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Sheep CRC Report 7_9

WALK - OVER –WEIGHING

INTERIM REPORT

FEB 2008

Contents

1. THE WOW CONCEPT

Walk Through Weighing

Walk through weighing (WTW) utilises the concept of remote individual animal management (RIAM) to monitor sheep without human intervention by electronically capturing and recording an individual sheep's tag and weight as it passes over weighing scales on its way to feed or water. It is ideal for pastoral settings where labour is scarce and the stress and cost of mustering sheep are important factors. It can also be used in feedlot or rotational grazing systems where it is important to regularly monitor a sheep's weight. WTW incorporates a set of trap yards and a race so the sheep's weight can be recorded as part of its natural movement to feed and/or water. Sheep require electronic (RFID) tags to collect individual animal weights but untagged animals can be monitored as a mob. Equipment required includes an electronic tag reader, electronic weigh scales and an indicator (data logger) to record the tags and weights. The system is powered from 12 volt solar panels and batteries. A drafting unit can be added. If using a Tru-Test indicator, remote access and data transfer from the indicator to a home computer using CDMA phone and modem technology is now available. Sheep require some training to use the system so they become used to the equipment and movement required to get to their feed/water point in the trap yard; this involves setting up the equipment and leaving the sheep to inspect it for a few days and then gradually closing gates as the sheep get used to it over a few days or so. The electronic equipment is becoming better integrated but there is a range of equipment to "fit together" so attending a workshop run by the Sheep CRC would be the best way of learning how to put together a WTW system. Users need to have some familiarity with how electronic tag readers and indicators operate; there is a fact sheet on the Sheep CRC website www.sheepcrc.org.au/e-sheep on how to set up a WTW system. Basic walk through weighing systems are commercially available now. Drafting systems that can be added onto a WTW system are currently being trialled. Currently the Sheep CRC is using equipment from two New Zealand companies: Tru-Test and Prattley Industries. You should contact these manufacturers and also talk to the Sheep CRC when you wish to purchase equipment for walk through weighing. Cost for WTW depends on the type of system you wish to set up and the features you require. There are a number of electronic components that need to be purchased so contact the manufacturers to get price ideas Manufacturers of weighers and other equipment are listed with contacts at the Sheep CRC web site: www.sheepcrc.org.au/manufacturers. If you intend to operate it in a remote location then you will also need to add in the cost of purchasing solar panels and batteries.

2. DEVELOPMENT TIMELINE

2003	Project commenced Proof of concept work with CSIRO (Chiswick)
2004	Field trials using proprietory hardware - Bourke and Trangie
2005	Various applications at Bourke and Brewarrina structural changes to improve animal flow drafting gates added Curved entry and exit Basic data cleaning (stage1)
2006	CAWD – curved platform – Remote drafting – sensors to locate animals – Full year monitoring – Bourke – Nutrition proof of concept – commence monitoring trial - Bookham -weighing accuracy trial (kda/jsr/ss) Excel weight analysis program (stage 2)
2007	trials weaner trial –Yass (Bogo and Armour) lamb feedlot – Tony Grant, Q lamb feedlot nutrition - Orange and Longreach Weigh Matrix software developed (stage 3)
2008	Weigh matrix integrated with lamb growth predictor (stage 4) Review/commercailization

3. THE WOW PRODUCT

3.1. Overview of product features and requirements:

- WTW incorporates a set of trap yards and a race so the sheep’s weight can be recorded as part of its natural movement to feed and/or water
- Sheep require electronic (RFID) tags to collect individual animal weights but untagged animals can be monitored as a mob
- Equipment required includes an electronic tag reader, electronic weigh scales and an indicator (data logger) to record the tags and weights
- Power is from 12 volt solar panels and batteries
- A drafting unit can be added
- If using a Trutest indicator, remote access and data transfer from the indicator to a home computer using CDMA phone and modem technology is now available

3.2. Product useability:

- WTW can be utilised in a variety of situations. It is ideal for pastoral settings where labour is scarce and the stress and cost of mustering sheep are important factors. It can also be used in feedlot or rotational grazing systems where it is important to regularly monitor a sheep’s weight
- Sheep require some training to use the system so they become used to the equipment and movement required to get to their feed/water point in the trap yard
- The electronic equipment is becoming better integrated but there is a range of equipment to “fit together” so attending a workshop run by the Sheep CRC would be the best way of learning how to put together a WTW system.
- Users need to have some familiarity with how electronic tag readers and indicators operate
- There is a fact sheet on the Sheep CRC website on how to set up a WTW system

3.3. Product availability:

- A basic walk through weighing system can be set up now
- Drafting systems to add to WTW are being trialled at present
- Currently the Sheep CRC is using equipment from Trutest (New Zealand) and Prattley (New Zealand). You should contact these manufacturers and also talk to the Sheep CRC when you wish to purchase equipment for walk through weighing

