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Review

Post-slaughter traceability

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ABSTRACT

Traceability programs can cover the whole of life, or parts of it, for individual animals or groups/lots of animals. Of 13 country or community traceability programs for cattle/beef, 11 are mandatory (4 encompass, or are scheduled to encompass, birth to retail; 7 cover birth to slaughter) while 2 are voluntary and encompass birth to slaughter. Of 10 country or community traceability programs for swine/pork, 2 are mandatory (1 covers birth to retail; 1 covers birth to slaughter) while 8 are voluntary. Of 6 country or community traceability programs for sheep/sheep-meat, 3 are mandatory (1 encompasses birth to retail; 2 encompass birth to slaughter) while 3 are voluntary. Mandatory birth to retail programs that include "post-slaughter individual animal identification (IAID) traceability" have been implemented for cattle/beef, swine/pork and sheep/sheep-meat by the European Union and for cattle/beef by Japan. Many of the voluntary as well as mandatory, birth to slaughter traceability programs for all three species are presumed (though that is not specified) to include "post-slaughter group/lot identification (GLID) traceability" – e.g., those qualifying products for shipment to the European Union. "Post-slaughter IAID traceability" can be accomplished in very-small, small, medium, large and very-large packing plants using single-carcass processing units, tagging and separation/segregation, and/or deoxyribonucleic acid (DNA) fingerprinting technology but all of these approaches are time-consuming and costly; and, to-date, in most countries, there has been no reason compelling enough to cause industry to adopt such protocols or technology.

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1. Introduction

Animal identification (ID) by means of marking animals' bodies was first recorded 3800 years ago in the Code of Hammurabi (King, 1910); during the human plague epidemics of the 14th century, animal products were monitored, and many products could not be traded internationally without certificates guaranteeing the origin and safety of the product (Blancou, 2001). Domestically and internationally, it will likely become imperative that producers, packers, processors, wholesalers, exporters and retailers assure that livestock and meat are identified, that record-keeping guarantees traceability through all or parts of the life-cycle, and that such information is authentic, visible and can be verified. Smith et al. (2005) characterized ten reasons identification and traceability can, could or will eventually be used by the livestock/meat industries.

As countries develop identification and traceability capabilities, at issue will be: (a) how and when (not if) animals and meat will be identified, because the entire concept hinges on keeping identity-based origin/movements/practices/processes/destination records; (b) the depth (i.e., how far back and/or forward the relevant information is tracked), breadth (i.e., the amount of information collected) and precision (i.e., the degree of assurance with which

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the tracing system can pinpoint a particular food product's movement or characteristics) of the traceability records (Golan, Krissoff, & Kuchler, 2005); and (c) the authenticity (others call this "precision," "accuracy" or "assurance") and "visibility" (i.e., access by stakeholders, customers and consumers) of identification and traceability records and data. As is chronicled in this paper, lifecycle individual animal identification (IAID) traceability – globally – is in its infancy, with several countries having developed IAID traceability capabilities from birth to slaughter but very few countries having developed such capabilities from slaughter through fabrication (i.e., "cutting" of the carcass into its parts – primals, subprimals and trimmings).

2. Identification

The World Organization for Animal Health (i.e., the OIE) defines animal identification as "the combination and linking of the identification and registration of an animal individually, with a unique identifier, or collectively by its epidemiological unit or group, with a unique group identifier" (OIE, 2006). Means of identifying individuals or groups/lots of live cattle, swine and sheep include (Smith et al., 2005): (a) paper records – e.g., passports, diaries, data-logs, (b) electronic records, (c) brands – on the hide or horns, (d) tattoos – on the ear, shoulder or lip, (e) tags – in the ear or around the tail; plastic or metal; button or dangle, plain or radio-frequency identification devices (RFID), (f) transponders – dangling in neck chains, implanted under the skin or bolused into the rumen, and (g) biometrics – deoxyribonucleic acid (DNA) fingerprinting, autoimmune antibody matching, iris scanning, retinal imaging, nose-print matching, facial recognition technology. Although any or all of these may be acceptable to United States (US) livestock producers, Bass et al. (2007) reported that only paper records, electronic records (swine only), shoulder tattoos (swine only), human-readable tags and electronic (RFID) tags are acceptable to operators of US cattle, swine and sheep packing plants. Nevertheless, any or all of these means of live animal identification will accomplish the purpose under specific circumstances in other countries/communities – provided that they are efficient, economical and can be verified. Accuracy, precision, repeatability, cost (and who bears that cost) and read-rate at the speed of commerce are but a few of the things that must be considered in deciding which of the methods of identifying live animals is used in a specific political entity (i.e., country or community).

