns about animal health, potential bio-terrorism, food safety, international trade, consumer demand for credence attributes, and improving supply chain management are forcing an array of changes in the global meat industry. Countries seeking to build, or even just sustain, access to international meat markets must respond to these concerns to meet demands of international meat consumers. Even more important than satisfying international consumers, U.S. meat industries must address demands of domestic consumers. The U.S. meat industries are fortunate that domestic consumers tend to have a high degree of faith in government regulatory agencies protecting the food supply; in fact, U.S. meat consumption has not dramatically changed following recent food safety events (Piggott and Marsh, 2004; High Plains). However, U.S. consumers demand meat product safety assurances and they have revealed a willingness to pay for meat traceability (Dickinson and Bailey, 2002) and for attributes that could easily be verified by traceability systems (Loureiro and Umberger, 2003).

Among the numerous responses to concerns regarding animal health, potential bio-terrorism, food safety, international trade, consumer demand for credence attributes, and improving supply chain management is a recent acceleration in development and implementation of national individual animal and meat traceability programs (Souza-Monteiro and Caswell, 2004). The discovery of a Bovine Spongiform Encephalopathy (BSE) infected dairy cow in Washington State in the U.S. in December 2003 increased the urgency of having a system to facilitate quick and accurate trace back of animals throughout the production process. In developing U.S. individual animal traceability systems, valuable information can be gleaned by examining experiences of countries who have already implemented such systems. As one of the pioneers of cattle trace back systems, Australia has had a cattle identification system of sorts in place since the 1960s. With evolving human and animal health concerns and the need for rapid trace back, the Australian beef industry has continued to develop animal identification and all states either have a mandatory individual animal identification system in operation or it is being phased in.

To better understand the Australian animal identification system, develop recommendations for the emerging U.S. traceability system, and expand awareness of changes occurring in the international meat marketplace, this study investigates the Australian beef industry and its

animal traceability system. Australia's animal identification system was chosen for this research because Australia is a large exporter of meat products that has taken a number of initiatives to build and sustain access to the international beef market. Furthermore, Australia has a long history of developing one of the world's more advanced national animal traceability programs.

This research was primarily conducted during a visit to Australia in June of 2004 to meet with government officials integrally involved in the identification system, information management associations, livestock lobby groups, private firms producing animal identification devices and developing traceability technology, and producers currently participating in the national animal identification system and using the technology to enhance management intensity. This paper proceeds with a section describing traceability systems and a brief discussion on the economics of animal traceability, followed by a description of the development of the Australian animal traceability system. Finally, comparisons of the U.S. and Australian beef sectors are provided followed by recommendations for the developing U.S. animal identification and traceability system(s).

TRACEABILITY SYSTEMS

Traceability systems are "recordkeeping systems designed to track the flow of product or product attributes through the production process or supply chain" (USDA, 2004b, p. 1). Policymakers worldwide are investigating the benefits of implementing national traceability systems within food industries to help manage animal health, prepare for possible bio-terrorism, food safety concerns, verification of product attributes, and many other individual motivations. In 2000, American companies spent $1.6 trillion dollars on supply-related activities, such as the storage, movement, and monitoring of products throughout the production process (USINFO). Substantial incentives exist to reduce marketing costs and to ensure product integrity and consumer confidence, and implementation of sound traceability systems offers one possible solution.

Liddell and Bailey (2001), describe traceability as "identity preservation" that can be accomplished by tracking inputs used in production of food back to their origin at various levels in the supply chain. The basic idea of tracing systems is to create and maintain an "information trail" that closely follows the path taken by the physical product being monitored.

Defining traceability is difficult as "traceability systems" are often unique and can operate in a number of different ways with a range of objectives. The *breadth*, *depth*, and *precision* of a traceability system are each carefully selected to help achieve the objectives of the system (USDA, 2004b). *Breadth* is often described as the quantity of information that is maintained in the traceability system. For example, breadth might include issues such as what farms the animal has resided on, how long the animal was on each farm, what other animals the animal has been in contact with, what pastures the animal has grazed and for how long, to what forages were contained in those pastures, the age of the animal, if each producer possessing the animal utilizes growth hormones or genetically modified feeds, etc.

