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Nutrition Program completion activities

Milestone Report:

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Background

Animal identification with radio frequency identification devices (RFID) allows remote data collection which together with auto-drafting technology (developed by the Australian Sheep Industry CRC) allows differential management of individuals within an extensively grazed flock based on any information. Individual management of nutrition would allow targeted supplementation of individuals, control access to self-feeders and use supplements more efficiently.

Software for the nutritional management of individual animals (using walk-over-weighing (WOW) and auto-drafting systems) was developed and initially evaluated within Program 1 of the Australian Sheep Industry CRC, including the maternal weight calculator. The maternal weight calculator uses current liveweight and background information to estimate the maternal liveweight of individual pregnant ewes and compare them to targets relevant to current foetal age. Feedback from users of the maternal weight calculator has emphasised that the accuracy of the current liveweight measurement is pivotal.

The NSW DPI team at Orange conducted an experiment to determine the variability for pregnant ewes of liveweights collected with WOW *vs*. manual weighing of pregnant ewes, and the impact of that variability on maternal weight estimates. Included in this study is the use of software to screen (reduce the variability of) liveweights and the effect on estimates of maternal weight. The outcome of this work will be more robust estimates of maternal weight.

Introduction

The remote collection of liveweights using walk-over-weighing (WOW) can be achieved in extensive grazing systems as the animals move to water with minimal labour costs and stress to the animals. However, a single WOW measurement of liveweight may be inaccurate, but using a series of repeated measurements over a period of time can achieve a more accurate estimate of an individual's liveweight (Richards and Atkins *personal communication*). The accuracy of these estimates might be further improved by screening data using appropriate statistical techniques.

Weigh Matrix is software developed within Program 2 of the Australian Sheep Industry CRC to process liveweight data files collected using WOW systems. It uses previous liveweight information of individuals and group weight changes to identify weights that are incompatible with the current and earlier information. *Weigh Matrix* has proven to be successful in screening 'walk-over-weights' with dry sheep, but has yet to be evaluated with pregnant ewes.

This study compared the variances of the liveweights recorded once weekly from a conventional mustered method, WOW collected over weekly periods using minimal screening and the WOW screened using the Weigh Matrix program based on either the screened weight from the WOW data or on the previous week's crate weight.

Methods

A flock of 71 Merino ewes (13 dry, 6 carrying twins and 52 singles) grazed a perennial pasture within which was an enclosed area with a water trough and a "Cowra lick feeder", used periodically to offer an oat grain supplement. Access to the enclosure was only possible through a short race containing a weighing platform. The ewes were mustered and weighed in a weigh crate at the start of the study and at weekly intervals, when on each occasion the flock was weighed 3 times. WOW weights were collected weekly over a 5 week period.

Screening WOW liveweights

The WOW data was screened in 3 different ways. The first (Crude) only removed data with no animal identification and/or weight, and then discarded weights outside a range 50% either side of the weekly mean. The other 2 screening processes used the Weigh Matrix software using either the WOW mean from the previous week (WOW-base) or first crate weight taken in the previous week (crate-base) as a base.

Maternal weights

From each estimate of a ewe's liveweight, an estimate of maternal weight was calculated with the Maternal Weight Calculator, using base information for each ewe, pregnancy scanning data and current liveweight and relationships described by Freer *et al.* (1997) for mature ewes.

Statistical analyses

Estimating variance components: The within- and between-ewe variance components of liveweight from each of the 4 datasets (crate weights, and WOW weights screened using the 3 procedures described) were estimated by fitting pregnancy status, week and their interaction as fixed effects together with ewe and the ewe x week interaction as random effects using ASReml (Gilmour *et al.* 2002).