3.4. Product cost:

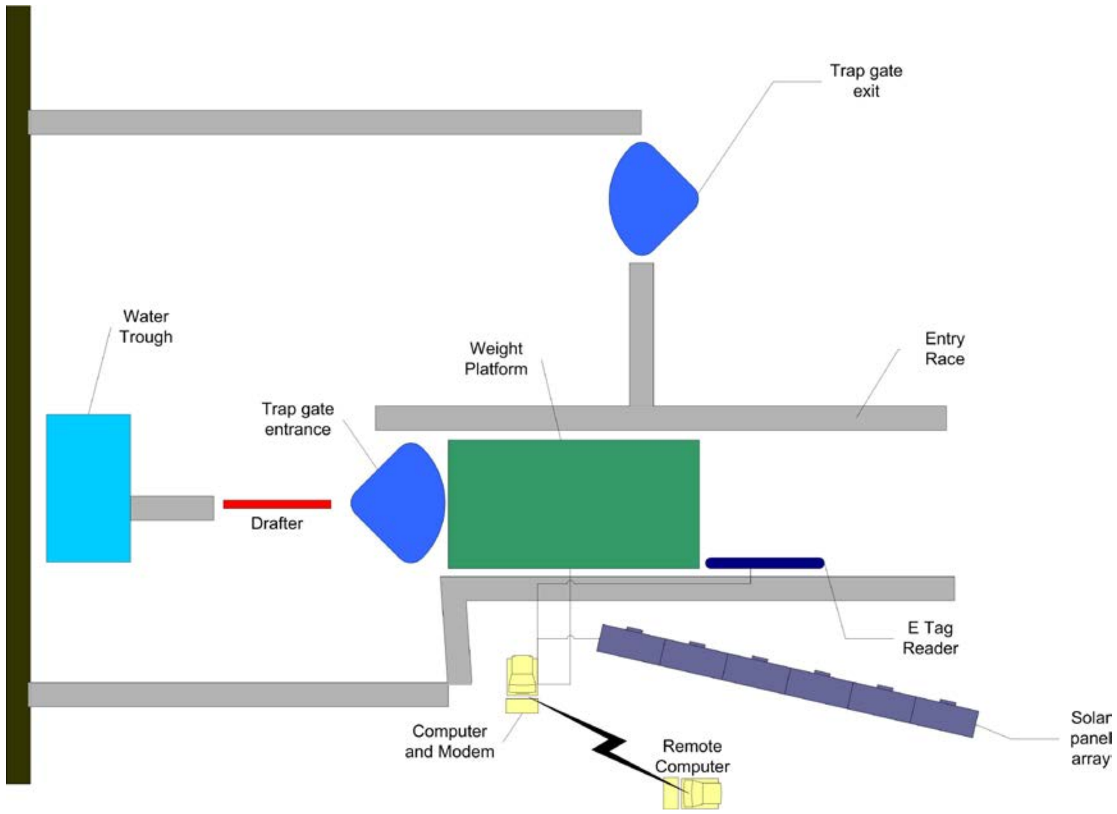
- Cost depends on the type of WTW system you wish to set up and the features you require
- There are a number of electronic components that need to be purchased so contact the manufacturer’s to get price ideas
- If you intend to operate it in a remote location then you will also need to add in the cost of purchasing solar panels and batteries and potentially telemetry

4. WOW: DESIGN AND OPERATION

The initial design of the system was such that using existing trap yard technology we could direct animals past a tag reader and over scales and so collect data on a regular basis.

The initial design is as shown in Figure 1.

Figure 1: Overall design.



The drafting module has only come on line in February 2006 but the initial design was very similar to this. The various components will be discussed as either "Hardware" or "Electronic" components.

4.1 Hardware Components

1. ***Entry race***: Initially the race was 1500mm long, 900mm high and V-shaped being 250mm wide at the base and 550mm wide at the top (recommended V race width). It was constructed from ply as timber would not interfere with the electronic tag reader. It is shown in Figure 2.

Figure2: V race: End view.

In October 2005, the design was changed to become more open as some animals was rushing through too quickly to be recorded and it was thought that the closed sides may be contributing to this. The new "high tech" design is shown in Figure 3.

Figure 3. New race design.

This design definitely improved data quality collected.

Another issue with the original race which was attached on top of the weighing platform was that it acted like a sail in windy conditions resulting in many false weights being recorded as a result of movement and taking up a considerable amount of memory.

The new design shows that this problem is overcome as the race is totally separate from the platform.

We have just constructed a new race from aluminium which is open and allows the platform to sit inside the race system which should do what is needed but be light and portable as well.