Depth refers to the distance traceability is ensured either backwards or forwards within the supply chain of the industry or firm utilizing a traceability system. Depth may include questions regarding whether a particular meat product on the retail shelf can be traced back through each location it has been from distributor, back to wholesaler, back to processor, back to all feedlots and auctions the animal resided on, back to its cow herd of origin, or even the ability to trace parental animals through these steps. The *precision* of a traceability scheme is the extent to which the tracing system can isolate product flow through a particular transaction within the supply chain. Precision refers to the detail with which any particular transaction can be traced to every individual activity that a particular product has undergone. This may include tracking a particular primal from a carcass to a precise kill time and slaughter chain slot (e.g., individual animal and product as opposed to lot identification or the accuracy of the traceability system in precisely estimating when the animal was at various locations in the production process). Alternatively, this could consist of tracking an animal to not only each owner throughout its production but also to individual properties of residences of those owners or tracking all medical treatments with specific indication of the day, time, and farm on which the treatments were administered.

Obviously, the more breadth, depth, and/or precision there is to a traceability program, the higher the cost of implementing and sustaining that program. The unique breadth, depth, and precision mix of a given traceability system is economically chosen to be the arrangement that most confidently provides the desired "tracing capabilities" at the lowest feasible expenditure.

ECONOMICS OF TRACEABILITY

National individual animal identification systems are being adopted worldwide for a number of reasons. The economic incentives pushing these new systems originate from forces changing the international meat marketplace and include improving animal health management and rapid response systems, meeting domestic and international consumer demands for meat safety, maintaining and building international trade, verifying product credence attributes, properly assigning liability, and in improving management throughout the meat supply chain.

Increasingly consumers worldwide are demanding meat products that are not only assured safe, but that are produced within a system capable of correctly identifying the source of potential food safety concerns in a timely and precise manner. Consumer response to food safety events is impacted by perceptions of risk inherent in consuming susceptible products (Pennings, Wansink, and Meulenberg, 2002; Wansink, 2004). Countries and producers that are able to provide consumers with such assurances will have a considerable competitive advantage in world meat markets relative to those who do not. Those countries or producers that cannot provide assurances being demanded by consumers will be entirely precluded from even selling products in certain countries as trade policy is rapidly evolving that mandates a variety of product assurances (Bailey, Jones, and Dickinson, 2002). Furthermore, countries or producers unable to provide necessary assurances will be denied access to an array of potential niche markets that become more feasible and possibly more attractive to countries or producers who have systems in place providing such assurances. The increasing likelihood of losing export markets, due to failure to instill confidence in foreign consumers (or in foreign political leaders) of the beef industry's ability to produce safe food, offers an increasing return to implementing a traceability system in the U.S. beef industry (USDA, 2004b). Widely known market access problems arising from food safety concerns include the European Union's ban on beef produced using growth hormones, and the Japanese (and much of the rest of the world) ban on imports of beef from Canada and the United States following discovery of a single BSE infected cow in each these two countries. If a traceability system was in place that satisfactorily met international consumer demands, the frequency, duration, and economic impact of such market access issues would likely diminish.

National traceability systems also offer meat producers an opportunity to expand upon their trade of products containing valuable

credence attributes. Becker (2000) defines credence quality attributes as those which "are of concern for the consumer but where no cues are accessible in the process of buying and consuming (p. 164)." Some examples of credence attributes offered by Becker include whether a product was created using growth hormones, is from a particular country of origin, or was organically produced. Becker further notes that "information on credence quality is not supplied by cues received during shopping and consuming, but that the consumer has to rely on other information as delivered by the media, word of mouth, etc. (p. 4)." Hobbs (1996) adds that if food product quality is deemed to be variable, risk-averse consumers will choose to purchase their food at a different outlet where quality is more predictable. It is important to note that traceability systems themselves do not create credence attributes but that they help to verify the existence of such attributes and as such can instill additional confidence in consumers that they are in fact purchasing a product possessing the characteristics they desire.

