Final report

Tullimba: Centre of Excellence for Feedlot R&D

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Abstract

In response to the Feedlot Program 2020 Strategic Plan, UNE and the federal government via MDC provided investment for upgrading UNE's Tullimba feedlot to provide an industry relevant research facility where novel and emerging technologies could be developed and evaluated to provide improved productivity, management, profitability, animal welfare and a reduced environmental footprint for Australian feedlots. The objectives were to upgrade grain (tempering) processing and delivery facilities, and review and expand Standard Operating Procedures to facilitate best practice management of research project for the beef feedlot sector. In addition, an advisory group was established for Tullimba consisting of a feedlot consulting nutritionist, the MLA Feedlot Program manager and UNE SMART Farms Research and Engagement Manager. Project upgrades to infrastructure and equipment were completed and further complemented by a large number of other improvements to the feedlot research capability. The tempering feed and delivery system generally met or exceeded processing performance industry benchmarks. As an indication of active demand for Tullimba feedlot research facilities, a total of 37 projects, funded by 23 providers, with a value of $10.15m were successfully commissioned since 2018, with a further $20m of projects to commence in 2022. Tullimba is a unique research asset enabling modern research in greenhouse gas suppression, cattle management, nutrition and genetics for the beef industry. Moving forward, UNE is keen to partner with MLA, state and federal governments, commercial companies and the industry to advance the sustainability and profitability of beef production.

Executive summary

Background

The Feedlot Program 2020 Strategic Plan highlighted the need for the Australian feedlot sector to have access to a dedicated, industry relevant research facility, particularly for undertaking productivity related R&D projects, which require multiple replicates of treatments, applied to small numbers of cattle per treatment group, under controlled conditions. Investment by UNE and the federal government via MDC formed the basis for upgrading Tullimba feedlot where novel and emerging technologies could be developed and evaluated to provide improved productivity, management, profitability, animal welfare and a reduced environmental footprint for Australian feedlots.

Objectives

This project was all about RD&E delivered through an optimised Tullimba research facility. The objectives were to:

- Upgrade infrastructure, equipment, and procedures so Tullimba offered a commercially relevant research feedlot with quality-assured grain processing and delivery to cattle on-feed.
- Establish an industry-based advisory group for Tullimba with regular meetings.

Methodology

- Deliver a number of upgrades to the infrastructure, equipment and procedures at the Tullimba research feedlot facility, including:
- Design, supply and construction of a tempering feed system
- Supply and delivery of a tractor driven Rotomix feed delivery wagon, fitted with DigiStar weigh and data transfer platforms
- Supply and certification of calibration weights
- Supply and delivery of one 4WD Front End Loader.
- Upgrades to pen infrastructure
- Review and development of Standard Operating Procedures

Results/key findings

Upgrades to infrastructure and equipment were completed but there were insufficient funds for upgrades to pen infrastructure. The tempering feed system and delivery system generally met or exceeded processing performance benchmarks. Standard Operating Procedures were completely reviewed and new Standard Operating Procedures developed where required. These form the basis of quality-assured grain processing and delivery and management of cattle on-feed. An industry based advisory group was established for Tullimba consisting of a feedlot consulting nutritionist, the MLA Feedlot Program manager and UNE SMART Farms Research and Engagement Manager.

Benefits to industry

The upgrades to infrastructure, equipment, and procedures at Tullimba feedlot have established Tullimba as an industry facility that provides commercially-relevant conditions under which tightly controlled and well-designed experiments and data recording are conducted that address productivity, welfare and greenhouse gas emissions. During the period of this project, many other improvements were implemented by UNE with its research and industry partners. As an indication

of industry usage, a total of 37 projects, funded by 23 providers, with a value of $10.15m have been successfully commissioned and/or completed at Tullimba since 2018. A further $20m of projects have been committed that will commence in 2022.

Future research and recommendations

Tullimba is a unique research asset enabling modern research in greenhouse gas suppression, cattle management, nutrition and genetics for the beef industry. Moving forward, UNE is keen to partner with MLA, commercial companies and the industry to advance the sustainability and profitability of beef production. As part of this proposed next step, the role and make-up of an Industry Advisory Group should be discussed to ensure developments meet the current and future needs of the feedlot sector.

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1. Background

The Feedlot Program 2020 Strategic Plan highlighted the need for the Australian feedlot sector to have access to a dedicated, industry relevant research facility, particularly for undertaking productivity related R&D projects, which require multiple replicates of treatments, applied to small numbers of cattle per treatment group, under controlled conditions. This cannot be achieved in a commercial operation.

