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MEASUREMENT OF FEED INTAKE IN SHEEP USING "OFF THE SHELF" TECHNOLOGIES

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SUMMARY

Feed intake and weight in sheep were measured using technologies designed for the pig industry to determine the suitability and applicability of said technology for sheep. Animal behaviour patterns in relation to proportion of animals accessing the feeder and frequency of visits per day as well as feed intake and weight parameters such as mean, variation, and repeatability are presented. Lessons learned regarding participation rates of animals (over time) and modifications to the system to enhance participation are discussed. Finally estimates of the numbers of days on feed required for valid results on measuring feed intake are presented. The system, with modifications, was found to be a suitable technology for measuring feed intake in ewes and lambs and has the potential to be deployed as a mobile unit to capture feed intake on industry animals.

INTRODUCTION

Feed is a significant cost of production for Australian sheep enterprises (Anderton and Weeks 2023) and is central to productivity and profitability. However, variation in feed intake and in the efficiency at which feed eaten is converted to product (meat, wool etc.) or allocated to bodily functions exists between animals. This efficiency can be expressed in terms of residual feed intake or as feed conversion ratio (Muir *et al*. 2020; Amarilho-Silveira *et al.* 2022; Johnson *et al*. 2022). The current study was undertaken as part of a larger project that aims to phenotype thousands of Australian sheep in order to develop genomically estimated breeding values for methane output and feed intake and correlations between other economically important traits (Fitzgerald *et al.* 2023).

The ability to accurately measure feed intake for sheep is generally hampered by the need to build "custom designed systems" which are generally large fixed structures that involve significant capital investment and require a 42-day trial period (Muir *et al*. 2020; Amarilho-Silveira *et al.* 2022; Johnson *et al*. 2022).

There is an opportunity to have smaller mobile systems that could be rapidly deployed to industry in order to measure smaller cohorts on farm, potentially over shorter periods. The Pig Progeny Tester (PPT) manufactured by FREEDA Solutions was identified as an "off-the-shelf" product that is capable of capturing feed intake and animal liveweights and is widely used in the pig industry. The system (Figure 1) consists of 1) a feed weighing module; 2) an animal weighing platform; 3) a feed hopper that delivers feed via a cup drop mechanism; 4) an electronic control box; 5) an animal weight indicator; 6) a feed weight indicator; and 7) adjustable sidewalls. In simple terms, each time an animal visits the PPT, it is identified via an RFID tag and the system measures the amount of feed eaten and the weight of the animal. A number of PPTs were purchased and trialled to assess their suitability for measuring feed intake for sheep.

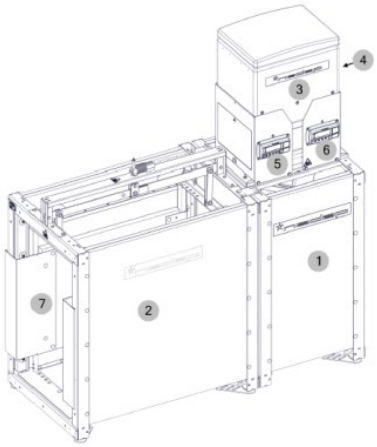

Figure 1. Schematic overview of a PPT

MATERIALS AND METHODS

Data on feed intake using Pig Progeny Testers (PPT, FREEDA Solutions) was collected on three batches of animals in separate trials between June 2024 and January 2025 at Kirby SMART Farm, Armidale, NSW. One group comprised 60 mixed breed lambs and two groups (of size 40 and 80) were Merino ewes. Animals had access to 3 (trial 1 and 2), or 6 (trial 3) PPT units from which they were fed *ad-lib* lucerne pellets (88% dry matter). Trial 1 ran for 6 weeks, while trials 2 and 3 ran for 7-8 weeks. All work was undertaken with the approval of the University of New England Animal Ethics Committee (Approval number ARA 21-086).

At least the first 14 days of each trial were allocated to training to allow animals to adapt and acclimatize to the feed and become familiar with accessing the PPTs. During this period, animals were provided pellets in open troughs in the pens with the same pellets available in the PPTs. Pellets were also placed on the weigh platform to attract animals into the units. The amount of feed and the frequency at which pellets were placed in the pen troughs was gradually reduced over time to encourage animals to access the PPTs. A portion of the Trial 3 animals had an additional training period of 7 days for animals that had not routinely accessed the feeders to maximise participation rates. After the training period, animals sourced all feed directly from the PPTs. Data for every visit that had > 1g feed intake were analysed including liveweights where feed intake events were > 60 seconds. Animals were also weighed in a separate crate pre, post and during the feeding periods to check the accuracy of the system.

Prior to the start of Trial 3, some modifications were made to enhance usage. A grated "foot mat" was placed in front of the entrance to the unit for animals to walk on prior to entry to reduce the amount of mud and faecal matter being walked onto the units during wet periods, which was perceived as reducing the accuracy of liveweight measurements. Non-transparent factory fitted sides were removed from 4 units and replaced with clear polycarbonate sides. These 4 units were placed in pairs side by side. Results presented summarise data from all 3 trials, with focus on the Trial 3 cohort of 80 Merino ewes.

RESULTS AND DISCUSSION

Duration and frequency of visits. Table 1 gives an overview of the number of visits, the duration and the amount of feed eaten per visit. Results are from the raw data, without removing outliers. In general, lambs visited the PPTs more frequently but had many visits of short duration (<30 seconds).

