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DEVELOPMENT AND IMPLEMENTATION OF A VERTICALLY-INTEGRATED BEEF CATTLE DATA COLLECTION SYSTEM

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ABSTRACT: Breeding decisions made by cow-calf producers may be suboptimal on a chain-wide basis if they never receive performance data from the feedlot or harvest sectors. However, the segmented nature of the beef industry presents challenges to sharing data collected by each of the supply chain members. We developed a data collection system using commercially available computer software to track the performance of individual animals from birth through subsequent production phases to the final carcass value. Both the University of California cow-calf herd and commercial cooperator herds participated in this project. The key to linking records from each phase was a radio frequency identification (RFID) ear tag assigned to each animal in the cow-calf herd. Sector-specific software developed by Midwest MicroSystems L.L.C. including Cow Sense® for ranch data, MARS for feedlot data, and Beef STAR® for harvest data collection were used for the real time transmission of field data to off-site "office" computers. A small commercial processing facility cooperated in the program and collected harvest data using a handheld device. After initial training focused on transferring identification from pre- to post harvest, carcass data were routinely obtained from all cattle processed. ID transfer at a small processing facility was simplified by relatively slow chain speeds. Data collected by collaborators were transmitted to a central server where they were connected with other research data (e.g. DNA genotypes) in a Microsoft® Access database. Data correction privileges were only extended to field collaborators. Data consumers received "read only" permission levels, thereby maintaining a single source of data control and integrity. Benefits were 1) minimal disruption or changes to individual sector data collection methods and labor, 2) integration of data across sectors, 3) data integrity and security, 4) returning performance data to cow-calf producers to facilitate more informed selection decisions, and 5) development of a comprehensive dataset for research.

Key Words: beef cattle, integrated data

Introduction

Cow-calf producers rarely obtain feedlot performance or carcass quality information on the calves they produce. As a result there is little opportunity or incentive for them to make genetic improvement in traits that are of importance to the feedlot and processing sectors, and consumers. Some producers have opted to join integrated beef production programs whereby they receive carcass data back from the processor, and receive premiums for the production of carcasses that achieve certain quality targets. Such programs provide both the information and the market incentive for producers to include carcass quality traits in their selection criteria. However, feedback requires a system that can integrate records coming from the different sectors of the beef supply chain. The increasing use of unique individual animal radio frequency identification (**RFID**) devices as a part of the National Animal Identification System (NAIS) offers an opportunity to introduce beneficial feedback to the supply chain.

The value of comprehensive data collection can be further increased through the simultaneous use of DNA markers to resolve the paternity of offspring produced in multisire breeding pastures, thus enabling on-ranch genetic evaluations (Dodds et al. 2005; Pollak, 2005; Van Eenennaam et al., 2007). In New Zealand over 20% the ram, and 30% of the deer breeding industry are now using DNA-enabled commercial ranch sire evaluations (McEwan, 2007). Ideally, information from each sector would be made available to breeders to use in selection decisions that optimize production to meet consumer demand (Figure 1).

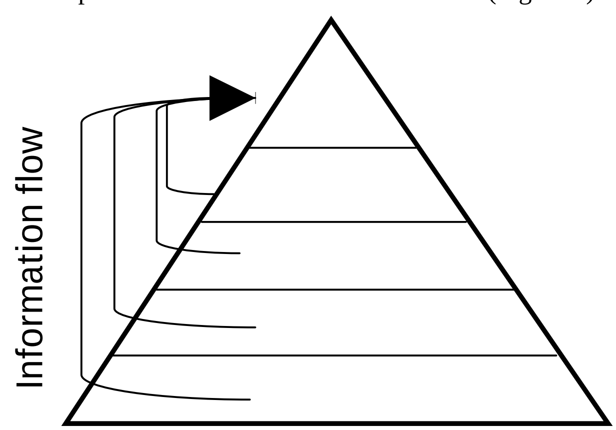

Figure 1. The greatest value of a vertically-integrated data collection system is obtained when breeding decisions are optimized for the entire chain (Modified from McEwan, 2007).