Means of maintaining, within the packing plant, the identity of a carcass (as having been derived from a specific live animal) include: (a) tagging or (b) trolley-tracking. Such "identity preservation" is only meaningful if each animal is uniquely identified upon entering the packing plant, if that IAID number is transferred through termination of the slaughtering/dressing/chilling process, and if the IAID number on the carcass at the termination of chilling allows traceback of the carcass to the live animal that entered the packing plant and backward – through all premises involved in intermediary animal movements – to the premises of the animal's birth.

Means of uniquely identifying primal/subprimal cuts and trimmings from a specific animal (via correlation of IAID numbers through forward and backward tracing of a specific carcass) during fabrication and through final in-plant packaging (e.g., in vacuum packages) or accumulation of trimmings (e.g., in boxes, cartons or containers) for transfer/transport to grinding or processing facilities, differ – depending on the volume of product handled in a designated time period. In very-small-volume plants, complete separation/segregation of all individual animal parts can be accomplished via fabrication in single-carcass processing units (SCPUs) through packaging, boxing or direct transfer to retail stores (Steinsträter & Jensen, 2001). In small- and medium-volume plants, it can be accomplished by tagging (i.e., via correlated tagging of carcasses, sides, quarters and primal/subprimal cuts) plus complete separation/segregation of the trimmings from a single-carcass (Smith, Belk, Scanga, Sofos, & Tatum, 2000). In plants as large as some of those in the US, identification of primal/subprimal cuts from a specific animal is very difficult, but possible, by use of DNA-fingerprinting technology (Smith et al., 2000) while identification of trimmings from a specific animal is theoretically possible but implausible.

In large-volume plants in US, according to Robb, Lawrence, and Rosa (2006): (1) IAID of cattle/carcasses is accomplished from birth through carcass grading by use of ear tags and carcass tags or trolley-tracking but then lot-integrity is broken because carcasses are sorted, according to quality grade, yield grade, weight, sex-class and program (e.g., branded beef, Non-Hormone Treated Cattle Beef, beef requiring Export Verification) for fabrication. (2) Fabrication is a "disassembly" process, not performed in a linear process, in which 500 or more components and products are prepared from a given carcass and exit the fabrication room at different times. (3) From 1000 to 6000 carcasses are fabricated each day in a single plant. (4) The nonlinearity in the fabrication production stage, the rapid reduction of carcasses into many beef products in different parts of the fabrication room and the commingling of like cuts and trimmings from different carcasses to create boxes and combo-bins of beef, make direct tracking of trimmings to an individual animal/carcass virtually impossible, while it is possible to use DNA-fingerprinting technology to track primal/subprimal cuts.

Topel and Eilert (2002) reported that a single pork carcass, in US, is fabricated into as many as 150 components, and the speed of the cutting process is very fast – making traceability (on an IAID basis) from fabrication to retail a formidable task. Use of DNA fingerprinting as a means for tracing swine/pork and cattle/beef through supply-chains from farm-to-fork was considered in the late 1990s by pork companies in US and by beef companies in Australia (AU) but, as of 6 years ago, there was no reason compelling enough to cause industry to adopt such technology (Topel & Eilert, 2002).

Robb et al. (2006) described use of DNA-fingerprinting technology for traceback – from a specific retail cut, to a carcass and back to the animal that produced it – as follows: (1) A sample of muscle is archived (identified by calendar date, time of day, carcass ID number) from each individual carcass as it enters the fabrication room. (2) As each box of fabricated product moves past the box scale, it is time-stamped and recorded in the packer's computer system. (3) At the retailer's site, the box serial number can be used to identify each retail package generated from primals/subprimals in that box. (4) If there is need for traceback, a sample of muscle from the retail cut in question, plus the serial number of the box from which it came, are sent back to the packer and the packer locates the box serial number in the computer database. (5) Knowing the average length of time required for that cut of beef to be produced, boxed and scaled on the fabrication floor from the time the carcass entered the fabrication room, the packer can identify a range of potential carcasses from which the primal cut originated. (6) The packer then sends the sample of the retail cut, along with the samples from that range of potential carcasses to a DNA testing laboratory, to be analyzed until a DNA fingerprint match is achieved.

Nortje (2002) indicated: (1) The problems in following cuts through fabrication can be solved – at a cost – lower line-speeds, additional equipment, development of reliable and economical data-capturing devices or DNA fingerprinting. (2) The "full-traceability paddock-to-plate system" employed in New Zealand (NZ) uses DNA-fingerprinting technology but it is "batch-based" (i.e., at least a "batch" size of approximately 50 samples needs to be