Comparing methods: The effects of collection/screening method (single crate-weight, triplicate crate-weights, and WOW weights screened using each of the procedures described), week, pregnancy status (single-, twin-bearing or dry) and subsequent date of parturition (reflecting foetal age) on both liveweight and the estimated maternal weight were analysed using ASReml (Gilmour *et al.* 2002). The model used fitted method, pregnancy status and week as fixed variates, together with the covariate subsequent date of parturition (linear) and the first order interaction of the fixed terms, with ewe and the covariate subsequent date of parturition (spline) and its interactions with the fixed variates fitted as random effects. Non-significant terms were sequentially deleted from the model.

Relationship between methods: The correlations and regression coefficients between weights estimated by each of the method/ screening methods were estimated from bivariate analyses using ASReml (Gilmour *et al.* 2002), fitting pregnancy status, week and their interaction as fixed effects and animal as a random effect.

Results and Discussion

a) Variance Components of Liveweights of Pregnant Ewes Measured By Manual or Remote Methods, With and Without Processing By Data Screening

The weekly mean number of weight records available in each of the datasets ranged from 212 for the crate weights to 1883 for data screened through Weigh Matrix screened using screened WOW data (Table 1).

Table 1 Within- and between-ewe variance components of liveweight of pregnant ewes collected once weekly or over weekly periods using remote walk-over-weighing and screened using 3 different processes

		Walk-over-weighing		
	Crate	**Crude**	**WM crate-base†**	**WM WOW-base‡**
Between-ewe	43.08	28.92	43.44	43.87
Within- ewe	0.47	52.94	5.06	4.46
Repeatability	0.989	0.353	0.896	0.908
n/week	212.2	1436.4	1615.2	1883.0

Screened by Weigh Matrix using base information from †weigh crate data or ‡ earlier screened WOW data

Liveweight was most precisely measured by crate weighing, and least precisely in the Crude WOW data. Screening liveweights obtained using WOW with Weigh Matrix markedly reduced (95%) within-ewe variances regardless of the source of the base information. The between-ewe variance estimates obtained from the weigh crate and either of the Weigh Matrix screened WOW datasets were in close agreement.

The repeatability of liveweight estimates using the crudely screened WOW data was low, a consequence of a high within-ewe variance and a low between-ewe variance. Together these factors reduce the ability to distinguish differences between individuals, both in terms of mean liveweight and changes over time.

The relative precision (a) of pooled records (Turner and Young 1969) achieved by increasing the number of samples (m, per individual animal) can be expressed as:

$$a = m.t /(1 + (m - 1) . t)$$

where t is the repeatability of the measurement. Figure 1 shows the changes in the relative precision of liveweight estimates with increasing sample size for the repeatability calculated for each of the method/ screening methods. It can be seen from Figure 1 that for WOW liveweights screened using Weigh Matrix (repeatability of *circa.* 0.9), the improvement in the relative precision of the liveweight estimate will be small after 3-5 retained weights, while only one crate weight is sufficient. However, to achieve a similar precision in the crude WOW liveweight estimate as Weigh Matrix screened WOW liveweights would require 20-40 retained estimates, although the marginal improvement is small for each additional measurement above *circa.* 15.