McEwan (2007) proposed that the widespread adoption of DNA technologies will depend on reducing the costs associated with sampling, DNA extraction, reporting and integrating the data into genetic evaluations. In New Zealand, DNA collection is being linked to electronic tags, allowing automation of subsequent steps and return of data to genetic evaluation entities. If DNA information is going to become widely adopted and used for genetic evaluation purposes in the U.S., it is likely that such approaches will also need to be implemented here. Currently, different sectors of the beef cattle industry are adopting computer technology for their own needs, and there is little integration between sectors, limiting both proactive exchange of information for management as well as post hoc evaluation of data for decision-making purposes. Effective traceback related to food safety or animal health issues is also limited by industry fragmentation. Development and implementation of voluntary integrated animal identification systems that simultaneously provide assistance in management as well as biosecurity features would be useful. We developed a data collection system using commercially-available computer software and RFIDs to track the performance of individual cattle from birth through subsequent production phases to final carcass data measurements.

Material and Methods

Cow and calf herds owned by the University of California Animal Science department and three commercial ranchers were involved with this project. The UC herd consisted of about 300 breeding females that calve in the fall (October). Steers and cull heifers were sent to the campus feedlot about 100 km away for finishing. Harvest-ready cattle were transported 225 km to a commercial harvest facility for processing. Commercial cow calf ranches were part of an integrated beef production program with a feedlot and harvest facility about 700 km away. Commercial ranch A consisted of a fall calving (September) herd of about 500 breeding females and a spring calving (January) herd of about 300. Commercial ranch B consisted of a fall calving (October) herd of about 300, and a spring calving herd (February) of about 200. Ranch C was spring calving (January) with about 200 breeding females. The UC herd and feedlot had a history of computerized performance records primarily using spreadsheets (Microsoft® Excel). The commercial herds had no prior experience with computerized records with the exception of ranch B, which had used a database program (CowBoss) to a limited extent. Prior to this project, carcass grading reports were provided on UC cattle via fax from the harvest facility. The commercial ranches received printed individual carcass data without individual animal identification, and some summary carcass data statistics.

All ranches on this project used multisire breeding pastures of 50 to 100 breeding females with ratios of approximately 25 females per bull for fixed durations of 45 to 90 days, depending upon the ranch. Calving records consisted of birth dates and dam identification, typically recorded within 1-2 days of birth in pocket-sized cattle record books. At birth, calves were identified with individual numbers and ear tags were applied. During the course of this project these records were then transferred to Cow Sense® herd management software (Midwest MicroSystems, Lincoln, NE). RFID ear tags were applied at weaning, at which time hair samples from calves from UC and commercial ranch A for 3 calf crops were collected for DNA-based paternity assignment (Van Eenennaam et al., 2007; Van Eenennaam et al., 2009).

During the feedlot phase, UC calves were weighed upon entry and at 30 day intervals. Feedlot data was collected using the Measurement and Analysis Research System (**MARS**), a computer program for multiple measures of cattle (Midwest MicroSystems). Cattle were harvested based on visual estimates of finish and shipped in groups of approximately 20 head for harvest and carcass data collection by a USDA grader. Carcass data were collected at the processor using a handheld device (PSION Workabout Pro) similar to those used by overnight delivery services, and Beef STAR® Processor software (Midwest MicroSystems). Beef STAR® is designed specifically for carcass data entry and transmission.

The calves from the three commercial collaborators were fed in a single group for each ranch and harvested in a single day. Harvest criteria varied depending on the needs of the processor. No individual feedlot performance information was available on these animals. Carcass data were collected at the large commercial processing plant by a company grader and provided to the collaborators in spreadsheet format. This data were then brought into Cow Sense® using the import tool and matched up with cow-calf sector data using RFID.

