Animal Identification

WEMC FS#7-06 • Summer 2006

James G. Robb,
Director
robb@lmic.info

A.E. Lawrence,
Visiting Economist

Erica L. Rosa,
Agricultural Economist
rosa@lmic.info

Livestock Marketing
Information Center
Denver, Colorado

Issues Related to Beef Traceability: A Discussion of Transforming Cattle into Products[1]

Overview

A steer that enters a packing plant is transformed into many different products. Modern U.S. packing plants are complex operations incorporating skilled labor, mechanization, and government oversight at all production stages. Some aspects of the process have been modified as a result of Bovine Spongiform Encephalopathy (BSE). This fact sheet provides a description of the beef packing steps and highlights the nature of traceability, focusing on the difficulty of maintaining animal identification (ID) through the fabrication process. The actual production process currently in place constrains "farm-to-fork" traceability[2], a situation that is sometimes overlooked when policy makers, agricultural producers, retailers, exporters, and restaurants discuss animal identification. Aspects of traceability are becoming increasingly important market characteristics at the wholesale and retail levels.

Background

Over the past 30 years, the U.S. cattle and beef industry has undergone significant changes in the production, processing, and marketing segments. Retail and foodservice customers have driven many of these changes. A key development in the cattle/beef industry often overlooked is how beef is marketed today

Western Extension Marketing Committee

LMIC Livestock Marketing Information Center

Western Center for Risk Management Education

[1]This fact sheet updates and replaces fact sheet WEMC FS#7-04 of this series titled "Some Issues Related to Beef Traceability: Transforming Cattle into Beef in the United States" by J.G. Robb and E.L. Rosa.

[2]Traceability, as defined by the authors, is the ability to follow a product forward or backward through one or more stages of a production process; "farm-to-fork" is the most extensive form or traceability.

