ENHANCED DATA CAPTURE IN AUSTRALIAN RED MEAT SUPPLY CHAINS FOR THE GENETIC IMPROVEMENT OF EATING QUALITY AND CARCASE YIELD

S.Z.Y. Guy[1,2] and D.J. Brown[1,2]

[1]Animal Genetics & Breeding Unit*, University of New England, Armidale, NSW, 2351 Australia
[2]Advanced Livestock Measurement Technologies Project, Meat & Livestock Australia, North Sydney, NSW, 2060 Australia

SUMMARY

Australian beef cattle and sheep breeders have made substantial and sustained genetic gains in growth and carcase yield. This has been achieved through the breeding objective traits of saleable meat yield in beef cattle, and percentage of carcase lean (also known as lean meat yield) in sheep. However, the need to also simultaneously select for eating quality is increasingly being acknowledged. While it is possible to counteract the antagonistic genetic relationships using index selection, data on both eating quality and carcase yield are required. Genomic reference populations play an essential role in obtaining these data. The aim of this paper is to summarise the measurement program of carcase and eating quality traits for Australian beef and sheep genomic reference populations, and the challenges involved in the process of data collection. The paper then discusses enhanced data capture through online objective carcase measurement technologies that will further contribute to genetic gains in eating quality and yield in red meat supply chains. The incorporation of technologies in harsh processing environments is challenging. However, if such technologies are appropriately incorporated in the processing chain, and also validated for the measurement of eating quality and yield for their respective species, this may decrease the cost and increase the efficiency of carcase data collection for genetic improvement. Combined with enhanced processor systems that allow tracking of individual carcases, as well as on-farm information collection and transmission systems, the aim is to move towards better collection and flow of accurate phenotypes to genetic evaluation systems. Enhanced data capture of disease and defect phenotypes are also important. Ultimately, a whole supply chain approach is required to increase collection of accurate carcase measures, which will lead to higher accuracies in estimated breeding values and greater genetic gains in eating quality and carcase yield.

INTRODUCTION

Australian beef cattle and sheep breeders have made substantial and sustained genetic gains in growth and carcase yield (Johnston 2007; Swan *et al*. 2009). This has been achieved through the breeding objective traits of saleable meat yield in beef cattle, and percentage of carcase lean (also known as lean meat yield) in sheep. However, consumer-eating experience of red meat is becoming increasingly important, and care must be taken to avoid selection for carcase yield at the detriment of eating quality. While it is possible to counteract this antagonistic relationship in breeding programs using index selection, it is difficult to select simultaneously for both eating quality and carcase yield due to the lack of data on these traits.

Genetic gains in eating quality and carcase yield rely heavily on genomic reference populations, which are measured for growth, carcase and eating quality traits on individual animals. The aim of this paper is to summarise the measurement program of carcase and eating quality traits for Australian genomic reference populations, and the challenges involved in the process of data collection. The paper then discusses enhanced data capture through online objective carcase measurement technologies that will further contribute to genetic gains in eating quality and yield in red meat supply chains.

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AUSTRALIAN BEEF AND SHEEP GENOMIC REFERENCE POPULATIONS

Genomic reference populations are constructed as a representation of the genetic diversity present in the industry. In Australia, the genomic reference populations established include breed-specific Beef Information Nucleus (Banks 2001), the Information Nucleus/MLA Resource Flock for sheep (van der Werf *et al.* 2010), as well as well-recorded industry herds or flocks. These reference populations are genotyped and extensively phenotyped for a range of traits, including production and carcase traits. By understanding the genetic relationships between (correlated) traits, and use of genomic technologies to quantify their genetic relationship with reference populations, estimated breeding values (EBVs) for industry animals can be derived for hard-to-measure traits. A major future challenge will be the continued collection of phenotypes to derive accurate genomic predictions (Swan *et al*. 2011).