Results

Conceptually the data management system that is in place for the UC Davis cow-calf herd is composed of several distinct operations (Figure 2). Various sectors (users) collect data with commercially available software designed for their specific needs. This data are exchanged via remote computer servers (Figure 2; dotted lines) to a central office computer (Figure 2; large bold arrow) that resides in the UC Davis Animal Science department. The users can be physically separated with the data exchange being made via the internet through the Beef STAR® software program. At the central location or server, databases from the sectors are connected in a generic Microsoft® Access database. Data flows through Beef STAR® back to Cow Sense® herd management software to provide the herd manager with information on calf performance in the feedlot and at harvest. Data integration also enables development of on-ranch EPDs for the herd bulls on each ranch (Van Eenennaam et al. 2008, Van Eenennaam et al. 2009).

A specific example illustrates data flow (Figure 3). Calving data were collected at the cow/calf ranch in Cow Sense®. Additional data at that sector were collected until the calves were shipped to the next sector, the feedlot. At this time, data were sent from Cow Sense® to the central server allowing feedlot personnel access to data as calves were incoming and processed. Feedlot-specific data such as pens, rations, and in-weights associated with the RFIDs were recorded chute-side in MARS, which is their sector-specific software program, then transmitted to the central server. The processor and/or USDA personnel collected carcass data in the cooler with an electronic ID reading device (Psion). These data were transmitted electronically via Beef STAR® back to the central server where the data were stored. The commercial ranches received carcass data electronically in spreadsheets from the processor, and these were downloaded into Cow Sense® linked by the animal's RFID.

If additional research data (e.g., ultrasound scans or DNA genotyping results) were collected beyond that identified in the commercially available software, the information was linked via the RFID number and included in the central Access database (Figure 2).

At cattle handling facilities where data collection occurred, whenever it was possible, wireless connections were established so data flowed directly into office desktop computers rather than onto portable computers carrying copies of the database. This networking improved data security and integrity. Additional database security was provided with remote location backup of databases and read only privileges for researchers accessing the central database.

Discussion

Cow and calf sector. Collection of calving data was the most problematic for a variety of reasons. Unlike the feedlot and harvest where large numbers of cattle were processed at one time, calving is ongoing over several weeks or months. Frequently, when ear tagging neonatal calves, behavioral difficulties were encountered with their mothers. Cold or wet weather also often made the collection of detailed records difficult. Dam identification is important for improving production, but it can be difficult to read or remember the identification of the mother when working with neonatal calves. All cow/calf producers continued to record calving data in "red books" or their equivalent despite the opportunity to use handheld electronic devices (PDAs). In some cases, lists of periparturient cows were developed from the computerized records to facilitate accurate recording of dam identification. The field forms helped prevent errors reading dam ear tags and also provided a cross check for dams already recorded as calved. Data entry into Cow Sense®, the cow/calf database, was facilitated by data entry options in Cow Sense®, including importation of interim spreadsheet calving data.

Pre-weaning management procedures such as vaccinations were generally enhanced by having computerized records. Weaning weights were obtained with electronic scales interfaced with Cow Sense®. RFIDs were typically applied at weaning. RFID application and weighing were completed in conjunction with other standard cattle management activities.

Feedlot sector. Ownership of UC calves was retained through the UC feedlot, and data collected at the cow/calf ranch was accessible on receipt of the calves at the feedlot. This facilitated assignment of dietary, production and/or experimental groups. Physically, cow/calf data in Cow Sense® was transmitted via Beef STAR® to the feedlot to be utilized real-time for incoming calves. RFIDs were used as the linking field between cow calf and feedlot performance. Intensive feedlot data were collected in MARS. The most common measurement was repeated weighing at 30-day intervals. Commercial ranch calves did not have feedlot data collection as they were sold to the vertically integrated feedlot/processor.