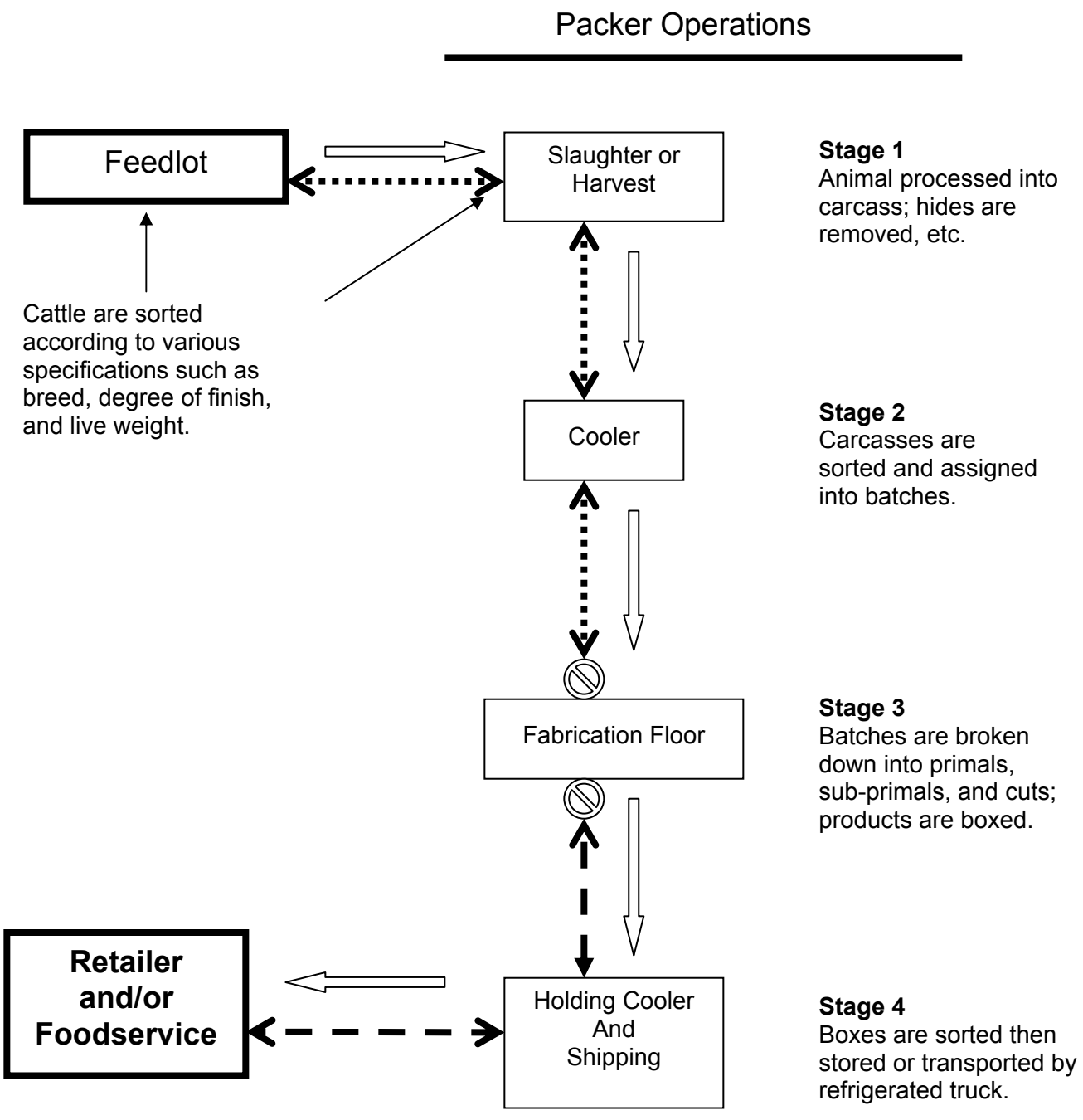
at the wholesale level. At one time, the U.S. beef industry was a carcass-based industry, in that much of the beef was marketed to retailers and further processors in full carcass form. However, for some time it has not been a carcass-based industry. The majority of beef marketed by packers is in the form of sub-primal cuts derived from a carcass. Sub-primal cuts, typically from several carcasses, are boxed in preparation for shipping to retailers and food service buyers. More recently, some retailers now buy beef products from packers in case ready form. Additionally, more and more beef products sold to restaurants and other food service institutions are pre-processed and sometimes fully pre-cooked.

This modern U.S. beef processing and marketing system is a major contrast to the much smaller scale production systems (20 to 500 head per day) that dominate other regions of the world where traceability from farm to retail consumer has generally moved forward more rapidly than in the United States, specifically in parts of Europe and Japan. A typical U.S. beef slaughter facility is much larger with higher capacity (1,000 to 6,000 head per day) than in other countries. Additionally, the U.S. packer typically purchases cattle from a rather large geographical area and transports the end-product long distances to domestic population centers and to foreign destinations.

The U.S. packing industry can be described as a low cost, high volume business. A rather high proportion of costs are fixed in the form of plant, equipment, etc. That is, they are not easily adjusted, and processing a high volume is key to maintaining low per unit costs. The packing/processing sector of the beef industry can also be described as relatively concentrated in terms of the number of firms involved (Ward, 2002) and the geographical location of the firms (beef packing plants tend to be located near the areas where feedlots are concentrated, especially in the High Plains). In general, the beef processing sector mass produces high quality and very safe beef products. In the context of implementing traceability systems and policy, how the processing sector operates in the United States helps identify issues and constraints.

Transforming cattle into beef is often described as a disassembly process. A general schematic is provided in Figure 1 (note the wide arrows that indicate cattle, carcass and meat flow). Disassembly is a good descriptor of the beef packing process and highlights the contrast of this business with most other manufacturing processes. Most manufacturing processes construct, or assemble products by putting pieces and parts together. However, a beef packer takes a complex unit, a beef carcass, apart to create numerous final products. The end products of a modern beef packing plant are boxes of cuts (e.g. tenderloin, chuck, top round, strip steak, beef trimmings for hamburger), not whole carcasses. In addition to meat products, end products also include offal or variety meats (i.e. liver, tongue) and the hide. For example, USDA's Institutional Meat Purchase Specifications (IMPS) lists about 30 beef products for the loin, some of which have four standard weight ranges. In addition to standard meat cuts, many packers also sell branded (i.e. Certified Angus Beef) and further processed products. It is common for a packer to produce 500 or more beef items.