2. ***Weighing Platform***: The weighing platform is a 1500mm TruTest platform on TruTest MP600 load bars. A short platform has been used to minimise the effects of more than one animal being on the system at one time.

This is a trade off because the longer the platform, the more accurate the weight will be as the animal is on the scales for a longer period of time. As we develop better design to optimise sheep flow we may be able to use longer platforms.

It can be seen in Figure 3 that the platform is covered. This preferred as is doesn't baulk the sheep as much as mesh, it doesn't "ring" and doesn't fill with dust.

3. ***Spear gates***: As this technology has been used for some time in pastoral areas we used an existing spear gate design. The design is a Bettini gate. The system uses one as an entry and one as an exist and can be seen in Figures 2 and 3.

The reason the entry gate is after the race is that this prevents animals going back over the platform and filling the memory with may not be of much use.

As the gates are only guiding and not forcing animals we are going to incorporate Prattley anti backing gates instead of spear gates as soon as the arrive.

4. ***Tag reader***: The systems we have been using to date have used Edit ID readers supplied by TruTest. The new Allflex "portal" readers should also be ideal for this aaplication.

5. ***Power***: The system is powered by 12 volt deep cycle batteries which are kept charged by solar panels. It appears that without drafting 2 batteries and two panels are required. However we need to determine exact requirements when drafting is being undertaken. The Bourke system has 5 batteries and 5 solar panels.

6.***Drafting gates***: The drafting gates used in this system have been designed by Prattley in New Zealand and being used as of mid February 2006.

4.2. Electronic Components

1.***TruTest XR3000 Indicator***: This is the centre of the whole system. TruTest have worked very closely with us to develop software which allows this system to work. Central to this is the Walk Over Weighing software which allows the animal to be weighed as it walks over the platform without being restrained.

This unit collects and stores data as well as controlling the rest of the system.

2. ***Solar regulator***: This ensures that system is properly powered.

3**.** ***Modem***: This allows us to communicate with the system remotely so that we can upload/ download data and change system settings from our office. This aspect of the system has been operational since November 2005.

In the immediate future we will be using simple engineering changes to the yards such as hock bars, ramps, old tyres etc to try to regulate sheep flow so that the drafting aspect works as well as possible. We don’t know what will work and may have to investigate electronic solutions.

With all future developments we need to look at the simplest solutions first and only make the system as complicated as it needs to be.

5. PROGRESS WITH WEIGHT ACCURACY

PERIOD	% VALID WEIGHTS
Jan-Feb 2005	54
Nov-Dec 2005	71
Feb-Dec 2006	68
2007	83
2008 Further analysis	estimate 85
Feedlot data	estimate 70-75

6. Developments in Data Management

The table below outlines the stages of development that have occurred in the data management process (2005-2008)

Data Cleaning Option (stage 1)	This program was used to process the weight data files generated from using the walk over weighing system (WOW). The program was an initial attempt to filter out zero and out of range weights from the WOW file before the data was examined in MS Excel.
Excel Software (stage 2)	This software enables raw data to be converted to more useful information - software relies on receiving multiple records containing both an ID and a weight for each animal. Any records without a linked identification or any records with a nil weight are removed before any other calculations are made. A very broad removal of extreme weights is next, based on a range determined by the mean of the flock. From the remaining records a starting weight value for each animal is determined and a fixed range either side of this value is deemed an “accepted” value. An average of these “accepted” values is used as the weight for that animal during that time period. The starting weight can be an earlier weight using conventional weighing or a processed walk-over weight relying on both the current period of data and any previous data on the individual animals as well as the whole flock. The result is a list of estimated weights for each animal for

	each weighing period. Using the animal weights for each period the growth rate of the mob as well as groups within the mob can be estimated to determine how the animals are performing
WeighMatrix – Basic (Stage 3A)	This version of the program picked up the data from the WOW file to be processed and generated a matrix of RFID, individual weights, average weight and number of weights for all animals present in the WOW file, using a set cut off level as an “out of range” filter.
WeighMatrix – Using base weights (Stage 3B)	To enhance the program, a base weight (generated from a crate weighing operation) is loaded into memory and then the WOW file data is picked up by the computer. Using the base data minimum and maximum figures, the weight records are filtered to remove any zero or out of range weight values, then producing the required results.
WeighMatrix – incorporated with Lamb Growth Predictor (Stage 4)	The processed results files were then able to be fed directly into the Lamb Growth Predictor to give estimate of likely finish date or weight, based on the growth patterns recorded in weigh matrix result files.