Westgren (1999) notes that controlling risks from adulteration and contamination is a significant motive in forming supply chains. Traceability systems do not alter the liability of an event; however, they can provide useful information in properly accessing legal responsibility by those involved in the production chain. Roberts and Pittman (2004) argue that the U.S. animal identification plan will "increase the exposure of producers to liability" (p. 8). However, the current system being developed in the U.S. does not alter liability rules as they apply to producers. That is, liability exists either way to follow approved production protocols, but an animal identification system does make tracing the incidence of a problem easier. To this end, the liability to the U.S. meat industry as a whole may actually decline with implementation of a sound individual animal traceability system. Such a system enables authorities to more precisely pinpoint causes of adverse events and assign liability accordingly.

Furthermore, the existence of sound traceability systems can improve management throughout the meat supply chain. "A business's traceability system is key to finding the most efficient ways to produce, assemble, warehouse, and distribute products as it can aid in the transfer of information throughout the production process. The benefits of traceability systems for supply management are greater the higher the value of coordination along the supply chain" (USDA, 2004b, p. 4). Implementation of a traceability system in the beef industry may aid in bringing the beef industry's ability to transfer information throughout the production process much closer to that currently enjoyed by the pork

and poultry industries (Brester, 2002). This may allow the beef industry, through its use of quicker transmission of more detailed information, to increase the consistency and quality of its products to better compete with the pork and poultry industries.

Interestingly, cattle producers have mixed emotions about animal traceability and are concerned about where the costs and benefits of such systems may reside. Bailey and Slade (2004) surveyed leaders of state cattle producer associations and found support for USAIP (U.S. Animal Identification Plan) significantly declined if processors were perceived as benefiting more from USAIP than farmers or ranchers. Bailey and Slade suggest that many producers are fearful that most of the benefits of a plan such as USAIP would accrue to firms other than producers. If research and/or additional education efforts were undertaken that was able to demonstrate benefits of individual animal traceability exceeded costs to producers, support for such programs would likely increase. Either way, failure to adopt a national animal identification and meat traceability system will make competing in global markets considerably more difficult in the future and hence negatively impact all in the beef industry.

AUSTRALIAN TRACEABILITY HISTORY/DEVELOPMENT

Australia is the world's largest red meat exporter, with total beef exports exceeding $3.5 billion Australian dollars in 2000 (MLA, 2004a).[1] Because the Australian livestock sector is so highly dependant on red meat exports, the country has been very progressive in its development of traceability systems.[2] In fact, this process has been evolving since the late 1960s when Australia introduced a campaign to eradicate bovine brucellosis and tuberculosis (Animal Health Australia, 2004).

Australia has used a tail tag system for over 30 years to identify the most recent property of origin for cattle. The tail tags cost about 2 cents each, have a retention time span of at most approximately 30 days, and are required to be applied to cattle prior to each transaction. This system, in its original form, was limited in its traceability capabilities as the tail tag only indicates the Property Identification Code (PIC) of the property where the cattle most recently resided. Furthermore, the tail tag is unique only to a pen or lot of cattle, and not to individual animals (MLA, 2004c).

In 1996, 25 farms in Australia were placed on quarantine following detection of excessive residue levels of Endosulfan (a chemical used to treat *Helicoverpa* in cotton) in their beef cattle (Pesticide News 1999). This prompted supplementing the tail tag system with an additional paper-based system referred to as the National Vendor Declaration (NVD) program, now called the National Vendor Declaration and Waybill. Among other things this declaration includes assurance by the cattle owner whether the cattle (1) have been treated with a hormonal growth promotant, (2) were produced at that location using practices consistent with an independently audited quality assurance program, (3) were born and raised on the vendor's property and if not, how long they resided there, (4) in the last 60 days had been fed any by-product stockfeeds and if so a list is required, (5) in the past 6 months had been grazed on any property placed under grazing restrictions because of chemical residue, (6) were still within a holding period for treatment of any drug or chemical, and (7) had grazed or been fed fodder at risk for endosulfan spray drift. Each group of cattle has a NVD completed by the seller prior to each transaction. Completing this form is not mandated by Australian legislation, but it is demanded commercially and therefore is widely used. The NVD is required for all animals destined for export markets and because it is a legally binding document, it is taken seriously by livestock producers as it can be used for liability recourse in the event of a legal claim by future owners of the cattle or beef for which the NVD was completed. The NVD program is conducted using paper copies and to date has not been integrated into an electronic system.