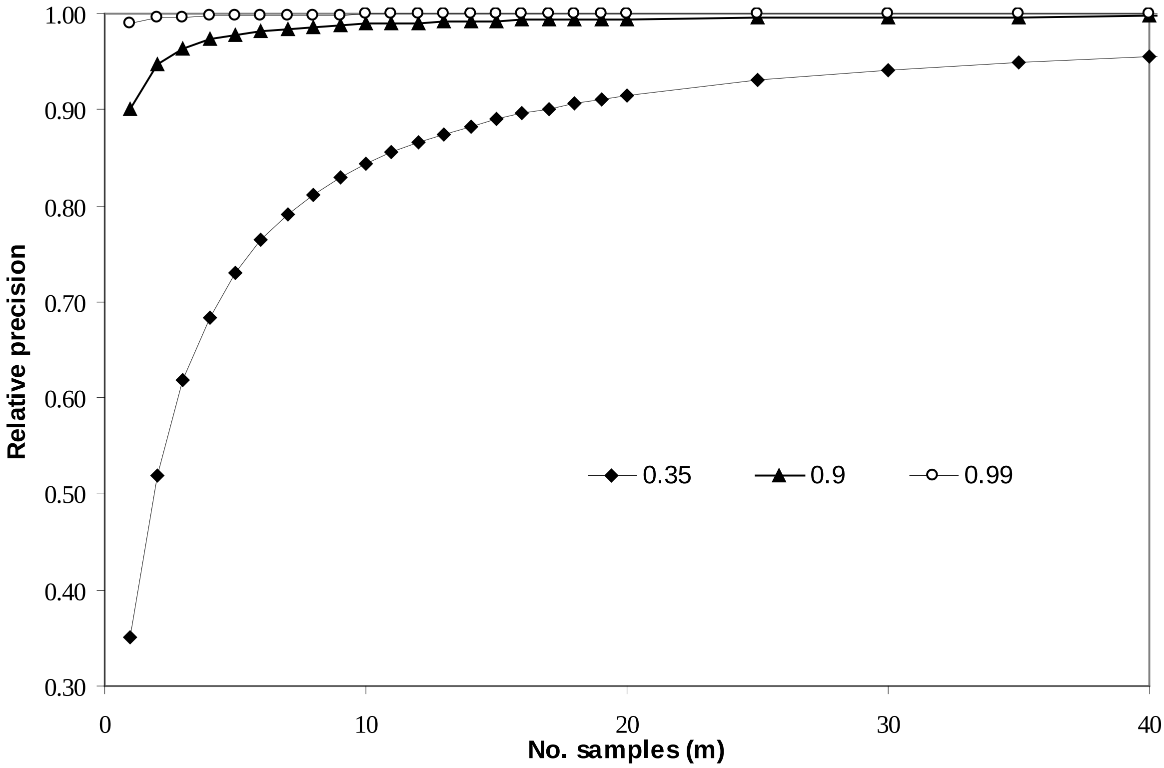

Figure 1 Relationship of the relative precision of liveweight estimates and the sampling frequency when the repeatability of the measurement is 0.35, 0.9 or 0.99.

b) Liveweights of Pregnant Ewes Measured By Manual or Remote Methods, With and Without Processing By Data Screening: Comparing collection methods and data screening

Comparing methods

Maternal and total liveweights estimated by each of the methods are shown in Figure 2 and Figure 3 for dry, single- and twin bearing ewes. Over time, both total and maternal weight increased for each of the pregnancy status groups. Any effects on either liveweight or maternal weight of the date of parturition were not significant.