7. EXCERPTS FROM TRIALS

BOURKE (2005)

A trial was conducted at Bourke, NSW, where about 200 animals were weighed over a time period of 2 months (with some gaps), separated into 4 arbitrary periods of 1-2 weeks each. After ignoring zero weights or those without any associated animal identity, there was an average of 39.8 weight records per animal over the 48 days of recording. After data analysis, 75% of all records (a range of 69 to 78% across time periods) were included in the liveweight estimation for each animal in each time period. The average weight of the mob in each time period was estimated with a standard error of less than ±0.5 kg with a mean of about 55 kg.

Information on individual animal performances was the most significant outcome. Average correlations among animal weights across time periods were all very high (0.89 to 0.93) but substantial differences between groups of animals within the mob were apparent. The average growth rate of the mob was a loss of 26 g/day (-1.7 kg over the whole experimental period). When the data were split into quartiles according to liveweight gain over the 2 months, the top quartile had an average gain of +33 g/day (+2.1 kg gain in liveweight over the whole period) whilst the bottom quartile were losing weight at a rate of 90 g/day (-5.1 kg loss in liveweight). Even though the growth was negative for this trial there was still an obvious difference between the top and bottom quartiles of animals within the flock. This is useful information to the producer to either identify the lowest ranked animals to sell before losing more money, or to identify those for differential management to the rest of the animals (e.g. health or nutritional management). It also allows identification of animals for different target markets depending on their weight and growth rates.

The use of walk-over weighing has the potential to allow producers to obtain simple weight measurements of their flock and improve their flock management without high labour costs normally associated with mustering and weighing. This will reduce the stress on animals as well as improving the options for management.

Bourke (2006)

A process of screening recorded weights was investigated using data from a pastoral grazing property in Bourke, NSW. The opportunities of using such data for management decisions are discussed.

Aims

Walk-through-weighing is a system for capturing weights of individual animals as they walk over a weighing platform to get to water or some other incentive. The Sheep CRC has developed a prototype walk-through-weighing system by modifying commercially available hardware. Such systems are being evaluated in a number of commercial trials. The aim of this paper is to discuss potential ways information from walk-through-weighing could be used to enhance management decisions.

method

Data from a walk-through-weighing system set up on a pastoral grazing property in Bourke, NSW, was retrieved and used for analysis. There were a total of 629 animals in the trial. The results were divided into four weighing periods ranging from early January to late February 2005. The data contained a radio frequency identification (RFID) tag number and a single weight for each weighing. There were on average 3200 recorded weights for each weighing period (after any nil weights were removed and any weights with no linked RFID tag number). Two mustered weights were taken to ensure the correct range in weight values were being achieved during the screening process.

The screening process involved removing weights of 0 kg and then an average weight was taken from weights within an acceptable range for each animal at each weighing period. This information was then examined to determine what benefits could be achieved with having these multiple weights of each animal for management decisions. Observations can be made about their growth rates over time.

results

The raw weights ranged from 0kg to 115.5 kg (SD=14) and after the average weight per animal calculation the weights ranged from 14 to 70 kg (SD=9). The earlier results were more variable, but improved in later weighing periods. A settling period is needed for the animals to adjust to the new environment so they move more freely through the system and more accurate weight measurements can be taken. Adjustments were made to the system and setup as problems occurred, which reduced the variation in the data. While the data editing process is still being refined, initial results from the whole mob over time are summarised in table 1.

Table 1: Average weights over time

	8/1/05-24/1/05	24/1/05-26/1/05	26/1/05-12/2/05	10/2/05*	12/2/05-17/2/05	19/4/05*
Average wt (kg)	38.6	41.2	39.7	45.3	45.3	42.3
SD of wt	9.5	8.1	9.9	8.8	8.8	6.9

*****Mustered weights

The average growth rate of the mob up to 10/2/05 was 168 g/day reflecting the feed available after a long period of destocking with some modest summer rainfall at Bourke. Between 10/2/05 and 19/4/05 the mob average declined by 49 g/day as the region slipped back to drought conditions. Over the whole period of observation the average growth rate was only 25 g/day. Simply separating the mob into two groups on growth rate showed that the top 50% grew at 85 g/day whilst the bottom 50% lost 36 g/day over the whole period.