The most recent update to Australia's animal identification efforts has occurred with implementation of the National Livestock Identification System (NLIS). NLIS is a permanent whole-of-life individual animal identification system allowing an individual animal to be traced from its property of birth to its slaughter destination. NLIS has been designed to improve traceability, enhance food safety, ensure beef product integrity, to allow and sustain international market access, and to provide progressive livestock producers with enhanced managerial opportunities. The NLIS is an enhancement of the tail tag and NVD systems and it moves the nation's traceability systems from primarily herd-based identification to electronic, individual animal identification.

NLIS requires all calves to have NLIS compliant, Radio Frequency Identification (RFID) devices applied prior to calves leaving the property on which they were born. These RFID devices can be either ear tags or rumen bolus/ear tag combinations. Each RFID device contains a microchip encoded with a unique Property Identification Code of the

property where the animal was born. The RFID devices are electronically read as the cattle move throughout the production system; in particular, readings are mandated at each cattle transaction.[3] Over time, these readings create a history of each animal's movement, developing a comprehensive, electronically based database to facilitate individual animal traceability. A single centralized database, maintained by Meat and Livestock Australia (MLA), an industry-funded private service organization funded by levies obtained from livestock producers from each animal transaction, contains all individual animal trace back records for the entire country.

To comply with NLIS, producers are required to identify each animal with an approved NLIS device. The NLIS system offers numerous management opportunities to livestock producers who choose to take advantage of them. These benefits can include detailed records of medical treatments, animal growth performance data, pasture performance data, movement of animals, purchase and sale dates, and carcass feedback data. These benefits are realized by those who invest more in information technology and purchase appropriate computer software, RFID reading equipment, weight scales, internet connection, etc. and by utilizing the web-access provided by MLA to an array of information pertaining to the cattle herd. When the benefits of the NLIS system are fully realized, a producer gains a wealth of intensive management information that can be used to improve efficiency and increase profitability.

The NLIS system is being implemented on a state-by-state basis. Each of Australia's seven states are required to meet national guidelines as set in the NLIS program, but each state is free to choose when the program will be implemented, with July 1, 2005 being the nationally mandated deadline for initiating the "phase-in" implementation process. The precedent set by states is to choose a date from which all calves born on or after that date must be identified with NLIS approved devices. Then, one year after this selected date, all cattle leaving any property in that state must be identified with NLIS approved devices. Furthermore, on this (one year later) date, all saleyards, feedlots, and processing plants will be required to read all NLIS devices and to transfer this information onto the NLIS database. This implementation procedure enables firms in the livestock sector to transition into the national identification program and thus provides these entities time to budget and plan for the adjustments that need to be made for NLIS compliance.

COMPARISONS OF THE BEEF SECTORS IN THE U.S. AND AUSTRALIA

In consideration of recommendations learned from Australia in developing its animal identification system to the upcoming U.S. system, it is important to note several underlying differences in the livestock sectors of the two countries. In terms of size, the U.S. cattle sector is significantly larger. The U.S. has approximately 800,000 cow-calf farms, with an average herd size of 41 beef cows, and a total cattle herd of about 96 million head. Moreover, feedlots in the U.S. market approximately 23 million head per year and annual U.S. commercial slaughter is around 35 million cattle, of which roughly 10% has historically (prior to the BSE infected cow discovery) been exported (USDA, 2004a).

In contrast, Australia has about 76,000 cattle producing properties, a total cattle herd of roughly 26.5 million, and a feedlot industry with a capacity of less than one million head and an average utilization of about 500,000 head (MLA, 2004a; ALFA, 2004). Additionally, Australia exports about 66% of its beef production (MLA, 2004b).