In response to identified industry need, this project was a foundation investment by UNE and the federal government via MDC in establishing an appropriate facility through which novel and emerging technologies could be developed and evaluated to provide improved productivity, management, profitability, animal welfare and a reduced environmental footprint for Australian feedlots.

The investment was intended to upgrade feedlot infrastructure and equipment including the purchase, installation and commissioning of new grain processing, feed mixing and feed delivery equipment. The project also provided support for the Livestock Productivity Partnership collaboration between UNE, NSW DPI, CSIRO and the MDC, and it delivered against the MISP2020 priorities of "Optimising product quality and cost efficiency" as well as "Production efficiency in farms and feedlots".

The project considered establishment of an Industry Advisory Group to strengthen connection with the feedlot sector, add a commercial focus to management of the Tullimba operation, ensure commercial industry R&D addresses industry priorities, and is commercially relevant, and positions Tullimba as the Centre of Excellence for Feedlot R&D. In addition to the usual MLA channels for extension of R&D outcomes, the establishment of the Industry Advisory Group was considered to provide an additional pipeline for dissemination and adoption of outcomes, utilising Tullimba for practical demonstration of automation technologies, accredited training, group and conference tours.

2. Objectives

This project was all about RD&E for the Australian feedlot industry delivered through an upgraded Tullimba research feedlot facility to provide the Australian Feedlot industry with awareness and confidence in opportunities for automation and best practice.

Output 1: Commercially relevant research feedlot operational with quality-assured grain processing and delivery to cattle on-feed.
Outcome 1: Feedlot sector and scientific community confident that Tullimba feed management provided is industry-relevant and quality assured in terms of treatment and feed-out.

Output 2: Industry-based steering committee for Tullimba initiated and meeting regularly.
Outcome 2: Tullimba is the Centre of Excellence for Feedlot R&D with the Industry Advisory Group providing input and support for feedlot operation, cattle supply and interfacing with the commercial feedlot sector in order to foster industry ownership of R&D outcomes.

3. Methodology

3.1 Infrastructure and equipment upgrades

The project was designed to deliver a number of upgrades to the infrastructure and equipment at the Tullimba research feedlot facility, including:

1. Design, supply and construction of a tempering grain treatment and milling facility, including roller mill.
2. Supply and delivery of a tractor driven Rotomix feed delivery wagon, fitted with DigiStar weigh and data transfer platform.
3. Supply and certification of 850 kg calibration weights for individual animal weigh platform.
4. Supply and delivery of one 4WD Front End Loader with Quick-Hitch attachment capability, and attachments including general purpose bucket and hay/pallet forks.
5. Upgrades to pen infrastructure, including sub-division of 'A' row pens, fit out with gates, water troughs and feed bunks to make 64 pens with a carrying capacity of 16 head at 15.6 m2/head.

In support of the demonstration of industry relevant practices, a further activity was updating of existing and development of new Standard Operating Procedures (SOP) in collaboration with MLA to cover relevant activities, including feed manufacture, distribution, recording, and scale calibration.

3.2 Feed and processing performance

The moisture content of tempered grain was determined daily from two x 120 g samples used for oven dry determination and a single sample (sufficient to fill an approx. 25 mm height x 25 mm diameter container) tested with a HE-50 Moisture Analyser. The moisture content of rations was determined daily by sampling the ration at 3-4 sites along a nominated feed bunk. Oven dry matter was determined from samples of tempered grain or ration weighed into shallow aluminium containers and placed in an oven at 80°C for 24 h. The change in weight between fresh and oven dry states was used to calculate moisture content.

Flake weight of processed grain was assessed on a daily basis using a Graintec Scientific test weight kit and compared to test weights of dry whole grain from the silo. A Processing Index was then calculated by:

(test weight of tempered processed grain/test weight dry whole grain in silo) x 100

Loading and delivery variances were calculated from the difference between actual (recorded from Digistar) and intended ration mass (kg). Feeding shrink is the feed that cannot be accounted for from feed delivery and was calculated as:

[(Total kg fed + Total kg returned) – (Total kg loaded)] / Total kg loaded x 100

4. Results and Discussion

4.1 Infrastructure and equipment

The purchase costs for the tempering plant, feed delivery wagon, and front end loader exceeded the budgeted amounts included in the Agreement with MLA (Table 1). In total, the exceedance amounted to $132k and this prevented works to upgrade the pen infrastructure (as previously reported in Milestone 3).