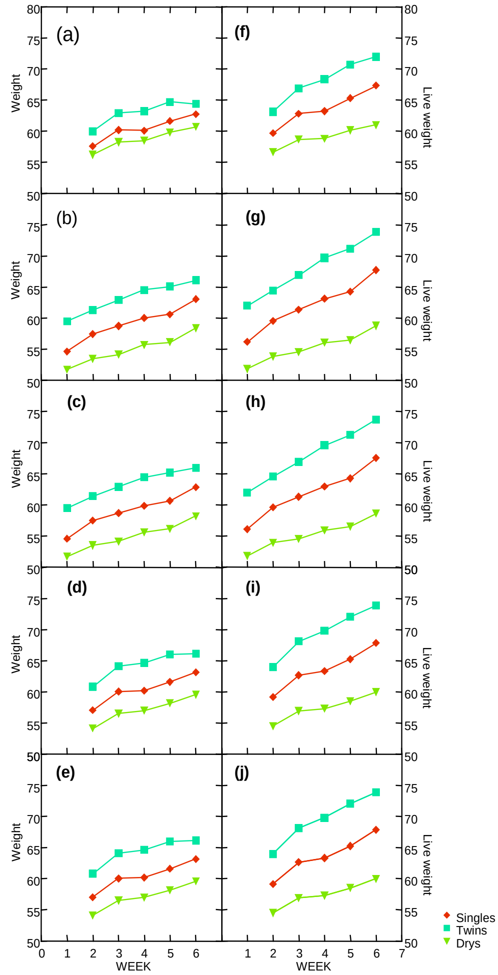

Figure 2 Maternal (a,b,c,d,e) and total liveweight (f,g,h,i,j) of dry single- and twin-bearing ewes measured/screened by WOW with crude screening (a,f), single crate weighing (b,g), triple crate weighing (c,h), WOW screened using Weigh Matrix with a crate weight base (d,i) and WOW screened using Weigh Matrix with a WOW weight base (e,j).

Ewe Liveweight:

The effects on ewe liveweight (Figure 2 and Figure 3) of pregnancy status, method and week, together with their first order interactions were all significant ($P<0.001$). The variation in the estimated liveweight between the methods was greater in the dry ewes than either single- or twin-bearing ewes (Figure 4). Weeks 3 and 5 tended to be associated with the largest variation (particularly for dry and single-bearing ewes) between the methods, although that was more to do with method of collection rather than screening technique.

The number of measurements retained after screening the WOW weights was relatively large (20-26 per ewe per week). Hence, despite the lower precision of the various WOW screenings, differences in the liveweight estimates were small, even when compared with the crate weights. However, using Weigh Matrix would accurately estimate liveweight from fewer measurements, allowing a shorter collection period.