discussion and implications

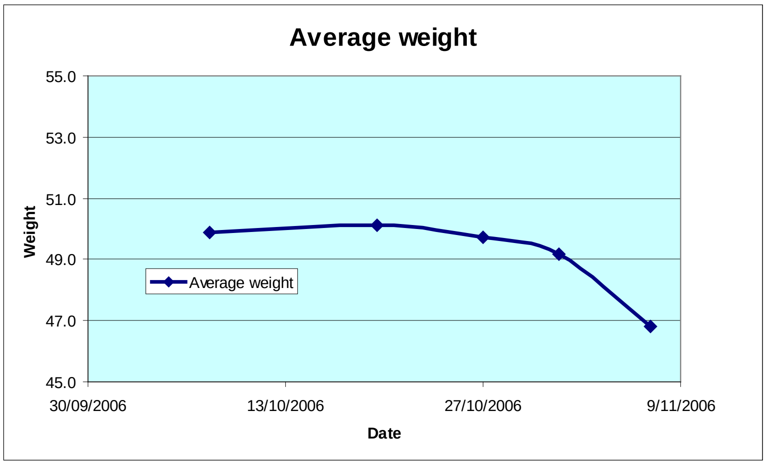
Within such an extensive grazing system in the Bourke area, effective animal performance data has not previously been possible. It is too difficult, costly and time consuming to muster the animals to obtain even irregular information on the animals. Even if this event is attempted it is unlikely to obtain all animals in one muster. Using this walk-through-weighing system all animals will eventually need to come for water and so a record of every animal will be obtained with little time and labour from staff and with little stress on the sheep to monitor their performance. The development of suitable software will be required to process the information and so aid in management decisions on farm.

Initially the data is useful to monitor the whole flock. The weights can be used to identify when the sheep require moving to another area of feed. Individual growth rates can be used to aid in the detection of ill health in a group of animals and can also be used to make predictions on their future growth and therefore weight. The predictions would be used to determine when animals will meet the market specifications (target weight) or can be used to predict what weight the animal is likely to be on a certain date. This is useful for producers in determining when to order a truck for slaughter and how many animals will be ready on this date. From the animals that do not meet market specs on the predicted date it is useful to see whether they will meet the target within the specified period or whether early sale might be required to reduce costs.
If sold early they may not achieve a high market value but it may still be an advantage to reduce the cost of maintaining them when pastures are limiting. Without individual records, these animals may go unnoticed as they never reach the target saleable weight. This animal performance information can be used in combination with pasture assessment. Growth rates of the animals can be used to determine, under the current nutritional conditions, how long this number of animals can be retained, or it can be used to determine how many may need culling to reduce the need for hand feeding when feed is limiting. In this case the animals needing to be culled can be identified to ensure the animals retained are the most suitable. If the same number of animals are to be retained their growth rates can be used to determine how long the current feed will last and how much feed will need to be brought in if they continue to grow at the current growth rate.

As the walk-through-weighing system continues to be improved a drafting capacity will be developed. This will achieve an even greater benefit as the animals can be selected on these growth rates and drafted off into a holding yard for trucking to slaughter or for treatment if the drafter detects a reduction in growth of the animals. It may also be useful to draft off the animals that are identified as losing condition to give them supplementary feed whilst the heavier animals do not get access to the additional feed, saving money by only feeding the animals that need it. Only treating animals that need to be treated (such as identified as losing weight) will also reduce costs.

Walk-over weighing at Yass

Phil Graham set up a simplified walk-over weighing system at his Bookham site in early October. It simply consisted of a weighing platform without gates with a TruTest indicator and Allflex split wire antenna powered by solar panels (see picture). 84 adult wethers were the monitored group and the system operated for 5 1-week periods.



Each week there was an average of more than 10 records collected on each animal. Most impressively, almost 90% of these records were informative weights giving very accurate weights on individuals at each time. The wethers showed a dramatic weight drop as pastures deteriorated rapidly (see figure) but before a change in visual condition was noticeable. Yet more entry levels for producers by using a small monitor mob or even weights on animals without tags to monitor weight change. The unit will now be used to monitor weaners over summer.

Nutrition experiment 2007 - Variance Components of Liveweights of Pregnant Ewes Measured By Manual or Remote Methods, With and Without Processing By Data Screening

The remote collection of liveweights using walk-over-weighing (WOW) has been possible with the use of radio frequency identification devices (RFID) for animal identification. This 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 the Australian Sheep Industry CRC to process liveweight data files collected using WOW systems. It uses previous liveweight information of individuals (base information) and group weight changes to identify weights that are incompatible with the current and earlier information.

This study compared the variances of the liveweights recorded once weekly from a conventional mustered method (crate), 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 crate weight.

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.

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 base information obtained from either the previous week's WOW mean (WOW-base) or first crate weight (crate-base).

The within- and between-ewe variance components of liveweight from each of the 4 datasets 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).

Table 1. Within- and between-ewe variance components of liveweight (kg) of pregnant ewes collected once weekly (crate) or in weekly periods with remote walk-over-weighing and screened by 3 different processes

	Crate	Walk-over-weighing		
		Crude	WM crate-base†	WM WOW-base‡
Between-ewe	43.09	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.