Table 1: Budgeted and actual costs for infrastructure and equipment purchases

Item	Budget cost	Actual Cost	Variance (budget to actual)
Design, supply and construction of a tempering grain treatment and milling facility, including roller mill from Kotzur	550,000.00	652,960.16	(102,960.16)
Supply and delivery of a tractor driven Rotomix feed delivery wagon, fitted with DigiStar weigh and data transfer platforms	50,000.00	70,209.84	(20,209.84)
Supply and certification of 850 kg calibration weights for individual animal weigh platform from Wedderburn	5,000.00	5,180.00	(180.00)
Supply and delivery of one 4WD Front End Loader with Quick-Hitch attachment capability, and attachments including general purpose bucket and hay/pallet forks from Western Farm Machinery	120,000.00	128,650.00	(8,650.00)
Pens	132,000.00	-	132,000.00
Total	**857,000.00**	**857,000.00**	**-**

Pen upgrade plans were developed by FSA for Row A and Row B of the feedlot including quantities estimated and costings that included: pen design, bunks and aprons, fencing, water troughs and aprons, water reticulation, electrical, concrete, and tender notes. These works were costed at $1.38m with a subcomponent of works restricted to feed bunks and aprons on Row A being $92k. These plans remain on file.

The details of the feedlot tempering system purchased from Kotzur are provided in Appendix 1. The key components of the system are:

- Tubular Screw Conveyor, Transfer Screw from Existing Drag to BE01
- “S” Series High Speed Centrifugal Discharge bucket elevator
- Tumble Aspirator for removal of dust and husk
- Rotary Drum Screener
- Dust Extraction Cyclone

- Tubular Screw Conveyor
- Tubular Weigh Screw Conveyor
- U-Trough Mixing Screw Conveyor
- "S" Series High Speed Centrifugal Discharge bucket elevator
- Diverter Valve
- Gravity Spout – Tempering Bin Feed Spout
- Gravity Spout – Roller Mill Feed Spout
- Sectional Elbows for spout connection and orientation
- Single Screw Discharge Feeder. Tempering Bin Discharge
- Tubular Screw Conveyor, Bunker Feed Screw
- Manual Flip- Flop Valve
- Tempering Silo
- Flaker Mill
- Structural Steel Supports/Stands
- Connecting Transitions & Surge Bin
- Grain Conditioning System

The details of the 274-12 Rotomix dual-axle feed delivery wagon purchased from Rotomix are provided in Appendix 2. The key components of the system are:

- 274-12 ROTO-MIX feed mixer trailer
- 274-12 trailer mounting kits
- 48 x 36 inch chain conv w/motor
- Tandem axle torsion axles and tyres
- Indicator power cord
- Ladder
- Scale battery/cores

The Rotomix feed delivery wagon and tractor were fitted with Digistar TMR4610 indicator and a remote RD2500V, fitted with receiver module, and handheld Elsema transmitter, purchased from AusLogic Systems.

The SDLG Front end (wheel) loader (Model LG936L) was purchased from Western Farm Machinery (Appendix 3). The key components are:

- Deutz turbo diesel engine, delivering 123 horse power
- 2 speed power shift transmission
- ROPS/FOPS cabin
- Air conditioned cab with pillarless wrap around wind screen
- Single lever hydraulic pilot control
- Hydraulic quick hitch with full powered 3rd function hydraulics
- 1.8m3 bucket capacity with 2,700kg lift capacity
- Long arms as standard
- 2way radio & stereo radio fitted
- Boom suspension kit
- 4kg STD BEKA-tronX1 Auto Grease system
- Loadlog 500+ Weighing system
- 4 tine square bale forks 1800mm back frame

The calibration weights were purchased from Wedderburn and included 43 x 20kg iron bars.

4.2 Feed and processing performance

The key measures of grain and ration characteristics and processing performance are described in Figures 1-5.

The between-day variance of grain moisture content for each month averaged 1.0% when determined from oven dry matter and 0.8% when determined from the moisture meter. Both variances are very low but the higher variance from oven dry matters is likely a function of the methodology where a smaller subsample of grain is tested with oven dry matter determination. Flake weights (± SD) averaged 43.7±2.7 kg/hL and Processing Index (± SD) averaged 67.5±4.9 % with both parameters within target bands. The between-day variance of oven dry matters for Finisher and T2 rations averaged (± SD) 0.9±0.4% remaining largely within the target band below 1.0% moisture. Between-day loading variances within each month were well below the target maximum of 5 kg/pen, and between-day delivery variances typically remained below the target maximum of 0.1 kg/head. Monthly average feed shrinkage averaged 0.45% with 35% of average monthly values exceeding the target maximum shrinkage of -0.5%. Nevertheless, these shrinkage values are very low and exceedances are likely a function of sensitivity of loading and delivery scales.