Figure 1. Schematic of Wholesale (Packer) Sector Stages and Linkages



Some Details of the Beef Production Process

The majority of cattle for slaughter are marketed by feedlots to a packing (meat processing) company. Upon arrival at the feedlot, feeder cattle typically are identified and grouped (or sorted) based on a variety of physiological characteristics such as frame size, breed, sex, in-weight, and expected degree of finish at the time of the sale. How cattle are sorted also can depend on whether the feeder cattle are owned by the feedlot, are being custom fed, or are being fed under protocols of a niche market program. During the feedlot stage, cattle may be sorted several times including just prior to shipping to a packer.

Packers have long practiced a kind of traceability from the receiving process through the grading process. Strong traceability measures have been established by the packer, and are monitored and verified by several USDA agencies, including the USDA Food Safety and Inspection Service (USDA/FSIS), Grain Inspection Packers and Stockyards Administration (USDA/GIPSA), and Agricultural Marketing Service (USDA/AMS) to ensure that producers' cattle are properly identified and paid for. However, traceability in this context focuses on the group (or lot) of cattle received by the packer.

Since the 2003 discovery of BSE in the United States,[3] traceability in beef packing plants has been complicated by new regulations and procedures. Additionally, new international trade regulations have been imposed. Beef Export Verification (BEV) procedures have been implemented (Lawrence, 2006), which require determination and marking of carcasses that are age eligible for Japan. All U.S. cattle are evaluated as to a 30-month age threshold, those animals determined to be over 30-months are identified for different processing and end uses.

Stage 1 in Figure 1 begins with receiving cattle at the packer's plant. Little if any ante-mortem sorting occurs upon arrival at the packing plant. Cattle move from trucks to holding pens where the integrity of groups (or lots) of fed cattle is maintained. An animal may be removed from the lot upon ante-mortem inspection by an FSIS inspector. Disposition of these cattle is well documented, and, as a result, traceability is maintained.

Cattle in groups are moved into the next process in Stage 1 (Figure 1), i.e., slaughter or harvest of the animal. During this process, blood, hide, head, feet, tail, and internal organs (collectively called the drop) are removed leaving a hanging carcass i.e., a carcass suspended from a trolley by which it is transported through the system. Carcasses are weighed and moved to the next stage, the cooler. The hide is conveyed away from the harvest floor for processing at a hide plant. Some of the remaining items are further processed into various edible products such as ox tail, liver, tongue, and trim products such as cheek meat, head meat, and ox lips. These products are conveyed from the harvest floor directly to processing stations, boxed, chilled, and stored

[3]See Mathews, Vandeveer, Gustafson (2006) for a chronology of BSE in North America.

in a warehouse. The remaining items are conveyed to the rendering[4] facility to be processed into tallow, meat and bone meal, and blood meal.

Although no sorting of carcasses occurs on the harvest floor, FSIS inspectors monitor the entire harvesting process to ensure cleanliness and wholesomeness of the carcass and offal products. However, a crucial characteristic of the animal is identified on the harvest floor due to the potential of BSE. Before the head is removed, the age of the animal is determined through a process called "dentition."[5] Carcasses of animals 30 months of age and older are identified and marked. Most of the offal items from these animals are not processed, but rather conveyed directly to the rendering facility.

The cooler stage (Stage 2 in Figure 1) consists of four processes. In the first, called the "hot box", carcass temperatures are reduced from approximately 105 degrees to 50-70 degrees Fahrenheit over a twenty-four hour period. Lot identity is maintained as carcasses move into the hot box in the same order as harvested. Carcasses 30 months and older may be sorted at this time. If so, this sort will be well documented.