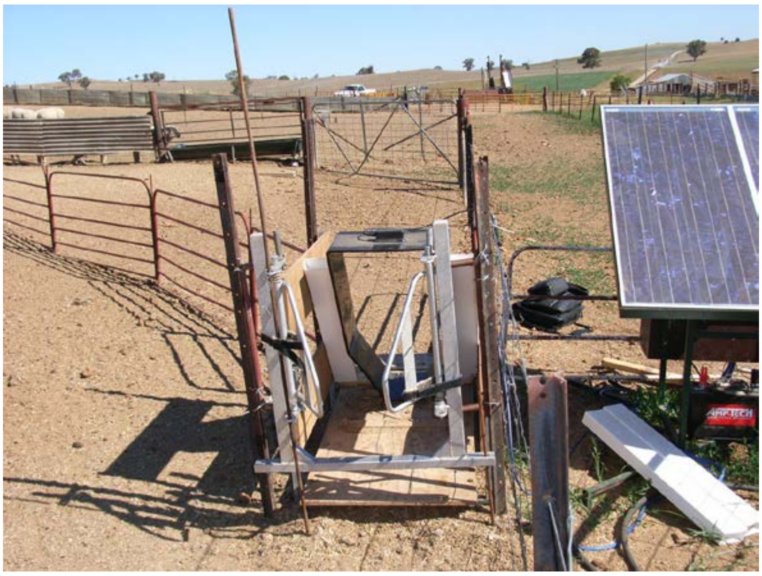
Weigh Matrix is a useful tool to improve the quality of liveweight data collected using WOW, in that it markedly improves measurement precision and hence the repeatability of liveweight estimates.

Feedlot 2007

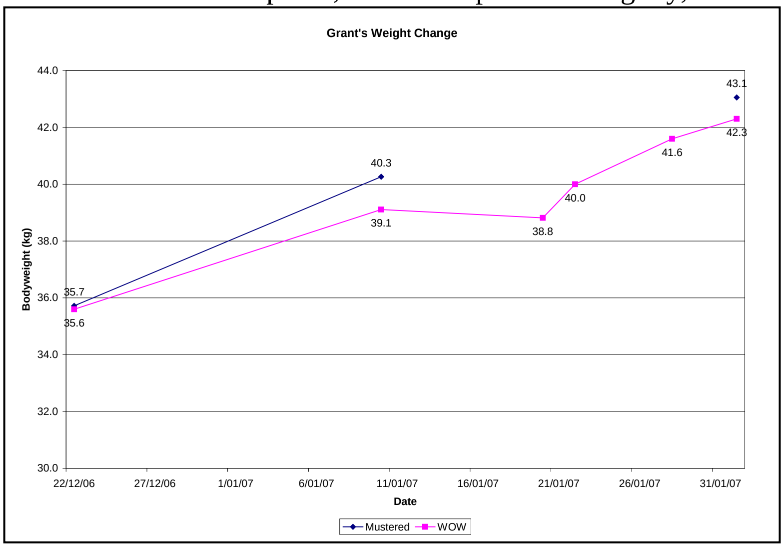
Title: Electronic Management of Lambs in a Feedlot; Demonstration

Aim: To identify and solve any practical issues with electronic management.

Brief Description: Trial 1. About 75 xbd lambs in this feedlot were electronically tagged and their initial live weight was recorded over a Racewell auto drafting platform. The animals were forced to walk through a trap gate to get to water and they were then weighed a number of times as they walked over a "Walk Over Weighing" (WOW) scale platform to exit the water yard. A one-way gate allowed them to return to the feeding supplement, the picture below shows the weigh platform in place with the water point in the background. Animals proceeded into water via a one way gate and then exited over the weigh platform.



There were numerous "teething" problems when the platform was first put in. The RFID read range was very poor, apparently from some sort of interference inhibiting the effectiveness of the reader. Originally a set of Allflex rubberised flap readers were used, with the animals tagged with FDX-B tags. More than 50% of the tags were not being read, so the reader was changed for an Allflex portal reader. This partially solved the read problems, but as can be seen from the above photo, if the setup moved slightly, the reader was able to rest on the platform and so distort the weights. The chart left shows the final weights that were achieved both through the weigh platform and the Racewell system. Even though there were many weights discarded, the equipment did a reasonable job of tracking the weight change of the animals.



Brief Description: Trial 2. 207 xbd lambs in this feedlot were electronically tagged (this time with HDX RFID tags) and their initial live weight was recorded over a Racewell auto drafting platform.
The direction of flow was reversed this time, with the animals walking over the platform to get to water and exiting the water yard via a trap gate. The WOW platform was re-designed to force the animals to go around a 90° corner to leave the platform. This design was to keep the animal on the weigh platform for a longer period to allow a more accurate weight.