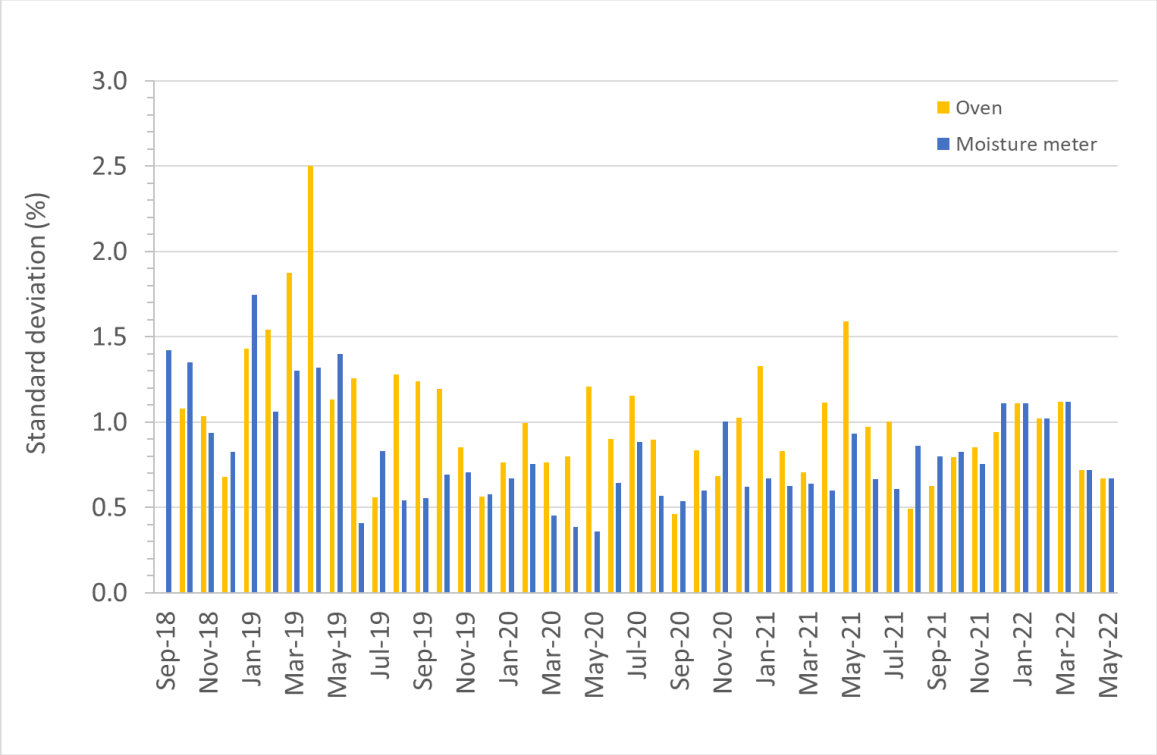

Figure 1: Monthly standard deviation (%) of tempered grain moisture as determined from oven dry matter and moisture meter. Note that the moisture content was determined daily and the monthly standard deviation reflects the between-day variation. The target standard variation of grain moisture <1.0%.