Data capture on eating quality and carcase yield. The eating quality and carcase yield traits collected on Australian beef and lamb genomic reference populations are outlined in Table 1. The genetic analyses of these carcase traits require additional data about each animal, including pedigree, date of birth (to calculate age at slaughter), birth type, rear type and management group. These data are essential for the genetic analysis of carcase traits to appropriately separate genotype from environmental effects. There are also requirements for how these animals are managed on-farm and specific protocol for measurements. For example, animals within a defined contemporary group must be kept in the same group across time, and there should not to be any systematic selection of animals to be measured based on one or more criteria (i.e. no harvesting based on weight). These requirements are in place to ensure the data structure integrity for accurate genetic parameter estimation and robust estimation of breeding values.

Table 1. Eating quality and yield carcase traits collected on Australian beef and lamb genomic reference populations, and used in genetic evaluation systems

Species	Eating Quality	Carcase yield
Beef	• Intramuscular fat % • Shear force • Marble score*	• Hot standard carcase weight • Retail beef yield (subset only) • Eye muscle area* • Rib Fat* • P8 (rump) fat
Sheep	• Intramuscular fat % • Shear force • Consumer testing (subset only) – tenderness, juiciness, liking of flavour, overall liking	• Computed Tomography (subset only) – lean %, fat %, bone % • Hot standard carcase weight • Primal bone out (subset only) • Fat (c-site, GR-site) • Eye muscle depth and width (for calculation of eye muscle area)

*part of Meat Standards Australia (MSA) beef grading

Challenges in carcase data collection. The collection of these phenotypes from reference sheep/beef carcases is a highly coordinated exercise. It is essential to negotiate with the relevant processor on the slaughter process and sample collection prior to slaughter. A team of research staff must be present at the kill to match up farm identification numbers with body numbers. Each carcase must be followed during processing to ensure that identity is not lost, and that the same traits are being collected in the same way in different abattoirs e.g. no excessive trimming. The operating environment is harsh due to moisture, heat, and fast chain speeds. Depending on the processing facilities, data are either collected from the slaughter floor (e.g. rump fat in beef), in the chillers (e.g. fat depth in lamb), and/

or meat samples are collected and transported to meat science laboratories for further analysis (e.g. intramuscular fat). Connecting different data points on individual animals requires integrated systems within the processing plant, and also alignment with on-farm and meat laboratory data.

OPPORTUNITIES FOR ENHANCED DATA CAPTURE

There is currently no technology available to measure eating quality and yield traits in real-time. Enhanced data capture and information flow have been identified as essential keys to increase producer confidence in carcase grading and pricing, transparency, competition, productivity and growth in the red meat supply chains (ACCC 2017). As a result, the development of technologies for independent and accurate descriptions of carcase performance has been prioritised by industry. Objective and predictive measures on carcase yield and eating quality, provided as feedback, will allow producers to improve decision-making to increase compliance and profitability.

The Advanced Livestock Measurement Technologies (ALMTech) project, 2015-2019. The ALMTech project for globally competitive Australian meat is funded by the Australian Government, in partnership with Research and Development Corporations, commercial companies, state departments and universities. This project involves many collaborations within multiple supply chains to maximise effective decision making, reduce risk and optimise profitability for all partners in the meat supply chain.

ALMTech has the following objectives:

- Accurate measurement (objective and predictive) systems of live animals, carcases and cuts in major beef, lamb and pork supply chains
- Valued producer feedback to effect decision making on compliance and profitability
- Enhanced supply chain information systems to extract maximum value of products

Figure 1 outlines the ALMTech activities and examples of the technologies currently being investigated for the enhanced data carcase composition, eating quality and health during processing.

