Technical Report

Program: Sub-program 1.1

Report Title: Compilation of final reports for LMY measurement technologies developed for commercial use in live animals

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Executive Summary

Non-destructive, objective methods of determining LMY that are cost effective and can operate in on-farm commercial environments are essential to enhance productivity and profitability of meat supply chains. Two on-farm technologies have been developed reaching varying levels of commercialisation. A hand-held microwave system has shown good capacity for measuring fat depth in both beef and lamb and has been tested in commercial environments by commercial partners. Similarly, a 3-D imaging system for live cattle has been installed in a marshalling race of a beef feedlot demonstrating successful prediction of carcase attributes.

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Contents

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1 Microwave scanning

The prototype ultra-wideband (UWB) microwave system (MiS) that was designed and fabricated at Murdoch University during ALMTech 1 has undergone significant modification. During ALMTech 2 the hand-held unit has been redesigned to improve its robustness and tolerance to water (splash proof) and dust. The antenna has been redesigned to enhance its strength, particularly at the connection point on the microwave unit (see "KPI 2.7 Report on antenna and probe design for portable microwave system"), and an improved calibration system has been developed. These changes have required acquisition of new calibration data and the training of a new algorithm (see "KPI 1.16 Continued improvement of the MiS operating system and algorithm").

In sheep the new algorithm was successfully trained from a single scan of the C-site in live animals to predict C-site fat depth and GR tissue depth in the carcase at slaughter. The prediction of eye muscle depth was less accurate (see "KPI 2.6 Validation of a prototype microwave device to measure fat depth at the rib and P8 sites on live cattle and validate against the corresponding ultrasound and abattoir measurements"). Furthermore, in collaboration with an MLA and AWI funded maternal productivity project an algorithm was trained to predict whole body fat percentage in mature ewes using a medical DEXA system (see "KPI 2.7 Ability of live microwave scanning in sheep to predict whole body fat composition as determined by live DEXA scanning"), in this being used as part of an on-farm strategy to manage maternal condition prior to mating. Lastly, the microwave was used in conjunction with nucleus flock ultrasound scanning to provide data for genetic selection indices, this aspect further reported in Program 4.

Commercial testing of the microwave system has been undertaken, albeit by untrained farm staff at research facilities. This has included staff at Katanning Research Station where the nucleus flock lambs were scanned, and by team members of the maternal productivity project with mature ewes measured on a range of commercial and research properties throughout Western Australia. Feedback has provided some guidance for physical design and system improvements, and particularly real-world factors that can influence results such as the requirement for dry fleeces, and how to part the wool during measurement.

In beef, the system was trained on P8 and rib fat depth scanned in live cattle to predict slaughter traits, with no change in the previously reported precision and accuracy (see "KPI 2.17 Report on the ability of a microwave device to predict rib fat and P8 fat depth in beef carcases"—note that this report is filed under Sub-program 1.3, as it has overlap with that Sub-program). This was simultaneously compared to ultrasound scanning of these same cattle, demonstrating superior performance for predicting these fat depths at slaughter. Some of these studies attempted to acquire microwave scanned fat depths in cattle immediately prior to slaughter. These were unsuccessful, likely due to the washing of these cattle immediately prior to measurement and the subsequent impedance caused by water retained in the animal's coat.

In beef, a commercial test of the microwave system is being undertaken by Michael Hughes at his cattle feedlot "Oro" in Deniliquin. In this case Michael is matching his on-farm microwave scanned data with the subsequent slaughter P8 measurements assess the capacity to improve compliance to fat depth specifications at slaughter. In addition to this a project plan is being generated with a

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major Australian beef processor to deploy a microwave system within one of their vertically integrated beef feedlots.

In conclusion the microwave system offers a promising alternative for on-farm subcutaneous fat depth prediction in its ability to safely operate at yard speed in the live animal without the need for shielding or extensive expertise of the operator. This activity has met the KPIs listed for this project:

1.1.1 KPI 3.7 The commercial utilisation of a prototype microwave device to measure fat depth at the rib and P8 sites on cattle.