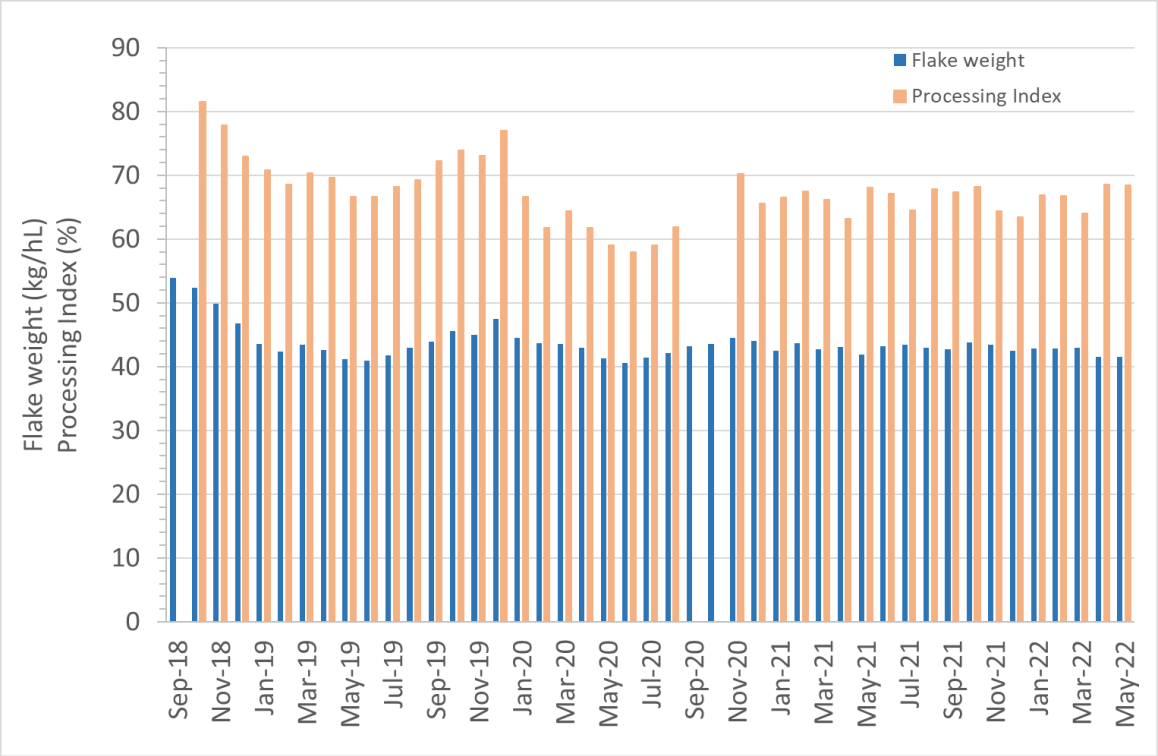

Figure 2: Monthly average flake weight and Processing Index of tempered grain. Note target Processing Index range for barley of 65-70%.

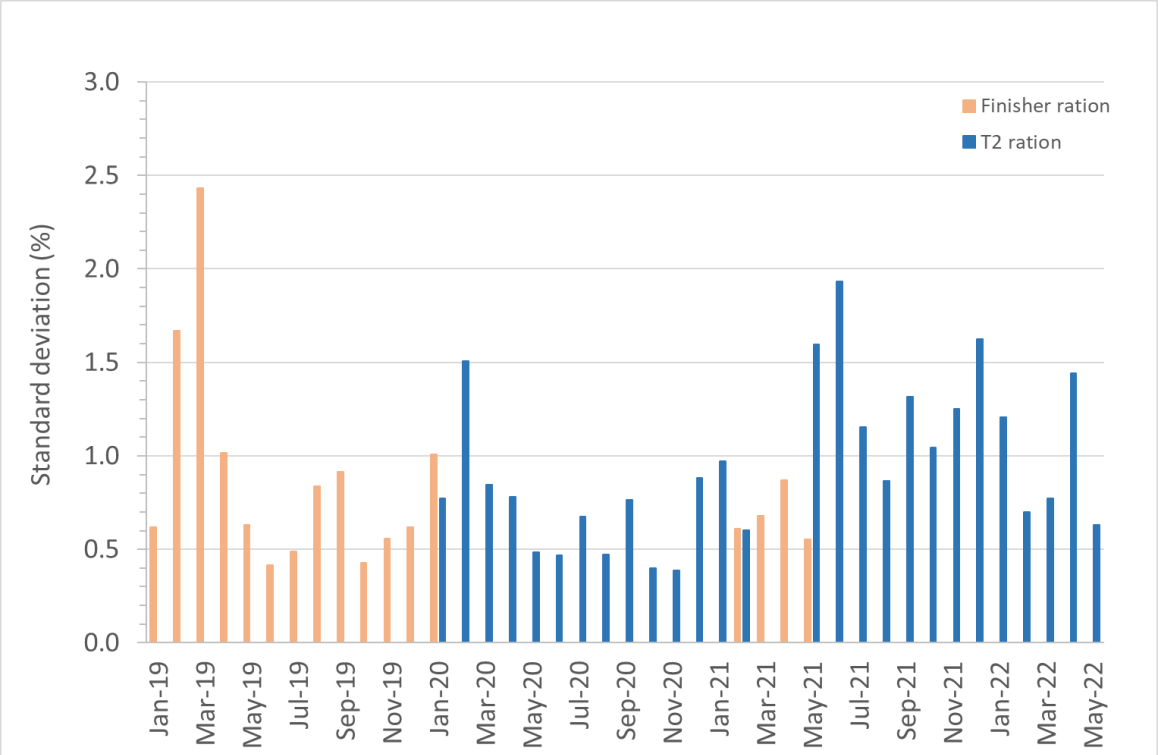

Figure 3: Monthly standard deviation (%) of ration oven dry matter for the Finisher and T2 rations. Note the target standard variation of grain moisture <1.0%. Note that the moisture content was determined daily and the monthly standard deviation reflects the between-day variation.