Cattle production in the U.S. involves many more operations than in Australia, and as such there are a lot more individuals to educate and inspire when adjusting to changing demands in the international marketplace, including implementing an animal identification program. Average cattle farm size is smaller in the U.S. and the cattle operation is not typically a major source of family income which could result in more resistance to changes that increase costs. Because exports are a smaller portion of the U.S. market, the typical U.S. producer is probably less aware of changes occurring in world beef markets resulting in less motivation to adopt a national animal identification program. Livestock producers in Australia have over 30 years of experience with national identification systems (i.e., the tail tag system has existed since the late 1960s), whereas the average American producer has little experience in this arena. Furthermore, the number of cattle that are transacted through feedlots is much higher in the U.S. and considerable co-mingling of cattle from multiple origins occurs especially relative to Australia where most cattle are grass fed. Thus, the average number of readings that will be required for each animal in the U.S. will likely be higher than in Australia. The increased readings may require additional equipment, higher labor costs, etc.; however, the increased frequency of readings should provide for a much more complete and current database of animal transactions providing possible managerial gains from the traceability system that extend even beyond those available to typical Australian

producers owning cattle that have been transacted fewer times. Possibly the biggest difference in the two markets is the higher percentage of Australian beef destined for export markets. This is one of the primary reasons that Australia meat industry has been more progressive in responding to the changing international meat market, in particular by developing its animal identification programs. Furthermore, the importance of beef exports is one reason that many Australian producers are accepting of the identification systems as they appreciate the importance of world market access to the viability of their businesses.

RECOMMENDATIONS FOR THE U.S. ANIMAL IDENTIFICATION SYSTEM

Based upon our review of the Australian animal identification system, primary recommendations we offer include that the U.S. individual animal identification system needs to eventually be mandated, free of significant regional differences, and a system that can easily be supplemented with meat traceability or other advancements as the need and opportunity arise. Mandatory identification, rather than voluntary, was one of the most frequent suggestions of Australian industry participants. A voluntary system leaves room for a handful of individuals to negate the efforts of more progressive producers who participate in a national identification program. In Australia this concern is enhanced by their beef industry being so dependent on the export market. Further, a voluntary identification program would likely result in two distinctive markets (those with identification and those without) which would increase industry costs of trying to deal with and keep cattle from each segment separate. Such a split market would likely reduce overall consumer confidence in the identification system.

Concern over regional differences in the Australian system was apparent. Each of the seven states is free to choose the exact date of implementing NLIS, with the "national" aspect being that there are national standards of the NLIS program and that there is only one database containing all of the NLIS transaction readings.[4] Applying this to the U.S. situation, we believe that the U.S. would be best served by having one national program for all producers regardless of the location of their production facilities. Furthermore, one entity likely needs to be solely responsible for maintaining the national database containing all transactions. The U.S. currently does not have an entity similar to Meat and

Livestock Australia which is the organization responsible for maintaining the NLIS national database. In some regards the U.S. industry may find it desirable to have a private agency maintain the national database, which would increase the confidentiality of the data from things such as the U.S. Freedom of Information Act (Roberts and Pittman, 2004). A centralized database manager offers numerous advantages to multiple databases spread around the country including consistency of data recording and management (including confidentiality assurances), enhanced ability to respond to technical problems in the field, and speed of animal trace back.

Implementing an animal identification system that is compatible with meat traceability is also strongly recommended. Several of the more progressive firms in Australia already have meat traceability from the retail shelf all the way back to the property of birth of the animal from which the steak originated. Adding meat traceability to the animal identification system is not difficult for producers (it can be as simple as taking a hair sample of each animal at the time the identification tag is applied). However, the costs of everything involved in obtaining, storing, and accessing this information relative to the benefits of meat traceability capabilities must be further assessed. The addition of meat traceability may be desired on a national basis as it theoretically could provide a mechanism for all retail meat to be traceable all the way back to the farm where the animal was born and all places it resided in a short period of time (Clemens, 2003). The benefits of such a meat traceability system might include enhanced consumer confidence in purchasing beef, better ways to properly deal with animals that have lost their identifying ear tags, and more in-depth ways to validate the production of branded products. Additionally it may provide an additional way of properly assigning liability and identifying stolen cattle.

In addition to these recommendations, the U.S. national animal identification program needs to remain as simple as possible while offering sufficient traceback capabilities, adequate educational and support resources need to be provided when implementing the program, and government subsidization in implementing the national program should be considered. Keeping the national identification program as simple as possible is important for an array of reasons. Several individuals in Australia noted that producers had a difficult time distinguishing between what is necessary to meet the requirements of the national program and what additional activities the program allows producers to undertake. Confusion between "what is required" and "what is possible" has made implementing NLIS a challenge at times. Furthermore, the simpler the

national program is in its design, the easier it will be to maintain and build upon. In addition to this, having a "cob-web" of different systems, as opposed to the one national system used by Australia, will likely slow and complicate animal trace back as well as add frustration to those participating in the program(s).