Initially the platform used was 1500 mm long, which proved to be too long for the size of the lambs. It was shortened to 1200 mm, to try and alleviate the possibility of 2 animals being on the platform at the same time. This appears to have worked reasonably well but there is still the possibility of this happening if 2 animals follow closely together or an animal “loiters” on the platform. In the feedlot situation, with the animals having little to do, they tend to use the WOW platform as a playground and quite commonly will spend time standing on the platform. The updated processing software is able to now do a better filtering job of removing the outliers from the data, thereby giving a more accurate weight.

The tables below summarise the output now available through the processing software and show the number of recordings since this trial started. Note that the platform was shortened on 3rd March, the longer platform in use before this date probably accounts for the higher weight at this time, with many animals being recorded with heavier weights because 2 animals consistently crossed the scale together. After the platform was shortened the proportion of records used increased.

Date	Total Number of Records Recorded	Number of Records with Valid Weight	Average Body Weight (kg)	Number of Records with no RFID
19/02/2007	207	Weights from Racewell Autodrafter		
26/02/2007	6198	5505	49.0	693
3/03/2007	2999	2275	36.2	724
9/03/2007	7111	5439	35.3	1672
12/03/2007	4705	4288	41.6	417
14/03/2007	2372	2184	39.5	188

Date	Final Number of Records Used	Final Average Body Weight	Number of Records per Animal	Standard Deviation of Weight (kg)	Proportion of Records Used
19/02/2007		31.6			
26/02/2007	2143	32.8	10.3	5.6	39%
3/03/2007	1176	31.5	5.7	6.0	52%

9/03/2007	2832	32.1	13.4	5.1	52%
12/03/2007	2458	34.8	11.4	5.6	57%
14/03/2007	1383	35.3	6.7	5.8	63%

The chart below shows weight change over time.

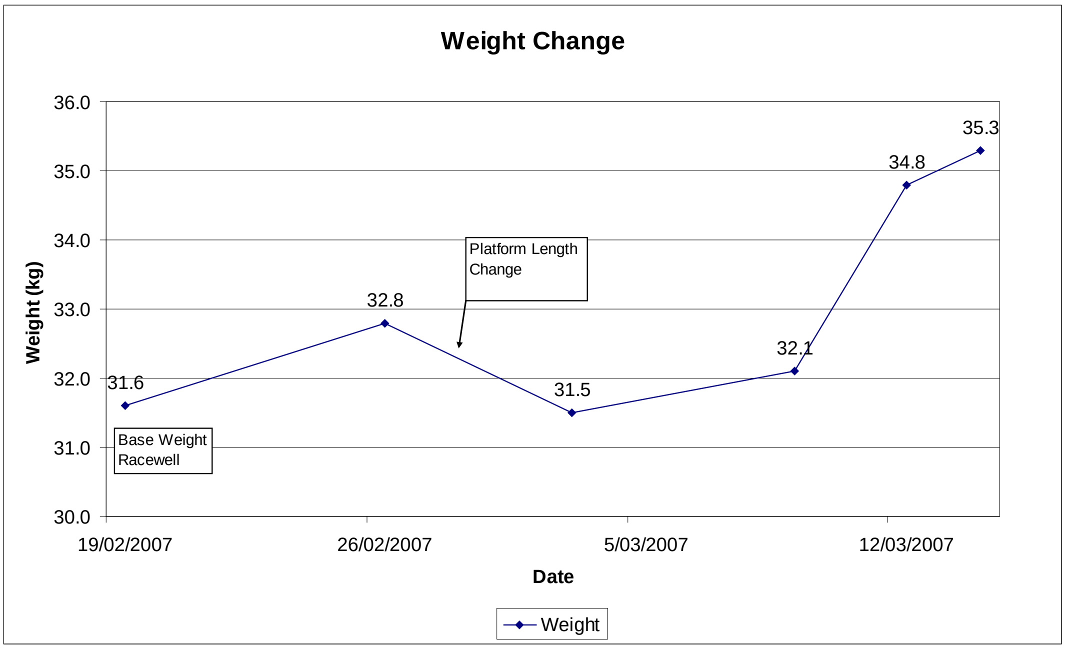


Chart 1 Initial average weight change

These animals were re-weighed on 21st March over the Racewell platform and the results for both the WOW weight and crate weight added to the chart below. The difference in average weight recorded by both methods was less than 1 kg.