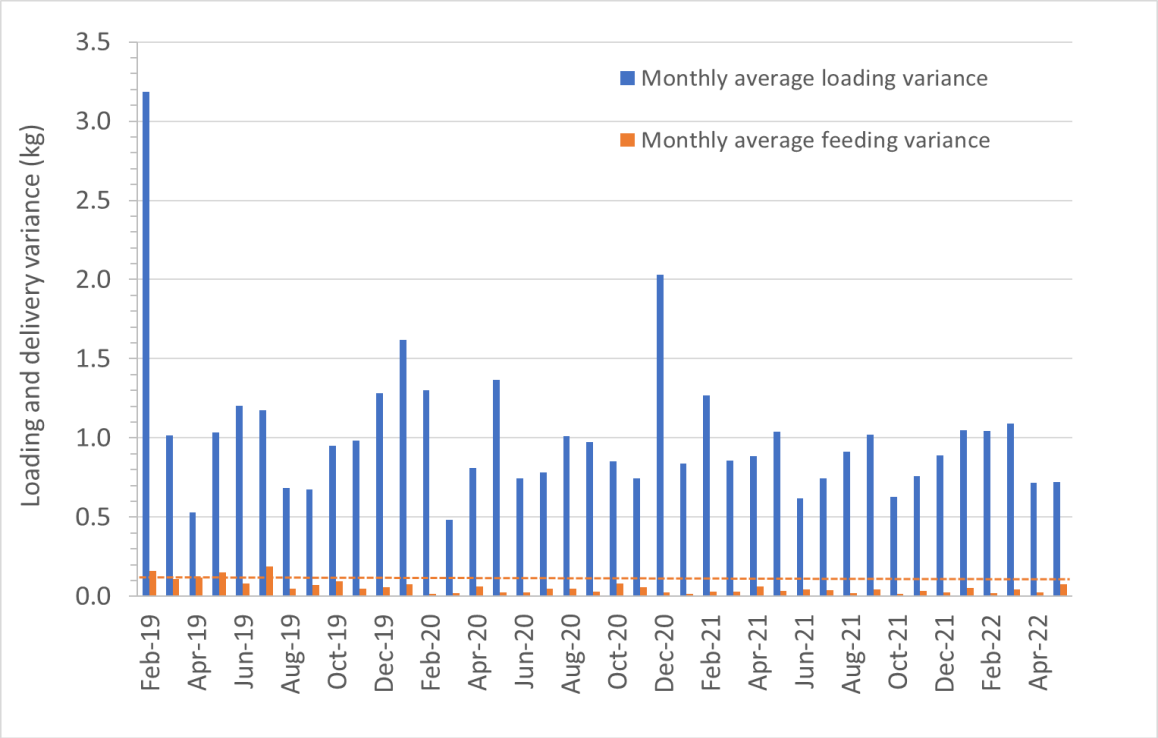

Figure 4: Monthly average loading and delivery variances. Note the target loading variance < 5 kg/pen and the target delivery variance <0.1 kg/head.