Harvest sector. Carcass data on UC cattle were collected by a processor employee operating a handheld electronic device using Beef STAR® software, working with a USDA grader. RFIDs were transferred from the live animal to the carcass during harvest, and were scanned by the handheld device. The USDA grader orally communicated to the employee, who entered the information directly into Beef STAR®. This process was rapidly adopted by processor personnel following a single instructional session on how to use the handheld device and Beef STAR® software. The integrated RFID scanner in the device simplified reading RFIDs and data collection.

When carcass data collections were finished, processor secretarial employees placed the handheld data collection device in a cradle, establishing a link with their computer. With a brief 15 minute training period, the employee transmitted the data routinely from that device via the Beef STAR® software program and the internet to the central database at the Department of Animal Science.

Implications

This integrated data collection system was used to obtain cow-calf and carcass data from three UC Davis calf crops, and carcass data from three seasons of calves harvested from one of the commercial ranches. Additionally, calves and potential sires were genotyped using a SNP-based parentage panel. We are now using the information in the central database to develop on-ranch EPDs. Now that the system is operational, the central database will expand with time. Eventually we hope to develop a comprehensive database of DNA and phenotypes that will prove useful for the future validation of DNA-marker tests and whole genome-based genetic predictions.

Acknowledgements

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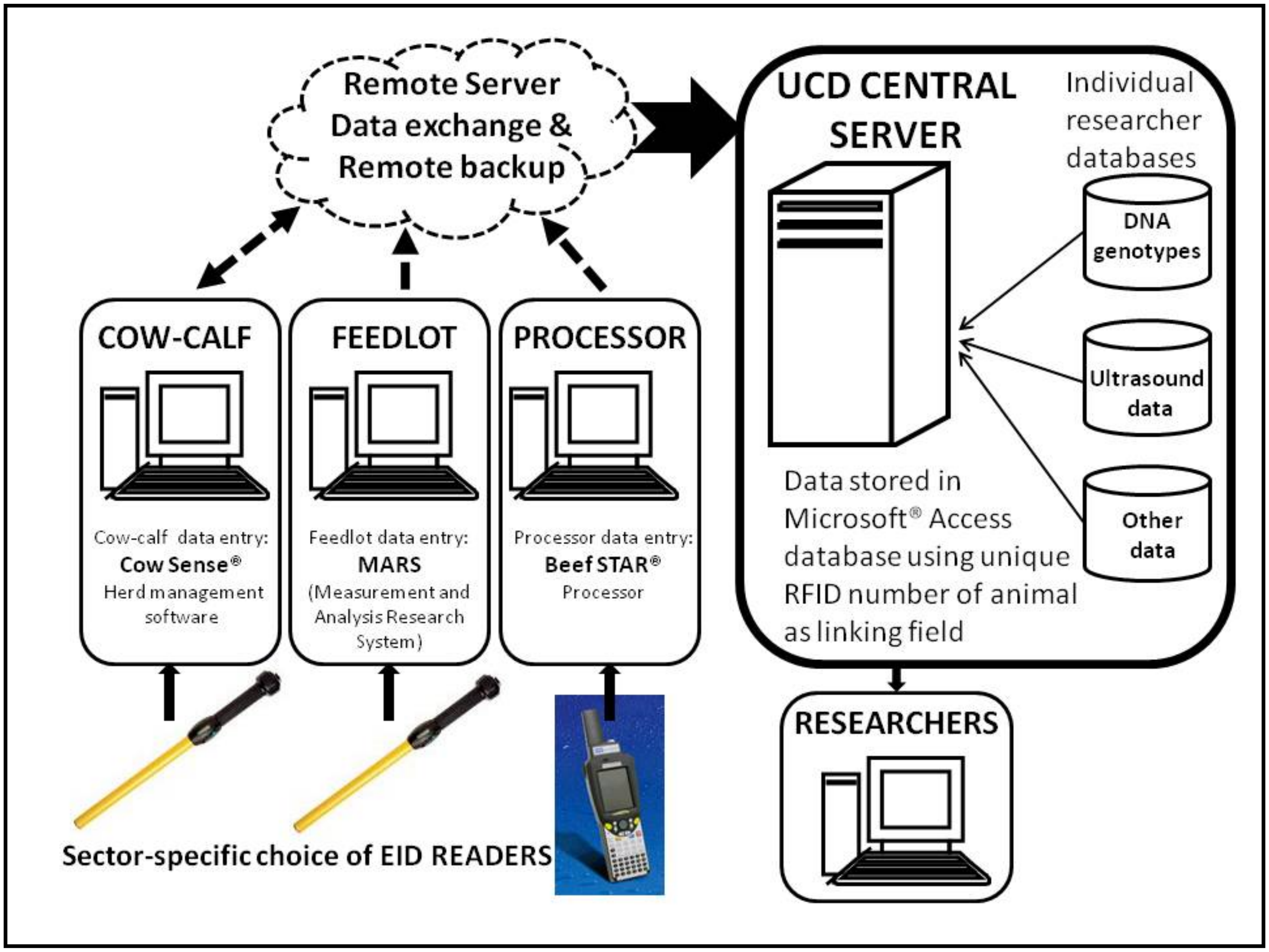