Carcasses are conveyed from the hot box to the grading station where the second cooler process, grading and inspection, is performed by AMS graders. A recent addition to USDA/AMS sort characteristics is due, once again, to the potential of BSE. USDA/AMS graders determine those carcasses of age 20 months and younger (using carcass maturity indications) which are eligible for export to countries such as Japan.

It is at the third cooler process, sorting into the sort cooler according to such characteristics as quality grade, yield grade, weight, sex, and program (Angus, Rancher's Choice, etc.), that lot integrity is broken. Carcasses are held here for an additional 12 to 24 hours while the internal temperature drops to 38 to 45 degrees Fahrenheit. Carcasses 30 months and older will certainly be sorted out by this point.

Carcasses are not only sorted into the sort cooler, but they are also sorted out of the sort cooler, which is the fourth process. These latter sorts comprise production runs, which go into the fabrication stage. An example of a production run is "Choice, Yield Grade 3 steer and heifer carcasses weighing less than 750 lbs and of age less than 30 months and older than 20 months."

The fabrication stage (Stage 3 of Figure 1) is often referred to as the "fab floor." This stage is not a linear process in that, as the carcass is disassembled, components and products are directed along different routes where specialized functions are performed by meatcutters. Consequently, different products from a given carcass exit the fab floor at different times. For example, depending on the

[4]Rendering is a commingled process through which fat, bone and discarded items from both the harvest and fabrication stages are cooked to produce tallow, meat/bone meal. Commingled blood is rendered separately from other items by a drying processes producing blood meal.

[5]Dentition is a method used to determine the age of animal through the examination of the animal's teeth.

physical layout of the fab floor, products from the chuck primal may be boxed and move into the warehouse twenty minutes before products from the round primal.

The fabrication process begins on the "break line" where components of the carcass are "dropped" from the hanging carcass onto conveyor belts and routed to various fabrication tables. Each table contains several cutting stations where the components are further cut, trimmed, etc. Depending on the size of the processing plant, there can be anywhere from four to twenty or more tables on the "fab floor." Finished cuts are conveyed to the packaging area where they are vacuumed packaged, sized, and placed into boxes.

At the final stage in a typical U.S. beef packing plant (Stage 4 of Figure 1) boxes of cuts move from the fab floor to refrigerated warehouses prior to transportation to end users (retailers or food service companies). As the box moves along a conveyor, it is weighed electronically, and a barcode label is applied to the box. This barcode includes data such as the production date, time the label was applied, as well as product weight and other information.

Throughout the fabrication process, beef trimmings (small pieces of beef containing both muscle and fat), fat, and bone are generated. *Escherichia coli* O157:H7 (E. coli O157:H7) is of special concern with respect to trimmings; and packers have taken strong measures to ensure traceability for trimmings. However, traceability with respect to trimmings is much different than traceability with respect to animal ID. The major purpose of traceability with respect to trimmings is to ensure that, in case of discovery of E. coli O157:H7 (i.e. hamburger at the retail level), packers can trace raw material back to the batch from which it came, and recall any raw material from the same batch that had been released into commerce and/or destroy any remaining raw material in inventory.

Trimmings can be boxed, but more often are collected in cardboard combos weighing 1800 to 2000 pounds. Trimmings from tens of carcasses are commingled in each combo or box. Tests for E. coli O157:H7are performed on a batch of combos and/or boxes. Production date and batch number are recorded along with test results as part of a packer's Hazard Analysis and Critical Control Point (HACCP) program[6] before releasing the trimmings into commerce. However, since trims are collected across production runs, it would be impossible to trace back to a specific production run.