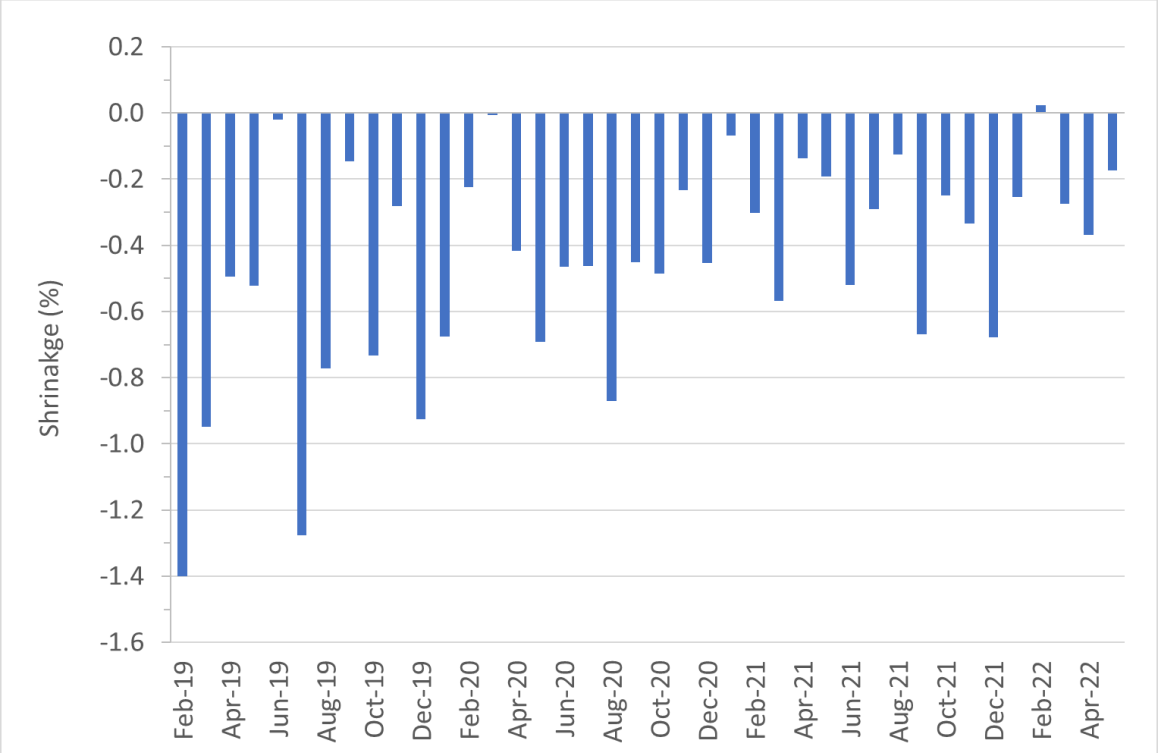

Figure 5: Monthly average feeding shrink (%) across all commodities and rations formulated. Note the target shrinkage 0 to -0.5%.

4.3 Standard Operating Procedures

As part of the upgrade of infrastructure and equipment, all Standard Operating Procedures (SOP) for the feed tempering system and the feedlot were reviewed and updated where required, and identified gaps in SOPs were addressed and resolved. The list of relevant SOPS is provided in Table 2.

Table 2: List of relevant Standard Operating Procedures matched to National Feedlot accreditation Scheme (NFAS) reference, with dates of last update and the next review.

Standard Operating Procedure	NFAS reference	Date last updated	Date due for review
Antimicrobial Stewardship Plan	LM5	9/02/2022	Jun-22
Biosecurity	LM6	24/02/2022	Jun-22
Biosecurity Management Plan	LM6	24/02/2022	Jun-22
Bunk call	PI2, LM2, LM4	8/02/2021	Jun-22
Cattle dispatch		18/01/2022	Jun-22
Cattle handling		18/01/2022	Jun-22
Cattle Induction	FS2, LM2, LM4, LM7	9/02/2022	Jun-22
Cattle receival	LM1, LM3, LM4	21/03/2018	Jun-22
Chemical inventory and disposal	QM5	5/02/2018	Jun-22
Cleaning and Calibration of cattle weighbox	QM10	18/01/2022	Jun-22
Cleaning and calibration of truck weighbridge	QM10	18/01/2022	Jun-22
Cleaning and Calibration of weighing equipment	QM10	24/02/2020	Jun-22
Cleaning Mixer and Mixer Flushout	QM10	25/11/2021	Jun-22
Commodity Stocktake	QM3, PI2	11/11/2018	Jun-22
Critical Incident Response Plan	QM9	18/01/2022	Jun-22
Daily Handling and Observations	FS2, LM2, LM4, LM7	28/01/2022	Jun-22
Diet Formulation		15/03/2018	Jun-22
Dry Rolling		12/09/2018	Jun-22
Emergency Animal Disease (EAD) Action Plan	LM8	22/10/2021	Jun-22
Emergency situation contingency plan	QM8	23/08/2019	Jun-22
Excessive heat load	LM6	9/02/2022	Jun-22
Excessive Heat Load Action Plan	LM6	9/02/2022	Jun-22
Faecal Starch	PI2	29/11/2018	Jun-22
Feed Mixer Scale Check	QM10	25/11/2021	Jun-22
HGP Implantation Instructions	FS5, LM1, LM2	30/11/2018	Jun-22
Humane destruction	LM4	18/01/2022	Jun-22
Internal auditing and corrective actions	QM2	24/08/2019	Jun-22
Job Descriptions	QM1; pi1	2/02/2018	Jun-22
Livestock Incident Reporting	LM8	9/02/2022	Jun-22
Misfed Pens	PI2	8/02/2021	Jun-22
Mixer Efficacy Check	QM10	25/11/2021	Jun-22