Devoting significant resources to educating those affected by the identification program and offering support for technical issues that will arise as producers adopt the program is also essential. The typical U.S. producer has relatively little knowledge of how national animal identification programs work or what exactly they need to do to comply with the new programs. Therefore, offering sufficient resources to keep these producers as informed and content as possible is vital to the proper implementation and maintenance of the national program.

Several of the states in Australia have cost-sharing agreements with livestock producers. In the event of a food safety event resulting in significant losses to the livestock sector, the state government has agreed to offer financial assistance to help offset financial losses resulting from a food safety breach. This results in an extra incentive for the Australian government to take steps to reduce the likelihood of financial expenses being incurred from these cost-sharing agreements. To this end, the NLIS program serves as an "insurance" type of product for state governments. The success of the Australian national identification program is partially due to the significant financial support by some of its state governments. In any animal identification system, the costs associated with not being able to quickly trace an animal have both private and public components. The private benefits are obvious in that traceability allows a firm to quickly identify a problem source and correct the problem without undue risk. From a public perspective, having rapid traceability helps ensure consumer food safety and welfare. Furthermore, the social gains of having trace back capabilities may be sufficiently high to justify public support to increase the quality and extent of an animal traceability system beyond what would otherwise be provided by the private sector. This is why during the implementation phase of the U.S. program, U.S. government financial assistance and/or incentives to speed up the adoption of the national program may be desirable. There are both private and public benefits to animal identification and traceability that may justify both private and public investment.

The U.S. beef industry may also want to consider implementing a system similar to that of the National Vender Declaration form in Australia. The Australian NVD system has increased product quality and assurance in Australia by assuring particular production practices. The

NVD provides additional information to cattle buyers and holds sellers legally liable if they sell cattle under false pretenses. Because of the amount of commingling of cattle that occurs in the U.S. a reliable NVD may be more difficult to make operational than in Australia, but the information is likely valuable for particular consumer markets.

CONCLUDING REMARKS

Animal identification and trace back systems are rapidly developing as concerns about animal health, bio-terrorism threats, food safety, international trade, consumer demand, and supply chain management escalate. The global beef market is highly competitive and producers and countries that can demonstrate rapid animal and meat traceability systems have considerable advantages relative to those that are not able to provide this assurance to customers and in managing and responding to animal disease or related outbreaks. Some countries are quite experienced and well ahead of others in development and adoption of various animal and meat traceability systems. If the U.S. beef industry desires to remain competitive in the international meat market it will likely be forced to adjust to the changing food market and implement systems such as national individual animal traceability programs. Furthermore, if U.S. meat industries want to be active in maintaining and building upon current domestic support of their products, an increase in the implementation of programs that provide consumers with assurances regarding possible concerns over animal health, potential bio-terrorism, and food safety issues is essential. The U.S. beef industry is in its early development stages of an animal identification system to meet these concerns and therefore a lot can be learned from others as the U.S. system evolves.

NOTES

1. This equates to approximately $2.6 billion in U.S. dollars.
2. Australia exported over 66% of its total beef production in 2000 (MLA 2004b).
3. Note that readings at each transaction will be mandated once the NLIS system is fully implemented; currently Victoria is the only state requiring electronic reading of all RFID devices on all transactions.
4. Note that each state's implementation date must be set prior to July of 2005.

REFERENCES

Animal Health Australia. "Animal Disease Surveillance: National Livestock Identification Scheme." 2004. http://www.aahc.com.au/nlis/.

Australian Lot Feeders' Association (ALFA). "ALFA Survey: Feedlot Numbers Remain Steady." 2004. http://www.infarmation.com.au/ALFA/ALFAReports/15_Mar_2003.pdf.

Bailey, D., Jones, E., and Dickenson, D. "Knowledge Management and Comparative International Strategies on Vertical Integration Flow in the Global Food System." *American Journal of Agricultural Economics*. 84(5 2002):1337-1344.

Bailey, D. and Slade, J. "Factors Influencing Support for a National Animal Identification System for Cattle in the United States." Selected Paper, American Agricultural Economics Association Annual Meetings, Denver, CO, August 2004.