Traceability for boxed cuts of beef is also part of a packer's HACCP program. Traceability in this context is much the same as for trimmings, and its purpose is to allow for recall of boxed beef items should the need arise. This functionality is accomplished by maintaining a log of serial numbers for each box produced. Data associated with the serial number include product code, production date, and ship to address. Packers are required to maintain these records for the expected life

[6]Hazard Analysis and Critical Control Point (HACCP) is a processing plant inspection program required and regulated under USDA/FSIS.

of the product. The time can range up to two years for frozen items.

Traceability back to production runs is not easily accomplished due to several factors. For example, during a production run of a given quality grade of carcasses, government regulations prohibit carcasses, cuts, or labels from a lower quality grade of beef to be fabricated at the same time. Therefore, production runs are scheduled from higher quality grades to lower quality grades. After a "grade change", packers sometimes pack the few remaining cuts of the higher quality grade along with cuts of the lower quality grade under lower grade's label. Consequently, production runs can be mixed in a given box of beef.

A Challenge for Traceability: The Fabrication Stage

Individual animal ID has emerged as one of the key issues confronting today's beef and cattle industry. ID is also part of the broader issues of traceability from producer to consumer (Bailey, 2004). Assuming ID is in place, what happens next?

The National Animal Identification System (NAIS) is often referred to as a "live animal" traceback system because this identification approach typically stops during the initial stages of the packer operations. In fact, the NAIS is designed to be an after the fact, live animal tracking system for disease containment and control. Nothing about the NAIS forces the conclusion that the system must move beyond live animal or whole carcass ID to allow traceback of a beef product from a consumer's plate or retail establishment to the farm gate. As discussed in the previous section and as shown in Figure 1, the nonlinearity of most beef packers' harvest production stage with respect to offal items, and fabrication production stage with respect to boxed beef cuts and trims causes a disconnection between an individual carcass and the resulting beef products.

Tracking products within the packing process is an ongoing and rather routine business practice. Traceability implies that information and tracking flows both forward with the product and backward to previous stages in the production/marketing system. The institution of HACCP programs has given packers the ability to track boxed beef cuts and trimmings. These systems are designed specifically for food safety related meat recalls, but do not help if the concern is related to a live animal disease.

Figure 1 (note the dashed arrows) depicts where continuous traceability and identification can be achieved with technology investments. Those packing plants with systems like a trolley tracking system can provide traceability beginning at slaughter and, with computer software, back to the feedlot of origin for those feedlots that have invested in eartag systems. Since the carcass stays on the same hook, traceability can be maintained through the cooler. However, traceability does not extend to offal items or harvest floor beef trimmings.

As a carcass moves onto the fabrication floor (Stage 3 in Figure 1), linear traceability of one animal from the time fabrication begins to the time it becomes boxed beef is a problem in modern, large-scale packing operations. The rapid reduction of carcasses into many beef products in different parts of the fabrication floor and the commingling of like

cuts and trimmings from different carcasses to create boxes and combos of beef makes direct tracking to an individual animal/carcass virtually impossible with current processing systems and animal ID technology.

Methods have been devised at the fabrication stage to link boxes of beef to a group or a production run of carcasses, and from a group of carcasses to individual animals. Even these methods do not accomplish full traceback in that only a subset of all beef cuts produced are traced back to the carcass. However, getting an exact link back to an earlier stage of the production system is not typically done because of costs, not only in terms of capital investment, but also in terms of production efficiencies. Even with the most advanced DNA systems, obtaining a match from a cut of beef to the carcass from which it came is not certain.

Refinements to Beef Traceability

The processes described above represent the norm for the beef industry. Several packers have refined traceability measures, usually to improve information systems, to accommodate niche producers or customers, and/or to establish marketing programs. Refinements require investment in equipment and manpower, and these costs can be significant not only to the packer, but for upstream producers as well.