Necropsy Protocol and Reporting Template	LM4	30/11/2018	Jun-22
Notification of Non-Conforming Product/Product Recall	QM7	18/01/2022	Jun-22
Pen Cleaning	LM2, LM4	28/01/2022	Jun-22
Pen Surface Management	LM2, LM4	29/10/2021	Jun-22
Pregnancy and Calving Management	LM4	9/03/2018	Jun-22
Ration Manufacture and Delivery	PI2	10/02/2021	Jun-22
Ration Transition Regime	LM4	8/03/2021	Jun-22
Rolling of Tempered Grain	PI2	28/01/2022	Jun-22
Treatment Schedule	LM5	1/08/2021	Jul-22

4.4 Additional upgrades to infrastructure and equipment

In addition to the major upgrades that were funded through this project, UNE with its research and industry partners have also completed other upgrades to infrastructure and equipment for a total value of $1.95m.

- 16 GrowSafe feed intake units taking total capacity to 64 units; software and hardware upgrade of 48 older units
- 22 Vytelle In-Pen weighing units
- S400 NDE Vertical Feedmixer with Topcon Digi-Star 4610 Display with RD2500V Remote Display
- ICT WH-536 Weather (Hub) station
- Connectivity across all of Tullimba for data capture with backhaul via NBN satellite
- Shade across 12 pens with infrastructure for all of A pad
- New memory boards and connectivity for cosign single feeders
- 16 GreenFeed Emission Monitoring units

4.5 Research activity

Over the period 2018-2022, a total of 37 research projects, supported by 23 funding providers, investigated issues of productivity, carcase, supplements, welfare, genetics, emissions, and feed intake. These value of these projects that utilise Tullimba feedlot was $10.15m. A further $20m of funding has been committed for projects to start in the second half of 2022.

5. Conclusion

This project provides an excellent example of the benefits to arise from close collaboration between industry experts and a research provider: in this instance UNE. The authors particularly acknowledge the guidance and major contributions provided by Mr Des Rinehart and Dr Joe McMeniman, from MLA.

The nominated upgrades to infrastructure and equipment emerged from co-design discussions between MLA and UNE. These changes have resulted in Tullimba feedlot meeting commercial expectations for quality-assured grain processing and delivery to cattle on-feed while offering controlled conditions for the conduct of well-designed and replicated research investigations on

the productivity, management, profitability, animal welfare and environmental footprint for Australian feedlots. The upgrades in concert with improved SOPs are the basis for feed and ration processing performance meeting or exceeding industry benchmarks. They also underpin the confidence from UNE and its research and industry partners to have completed further upgrades to infrastructure and equipment and the active research demand for Tullimba feedlot facilities.

5.1 Key findings

Upgrading of equipment and infrastructure in concert with review and improvement to SOPs has improved Tullimba feedlot's ability to meet the needs of the Australian feedlot sector. There was a period of several months after installation of the tempering feed system and the feed delivery wagon where regular adjustments, supported by product suppliers, was required in order to meet feed processing and delivery expectations.

5.2 Benefits to industry

The upgrading of infrastructure and equipment at UNE's Tullimba feedlot has met the objectives of this project. Additional improvements have further equipped Tullimba to meet the R&D needs of industry. Evidence of usage was provided through the 37 R&D projects, with a combined value of $10.15m, supported by 23 funders that have occurred over the period 2018-2022 with a further $20m of funding committed for projects to start in the second half of 2022.

6. Future research and recommendations

Following the successful completion of this project, Tullimba feedlot provides the Australian feedlot sector with the confidence of a feedlot facility that meets commercial expectations for quality-assured grain processing and delivery to cattle on-feed while offering controlled conditions for the conduct of well-designed and replicated research investigations on the productivity, management, profitability, animal welfare and environmental footprint for Australian feedlots.

Tullimba is a unique research asset enabling modern research in greenhouse gas suppression, cattle management, nutrition and genetics for the beef industry. Moving forward, UNE is keen to partner with MLA, commercial companies and the industry to advance the sustainability and profitability of beef production. As part of this proposed next step, the role and make-up of an Industry Advisory Group should be discussed to ensure developments meet the current and future needs of the feedlot sector.

7. References

None required.

8. Appendix

8.1 Specifications of the Tempering Feed System

See attached document.

8.2 Specifications of the Rotomix feed delivery wagon

See attached document.

8.3 Specifications of front end loader

See attached document.