Becker, T. "Consumer Perception of Fresh Meat Quality: A Framework for Analysis." *British Food Journal*. 102(3 2000):158-176.

Brester, Gary W. "Meeting Consumer Demands with Genetics and Market Coordination: The Case of the Leachman Cattle Company." *Review of Agricultural Economics*. 24(1 2002):251-265.

Clemens, Roxanne. "Meat Traceability and Consumer Assurance in Japan." MATRIC Briefing Paper 03-MBP 5. Iowa State University. September 2003.

Dickinson, D.L. and Bailey, D. "Meat Traceability: Are U.S. Consumers Willing to Pay for It?" *Journal of Agricultural and Resource Economics*. 27(2 2002):348-364.

High Plains Journal. January 2004. "Consumer confidence in beef strong in the face of single case of BSE." http://www.hpj.com/archives/2004/jan04/Consumerconfidenceinbeefstr.CFM

Hobbs, J.E. "A Transaction Cost Analysis of Quality, Traceability, and Animal Welfare Issues in UK Beef Retailing." *British Food Journal*. 98(6 1996):16-26.

Liddell, S. and Bailey, D. "Market Opportunities and Threats to the U.S. Pork Industry Posed by Traceability Systems." *International Food and Agribusiness Management Review*. 4(2001):287-302.

Loureiro, M. and W. Umberger. "Estimating Consumer Willingness to Pay for Country-of-Origin Labeling." *Journal of Agricultural and Resource Economics* 28(2003):287-301.

Meat and Livestock Australia (MLA). "*Fast Facts: Australia's Beef Industry*." 2004a. http://www.mla.com.au/content.cfm?sid=18.

Meat and Livestock Australia (MLA). *Source of Australian Beef Statistics*. 2004b. http://www.mla.com.au/content .

Meat and Livestock Australia (MLA). *"Australia's System for Livestock Identification and Traceability."* 2004c. http://www.mla.com.au/content. cfm?sid=131.

Pennings, J.M., B. Wansink, and M.T. Meulenberg. "A Note on Modeling Consumer Reactions to a Crisis: The Case of the Mad Cow Disease." *International Journal of Research in Marketing*. 19(2002):91-100.

Pesticide News. No. 44, June 1999, p. 21. http://www.pan-uk.org/pestnews/pn44/pn44p21.htm

Piggott, N.E. and T.L. Marsh. "Does Food Safety Information Impact U.S. Meat Demand?" *American Journal of Agricultural Economics.* 86(1 2004):154-174.

Roberts, M.T. and H.M. Pittman. *Legal Issues in Developing a National Plan for Animal Identification*. The National Agricultural Law Center, University of Arkansas School of Law, February 2004. Available at http://www.NationalAgLawCenter.org

Souza-Monteiro, D.M. and Caswell, J.A. "The Economics of Implementing Traceability in Beef Supply Chains: Trends in Major Producing and Trading Countries." University of Massachusetts Amherst Working Paper No. 2004-6. June 2004.

U.S. Department of Agriculture (USDA), National Agricultural Statistics Service. "2001-2002 Statistical Highlights of U.S. Agriculture: Livestock." http://www.usda.gov/nass/pubs/stathigh/2002/tables/livestock.htm#cofmark, accessed July 8, 2004a.

U.S. Department of Agriculture (USDA), Economic Research Service. "Traceability in the U.S. Food Supply: Economic Theory and Industry Studies." Agricultural Economic Report Number 830. by E. Golan, B. Krissoff, F. Kuchler, L. Calvin, K. Nelson, and G. Price. 2004b.

United States Animal Identification Plan. December 2003. http://www.usaip.info

USINFO. "Traceability in the U.S. Food Supply." March 2004. http://usinfo.state.gov/ei/Archieve/2004/Mar/29-403518.html

Wansink, B. "Consumer Reactions to Food Safety Crises." *Advances in Food and Nutrition Research*. 24(2004):455-479.

Westgren, R. "Delivering Food Safety, Food Quality, and Sustainable Production Practices: The Label Rouge Poultry System in France." *American Journal of Agricultural Economics*. 81(5 1999):1107-1111.

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