Several methods have been devised to associate characteristics to each carcass as it moves through the process. An example of this is a "trolley tracking system" whereby an individual trolley carrying a split carcass can be "read" at different points in the process. Normally, the first station in a typical trolley tracking system is at the hot weight scale on the harvest floor. As the trolley number is read into the computer system, the computer assigns a carcass number to it. An operator keys in the hot weight and sex. The next station would be at grading, where the carcass is reweighed and the grader determines such characteristics as quality and yield grade. An operator keys this data into the computer system where it is associated with the trolley number. Finally, the carcass is weighed again as it moves onto the fab floor, and this weight is associated with the trolley number. At each of these stations, the computer records the time, which is associated with the trolley number. With this kind of system, the packer not only has several characteristics of each carcass readily available, but it can also determine the physical location of a carcass at any point in time and how long it has been there. Note that none of the characteristics associated with the carcass links the carcass to the live animal. Such a system does not enhance traceability per se.

Other methods have been devised to trace an individual carcass back to the animal from which it came. These methods require feedlot operators to invest in an eartag system, and involve associating the animal's eartag number to the carcass number so that data up to the fab floor can be traced to the individual live animal. These methods can be manual or electronic. Several packers have installed an "eartag reader" early in the harvest process that reads an electronic tag in the animal's ear. This number is held in the computer and is associated with the trolley number when it passes the hot weight scale.

Methods devised to trace boxed beef cuts to a group of animals from which they came

require highly developed management systems and highly trained managers to be successful, so they have been applied only to well-defined marketing programs. These methods incorporate traceback methods from carcass to individual animals using eartags to ensure the integrity of a production run of carcasses. Before this production run is allowed onto the fab floor, all product and labels from the previous production run including unboxed cuts are removed. After the production run, all unboxed cuts are counted. This count, along with a count of cuts in boxes, is reconciled against the number of carcasses in the production run. Only after a successful reconciliation is production allowed to continue.

Seldom are all cuts available from the carcass boxed as program cuts. Many are boxed under commodity labels and distributed through commodity channels. Consequently, while program cuts can be traced to groups of program cattle, not all cuts from program cattle can be traced.

A few cutting-edge programs attempt to trace cuts of beef back to the individual animals from which they came using DNA technology. These programs require a high level of management not only for the packer, but also for the program customer. Typically, the method used for such programs begins with taking a DNA sample from an individual carcass as it enters the fab floor. The sample is associated with the carcass number. This sample is sent to a company specializing in DNA analysis, and stored there. Fabrication occurs using the same management protocols as for tracing boxed beef cuts to a group of animals. As a box of product moves past the box scale, a time stamp is applied and recorded in the packer's computer system as per its HACCP program. As the boxed cuts are processed at the customer's site, the box serial number can be recorded so that each retail package can be associated with the box from which it came.

Traceback, in its broadest definition of "farm-to-fork," begins at the retail level, and consists of sending a sample of an individual cut and the box serial number from which it came, back to the packer. The packer locates the box serial number in the computer database, and determines the time stamp for that box. Knowing the average length of time required for that cut of beef to be processed, boxed, and scaled from the time the carcass enters the fab floor, the packer can identify a range of carcasses from which the box came. The packer then sends the retail cut sample along with a range of carcass numbers to the DNA lab to be analyzed until a match is found.

Inherent problems for this type of program are relatively high. Responsibility for success rests not only with the packer, but also with the retailer and the retail customer. Association of the box with a set of carcasses depends on how closely the length of time the tested cut took to be produced, boxed, and weighed compared with a predetermined average. Since the packer pays per carcass DNA analyzed, costs beyond those incurred to perform the protocols may be unlimited with no guarantee of a successful match.

These traceback methods accomplish partial traceback in that traceback flows from the carcass to a set of boxed cuts. Traceback for <u>all</u> boxed cuts and trimmings would be much

more complicated and costly. Often the beef is not yet sold at the final stage in the packing process. So the packer may not know who the buyer will be. Therefore, throughout the production process, the packer will often not know if the buyer is interested in or willing to pay for traceability. Consequently, some firms view beef traceability as an "all or nothing" situation for a particular production plant, meaning that every product is traced or nothing is traced.