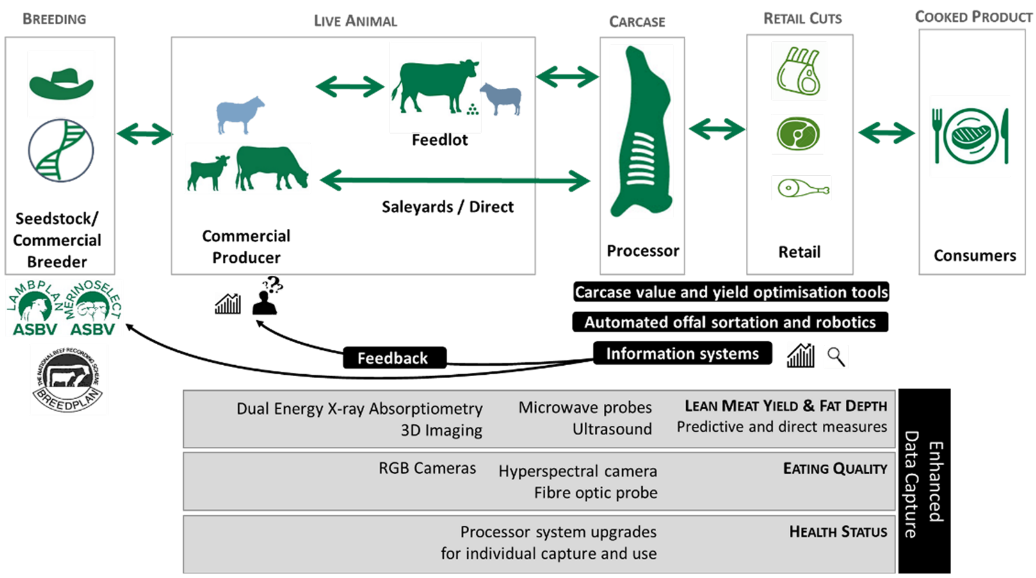

Figure 1. A snapshot of activities and technologies from the Advanced Livestock Measurement Technologies (ALMTech) project (2015-2019), aiming to enhance data capture and information flow along the red meat supply chain

Implications for animal breeding. In order to make effective selection decisions in the seedstock sector, a certain level of understanding of the process further down the supply chain is required. The supply chain is in fact a value chain, where there is a full range of activities required at different stages to create the red meat product. In addition to this, a whole chain approach is required to ensure the flow of data on accurate carcase measures.

Data collection on genomic reference populations have been aligned with, or identical to, the traits that impact value, especially in the processing and retail sectors. The measurement of reference populations with objective carcase measurement technologies will also assist with preparations for future market signals that may arise from the installation of technologies in commercial processors.

A validated technology appropriately incorporated in a processing chain will decrease the cost and increase the efficiency of objective carcase data collection on genetically informed animals. This also provides seedstock breeders more opportunities to collect carcase data through progeny testing, or testing of surplus (cull) breeding animals. These will help breeders to balance the selection based on live animal measures (such as weights, eye muscle area and fat depth) with carcase measures, and also allow them to overcome the unfavourable genetic correlations between yield and eating quality. Increased collection of accurate carcase measures ultimately will lead to higher EBV accuracies and therefore greater potential genetic gains in yield and eating quality.

There are also opportunities to select for good animal health using meat inspection data, which has primarily been investigated in pig production (Mathur *et al.* 2018; Horst *et al.* 2019). Although there are challenges with the accurate collection of such data on an individual basis, and the constraint of low and variable prevalence, preliminary genetic parameters demonstrate the potential to use this data for the selection of health conditions that may not be observable in the live animal.

CONCLUSIONS

Genetic gains in eating quality and carcase yield currently rely heavily on genomic reference populations. While there are opportunities to improve the efficiency and accuracy of data capture of carcase traits on reference animals, the incorporation of technologies in the harsh processing environments is challenging. However, combined with enhanced processor animal and carcase tracking systems that allow tracking of individual carcasses, as well as on-farm information flow systems, the aim is to move towards better collection and flow of accurate phenotypes to genetic evaluation systems. An entire supply chain approach is required to increase collection of accurate carcase measures, which will lead to higher EBV accuracies and therefore greater genetic gains in eating quality and carcase yield.

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