Figure 2. Schematic representation of the integrated data collection and management system. Individual users (denoted with solid-lined boxes) enter data from their facilities using combinations of office, facilities computers or handheld devices into commercially available software (Cow Sense®, MARS, Beef STAR®*;* Midwest MicroSystems, Lincoln, NE) designed for sector-specific data. Sole authority, capability and responsibility for data entry resides at these sites. Data are exchanged from the various data collection sectors via remote servers (denoted with dotted lines) to the central database files (thick solid line). Individual researcher databases are integrated with the sector data. Researchers and collaborators can access data with password permission, but they cannot enter or edit data on the central server.

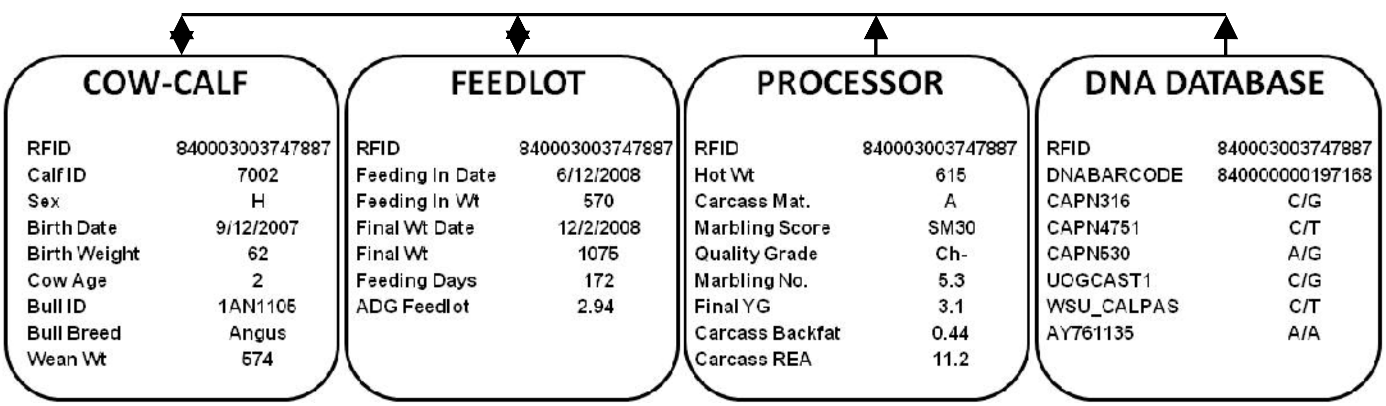

Figure 3. Representative data on a randomly-selected calf from the 2007 UC Davis cow-calf herd. This example shows data derived from the cow-calf sector, the feedlot, the processor, and DNA genotype data from an individual researcher database. Many more data fields are included in the actual database, this subsample is just for illustrative purposes. Double-headed arrows represent two-way exchange.