Further Traceability Challenges: By-Products and More

There are many products beyond typical meat case retail items (e.g. steak) that are produced from a beef animal such as glue, sausage casings, liver, soup stock, medicines and more. Those items and key standard retail items like hamburger also provide major challenges in traceability.

As stated earlier in this fact sheet, offal is removed at animal harvest. Those products are segregated and conveyed through the plant prior to when the carcass is given a number code. Further, those items move to separate processing stations unassociated with subsequent carcass processing. Fat, bones and other items emerge at both harvest and in the fabrication process and are commingled prior to rendering. Obviously, traceability to end products or an association with a carcass with these items is, for practical purposes, impossible at the processing facility and other firms typically responsible for making end products.

Recent export program developments (BEV) have raised concerns about how to tie an animal's age to liver, tongue, hearts, etc., products that depend on export markets. For example, identifying a tongue for Japan to be from animal harvested at under 20 months of age and segregating that product is difficult. When age determination is made based on carcass characteristics, that assessment does not occur until typically 24 hours after offal items are removed. So, the only tongue, etc., that could be exported to Japan would require actual animal age documentation (Lawrence, 2006).

Hamburger and other products from beef trimmings present additional traceability problems due to the nature of the packing production process, and due to subsequent commingling that takes place. As described earlier, those products (combos of trimmings) represent many animals. Several combos may be blended into one batch of ground beef. Even a DNA sample would provide no basis for individual carcass identification.

Summary and Conclusion

The disassembly process and the nonlinear flow of the beef through the fabrication process is why it is difficult, at best, to trace a specific beef product back to an individual carcass, animal, or producer with current commercial U.S. beef processing facilities. Thus, the same modern U.S. processing technology that allows carcasses to be efficiently turned into beef products causes individual product traceback to the original animal or farm to be difficult and potentially extremely costly. This disconnection between the farm-of-origin, live animal, carcass and its beef products is why the NAIS is referred to as a "live animal" identification and traceback system versus a complete "beef" or "meat" traceback system. The

question still remains whether the economic incentives (market access or consumer driven) exist to drive processing plants to invest in the development of new individual animal ID technology that will facilitate farm-to-fork traceback.

Traceback of meat products to individual carcasses and farms-of-origin may be difficult, but technology may soon be developed that makes the traceback process more and more complete. In order for the technology investment to occur, there likely needs to be an economic incentive for the processor and others in the supply chain to invest in the technology necessary to provide individual animal and product traceback throughout the supply chain. A question then exists regarding what economic incentive is there for a processor to invest in technology allowing traceback of beef products to the original carcass. When buyers desire product attribute verification or the maintenance of identity, there is increased interest in full traceback (Curtis, 2004). For some beef products, branded items already bring a premium, and branding implies traceback at least to the packer. Those interested in maintaining identity preservation through the packer stage need to understand the costs and limitations inherent in such systems.

References

Bailey, D. "Benefits and Costs Associated with an Animal Identification System for Cattle in the United States." Western Extension Marketing Committee Fact Sheet. WEMC FS#2-04. Fall 2004.

Curtis, K.R. "Animal-ID: Opportunities for Value-added Marketing and Production Efficiencies." Western Extension Marketing Committee Fact Sheet. WEMC FS#3-04. Fall 2004

Lawrence, J.D. "Age Verification for Japan: What is Involved and is it Right for Me?" Western Extension Marketing Committee Fact Sheet. WEMC FS#12-06. Summer 2006.

Mathews, K.H. Jr., Vandeveer, M., and R.A. Gustafson. *An Economic Chronology of Bovine Spongiform Encephalopathy in North America*. Electronic Outlook Report LDP-M-143-01. Economic Research Service, U.S. Department of Agriculture, Washington, D.C. June 2006. Online. Available at http://www.ers.usda.gov

Ward, C.E. "A Review of Causes for and Consequences of Economic Concentration in the U.S. Meatpacking Industry." *Current Agriculture, Food & Resource Issues.* 3(2002):1-28.