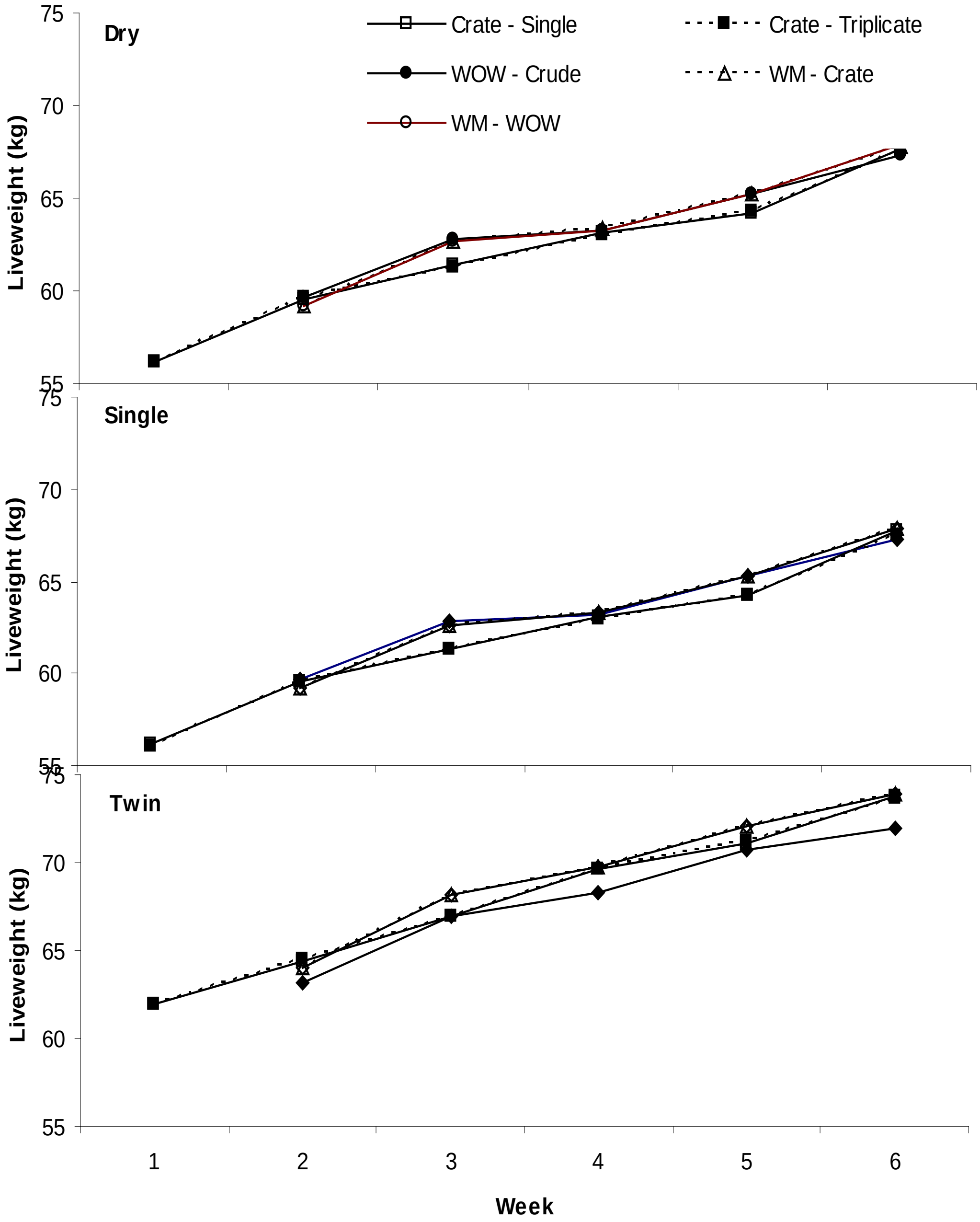

Figure 3 Weekly liveweights for dry, single- and twin-bearing ewes measured using different methods/screening techniques.

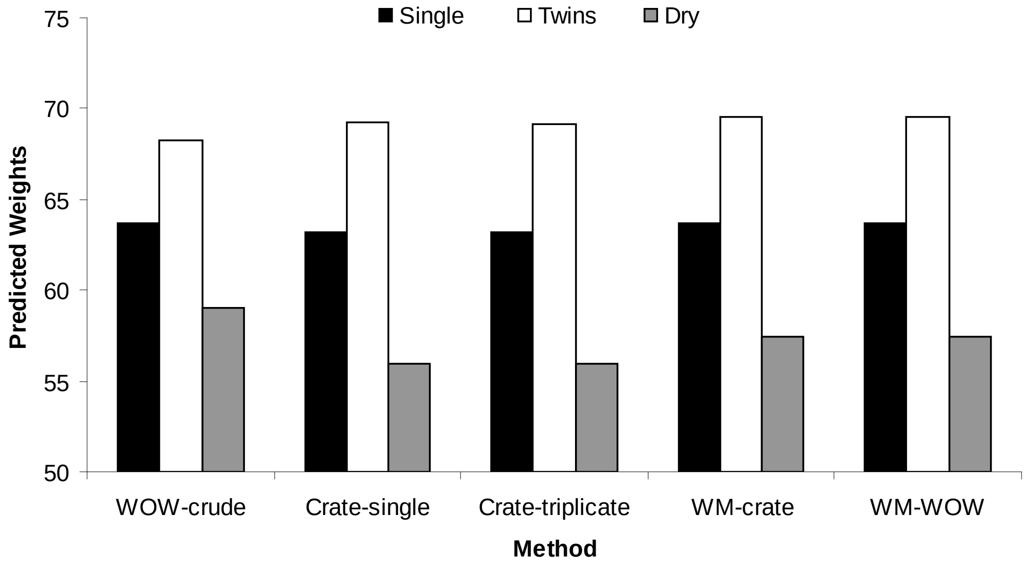

Figure 4 Effect of collection/screening method on variation in total liveweight estimates between lambing status groups

Ewe maternal weight:

The effects on maternal weight of pregnancy status approached significance (P=0.059), while method and week, together with all first order interactions between the 3 main effects were all significant (P<0.001).