A greater proportion of the lambs accessed the feeder, certainly after accounting for the number of animals per feeder. In general, lambs were more curious and accessed the feeder more frequently relative to ewes. The proportion of animals visiting and the duration of the visits was highest in the third cohort of 80 ewes, and more feed was eaten per visit. This might have been due to the larger number of feeders available in total, and the improved training.

Feed intake parameters during different parts of the test period. Different parts of the feed intake period were evaluated. The first 14 days are considered as the training period, with the number of animals accessing the feeders and visits per animal increasing during this period due to feed being gradually withdrawn from open troughs and only available in the PPTs by Day 14 (Figure 2).

The remaining 5 weeks (days 15-49) were considered as the test period. From the data of the 80-ewe cohort (trial 3) we extracted three feed intake phenotypes from the test period, defined as FI_3wk, FI_4wk, FI_5wk representing the daily feed intake averaged over days 15-35; 15-42; and 15-49, respectively. The average daily feed intake as well as the standard deviation and the average animal weight are summarised in Table 2. A valid measurement was defined as a day where an animal made more than 10 visits as 85% of the time, animals visited at least 10 times per day. The repeatability was defined as the variation between animals over the total variation in a linear model just fitting animal as a random effect.

Table 1. Raw data statistics of the three cohorts of animals measured

Cohort	Lambs	40 Ewes	80 Ewes
Number of visits with feed intake >0g.	131,170	39,531	67,649
Number of animals at start	60	40	80
Number of feeders	3	3	6
Number of animals accessing feeders > once	46	28	70
Number of animals accessing feeders during "test period"	46	24	63
Percentage animals accessing feeders during "test period"	77%	60%	79%
Median number of visits per animal per day	77	26	18
Median duration of visit (sec)	18	40	94
Percentage of visit duration < 30sec	65%	41%	20%
Percentage of visit duration > 5min	1%	6%	8%
Average feed intake(g)/visit	17	47	72
Median of Feed intake (g) per animal per day	1,596	1,860	1,737
Median number of Weight records per animal/day	13	7	12
Median of Weight (kg) per animal per day	37.3	54.0	67.3

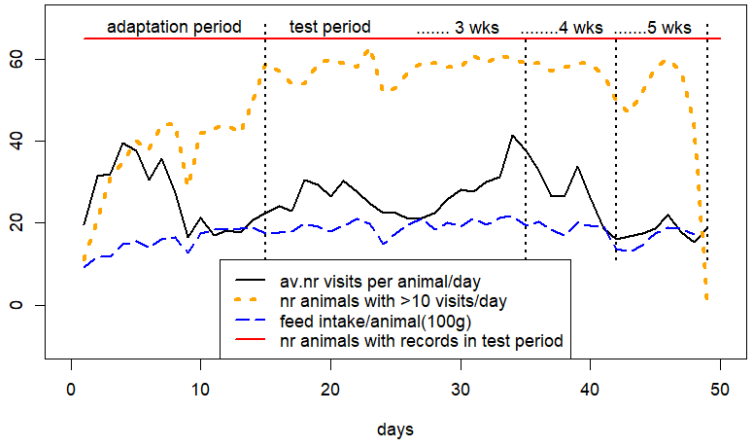

Figure 2. Participation rate, number of visits per day and average feed intake per day over the whole test period for the 80-ewe cohort

Table 2. Mean and standard deviation (Mean ± SD), variance between (Var_Anim) and within animals (Var_Res), repeatability and correlation with final test (r-FI_5wk) for feed intake and weight measurements, and correlation between PPT weight and scale-weight (r scale-PPT).

	Feed Intake (g)			Weight (kg)		
Phenotype	**FI 3wk**	**FI 4wk**	**FI 5wk**	**WT 3wk**	**WT 4wk**	**WT5wk**
Mean ± SD	1972 ± 550	1917± 553	1887 ± 548	68.7 ± 7.4	69.1 ± 7.3	69.7 ±7 .3
Var_Anim	143,133	125,708	118,814	60.77	60.68	59.13
Var_Res	169,448	179,729	181,831	11.31	11.46	11.33
Repeatability	0.47	0.41	0.40	0.84	0.84	0.84
r-FI_5wk	0.98	0.99	1.00	0.992	0.998	1
r scale-PPT				0.94	0.93	0.95

These preliminary results indicate that repeatability of FI is moderate and high for animal weight. The correlation between weight measured by the scale and the PPT units is >0.93 for weeks 3, 4 and

5 indicating that averaged values from the PPT animal weighing system is accurate and reliable. The correlation between mean animal performance for FI_3wk, FI_4wk, and FI_5wk is very high, indicating that it may be possible to shorten the feeding duration period in order to reduce cost and increase the number of animals measured over a year. This result is in agreement with Amarilho-Silveira *et al.* 2022 who found that an RFI model using 35-days FI data compared to 42 days-maintained accuracy. Further work can focus on data editing, for example by discarding deviating values on a within animal basis.

CONCLUSION

The Pig Progeny Testers (PPT) manufactured by FREEDA Solutions, with modifications, was found to be a suitable technology for measuring feed intake and body weight in ewes and lambs. A test period of 35 days may be sufficient for measuring feed intake in sheep. More time is required to further scrutinise the data and correct for additional fixed effects. The system appears to have potential to be deployed by commercial breeders to capture feed intake on industry animals as a mobile unit allowing more animals across industry to be measured compared to fixed facilities

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