1.1.2 KPI 3.8 The commercial utilisation of a prototype microwave device to measure fat depth at the C-site on sheep.

2 3D Imaging

The pre-commercial prototype 3D imaging system for beef cattle that was developed at University of Technology Sydney during ALMTech 1 has undergone significant modification during this project with additional support from MLA through project grant B.GBP.0051. The modifications were in direct response to deployment and integration into standard feedlot operations. Specified requirements included no added time to standard cattle weighing and the need for no additional pen handlers. This resulted in substantial mechanical design modifications and changes to software implementation (see "KPI 3.9 Report on the commercial use of a 3D imaging system predicting LMY pre-slaughter at feedlot exit.")

The redesigned 3D imaging system consists of panels that can be retrofitted into an existing cattle race that has a weigh box equipped with RFID reader. Weighing cattle would already require them to be individually separated. The small modification needed would result in separation occurring at the area where the 3D imaging system is installed, which we refer to as the "pre-weigh box".

There is a near-side and off-side panel to be installed in the pre-weigh box area, 3D cameras are attached to the panels via a removable sliding assembly. A multi camera calibration process needs to be performed at installation, for permanent installs this would be a one-time process. The system can interact with RFID reader and weight scales, recording objective traits against each individual animal without the need to inspect/record ear tags.

The 3D imaging system uses non-invasive technology, multiple depth images to reconstruct a 3D representation of the body of each animal from neck to tail, while it is moving unconstrained within the pre-weigh box. The entire acquisition of 3D data is automated; it operates in real-time; the pen handler gets informed when to release cattle into the weight box. The process of data capture depends on the temperament of cattle, in testing 95% of cattle are acquired within 10s of entry into the pre-weigh box. Thereafter, estimation of the trait takes approximately 30 seconds per animal, another animal can be scanned while the estimation is occurring. Generally, the results of the

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estimation are produced by the time the animal is to be released from the weigh-box and can be displayed to the operator.

Evaluation of the system was performed on Angus, Hereford, Charolia, Shorthorn, Wagyu cattle. P8 Fat range 1-28mm, includes cattle both at feedlot entry and feedlot exit (70-day grain finish). Unfortunately, no LMY values of cattle were obtained during the project, the focus pivoted to traits obtained on live animals using ultrasound as ground truth: P8 and EMA. Evaluation determined that the models developed, trained on P8 and EMA using previously scanned animals, can be used to estimate traits of unseen cattle. The analysis shows that beyond P8 of 18mm the estimation accuracy drops, the 3D models do not capture sufficiently discerning curvature to differentiate higher levels of fatness. The current breeds validated consist of British and Euro, the traits estimated were agnostic to the breed type. Analysis of HCW and impact of Brahman and Brangus (crosses) on estimation was not completed at the time of this report, given cattle availability and scheduled slaughter times (see “KPI 3.10 Report on impact of breeds of cattle on a 3D imaging system predicting HCW pre-slaughter (at feedlot exit)”).

A pre-commercial test of the 3D Imaging system is currently being undertaken at the University of New England feedlot “Tullimba” in Torryburn NSW. The cattle scanned are part of the Southern Multi Breed project co-funded by NSW DPI, UNE, Meat & Livestock Australia (MLA) and the Commonwealth Government. Traits are recorded for each individual animal at feedlot exit, allowing comparison against traditional ultrasound measurements of live cattle and in abattoir measurements of traits. In synergy with current testing, the technology is being readied for commercialisation via expression of interest planned for late Q2 of 2023.

In conclusion, the 3D imaging system provides an alternative on-farm trait estimation mechanism. It can be integrated into existing race design at feedlots, with no additional interaction/handling of cattle beyond separating them for weighing. There is minimal change to pen handling and ability to safely operate at close to current weighing speed. This activity has met the KPIs listed for this project:

2.1.1 KPI 3.9 The commercial use of a 3D imaging system predicting LMY pre-slaughter (at feedlot exit).

2.1.2 KPI 3.10 The impact of breeds of cattle on a 3D imaging system predicting HCW pre-slaughter (at feedlot exit).

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