The estimated maternal weights of twin-bearing ewes were higher than that of single-bearing ewes although that difference did decline by week 6 (Figure 2). The single-bearing ewes in turn were higher than dry ewes. Part of that difference may be attributed to differences in liveweights at joining of the pregnancy status groups (47.9 ± 4.8, 49.4 ± 5.8 and 54.6 ± 6.0 kg for dry, single- and twin-bearing ewes, respectively), although there is an expectation would be that the maternal weight of pregnant ewes (particularly twin-bearing) would decline as pregnancy continued compared with that of dry ewes. However, a further factor contributing to the maternal weight differences between pregnancy status groups is an underestimation of the conceptus/birth weights of the lambs by the procedures used. For instance, in week 6 the birth weight of single lambs was estimated from the single crate liveweight to be 4.6 (± 0.5) kg, but the birth weights of lambs born to sisters of these ewes (joined at the same time to the same rams) was 6.3 (± 1.0) kg. A number of factors would have contributed to that difference, including:

1. the assumption that ewes lambing at 2-years-old were mature,
2. the relatively high EBV’s for birth weight of the White Suffolk rams, and
3. the relatively high quality and quantity of available feed following the good “break” in the season (for ewes coming out of drought) from joining through pregnancy.

Relationship between methods

Mean liveweight and maternal weight estimates derived by both manual and WOW methods together with each of the screening procedures were all highly correlated (> 0.98; Table 2 and Table 3), indicating that they are similarly capable of ranking individuals.

Table 2 Between-method correlations and regression coefficients for total liveweight estimates of pregnant ewes based on liveweights collected once weekly or over weekly periods using remote walk-over-weighing and screened using 3 different processes

			Crate		Weigh Matrix
Independent variable		**Crude**	**Single**	**Triplicate**	**-Crate**
Correlation					
Crate	Single	0.9861			
	Triplicate	0.9881	1.000		
Weigh Matrix-	Crate†	0.9882	0.9993	0.9995	
	WOW‡	0.9882	0.9993	0.9995	1.000§
Slope					
Crate	Single	0.793			
	Triplicate	0.803	1.008		
Weigh Matrix-	Crate†	0.799	1.001	0.994	
	WOW‡	0.799	1.002	1.006	1.000§

WOW liveweights screened by Weigh Matrix using base information from †weigh crate data or ‡ earlier screened WOW data

§Approximation

However, the low regression coefficients (*circa.* 0.8) indicate that WOW with the crude screening (based on flock information only) would underestimate changes in the liveweights of individuals. All the other method/screening procedures were similarly accurate (regression coefficients approximating unity) in estimating liveweight, and hence the maternal weight estimates.

Table 3 Between-method correlations and regression coefficients for maternal weight (fleece- and conceptus-free) estimates of pregnant ewes based on liveweights collected once weekly or over weekly periods using remote walk-over-weighing and screened using 3 different processes

			Crate		Weigh Matrix
Independent variable		**Crude**	**Single**	**Triplicate**	**-Crate**
Correlation					
Crate	Single	0.9847			
	Triplicate	0.9869	1.000		
Weigh Matrix-	Crate†	0.9868	0.9992	0.9995	
	WOW‡	0.9868	0.9992	0.9995	1.000§
Slope					
Crate	Single	0.788			
	Triplicate	0.797	1.008		
Weigh Matrix-	Crate†	0.792	1.001	0.994	
	WOW‡	0.794	1.002	0.995	1.000§

WOW liveweights screened by Weigh Matrix using base information from †weigh crate data or ‡ earlier screened WOW data

§Approximation

Conclusion

Weigh Matrix is a useful tool to improve the quality of liveweight data collected using WOW, in that it markedly improves measurement precision and hence the repeatability of liveweight estimates. Hence the time taken to collect sufficient weights using WOW to accurately estimate liveweight is reduced.

Provided sufficient usable measurements are available, all collection method/screening techniques allowed animals to be ranked efficiently, although crudely screening liveweights would not reliably estimate changes in liveweight.

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