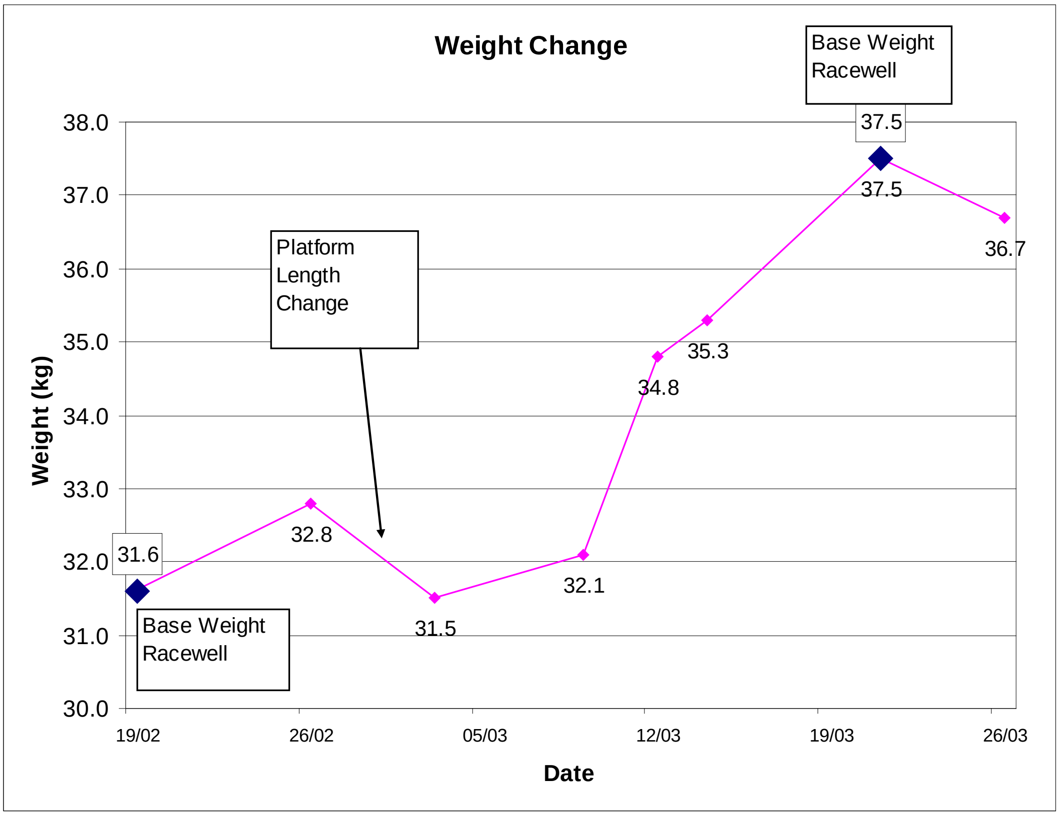


Chart 2. Weight change after addition of base weights

Trial 2 Continuation

The animals were weighed periodically through the Racewell drafter to monitor animals suitable for sale at a target weight greater than 44 kg. These weights were taken on 11/4/2007 and 30/4/2007, with animals being sold in the days following the weights being taken. WOW weights collected throughout this period and processed every 4 – 5 days. After the sale of animals following the 30/2 weighing, the final 33 animals were monitored via WOW until the trial was finished on 31/5/2007.

Processing Program changes

The Weigh Matrix program that is used to process the WOW files was altered to allow

1. the possibility to accept a base weight file, either from a set crate or previously processed WOW file
2. this base file was then used to limit the range of weights, to allow an animal's data to be either accepted or rejected, depending on previously captured weights

The data for all the WOW files was re-processed to determine if this filtering method was effective for capturing more accurate records, by limiting the number of outliers that remained in the data.

Table 1 below shows the results from the re-processing of data files, with a slight increase in proportion of values used for most files, plus a marginally tighter range of accepted weight values indicated by a lower SD of weight and increase in number of animal records..

Table 1 Re-processed WOW data file results

Date	Final Number of Records Used	Final Average Body Weight	Number of Records per Animal	Standard Deviation of Weight (kg)	Proportion of Records Used
19/02/2007		31.6			
26/02/2007	2145	32.2	10.4	5.1	39%
19/03/2007	1446	36.0	7.1	5.1	49%
22/03/2007	748	37.5	3.6	5.5	47%
26/03/2007	3176	36.7	14.8	5.1	74%
29/03/2007	1978	37.4	10.0	4.9	62%
5/04/2007	5602	38.2	28.3	4.6	63%
11/04/2007	**2473**	**33.7**	**12.6**	**4.1**	**39%**
18/04/2007	4428	39.8	22.4	4.6	64%
24/04/2007	3573	41.2	18.1	4.8	68%
11/05/2007	606	36.5	18.9	4.5	69%
16/05/2007	455	37.6	13.0	4.9	66%
21/05/2007	296	38.7	9.5	3.8	70%
25/05/2007	318	40.3	9.6	4.2	64%
28/05/2007	221	40.9	7.4	4.3	73%
31/05/2007	188	42.0	6.1	5.5	72%

Chart 3 below shows the full range of weights (WOW and Racewell crate) over the period of the trial. The weights depicted, reasonably follow the trend between crate weights, except for the weights processed on 11/04. For some reason there was a marked decrease in weight for this group associated with a high proportion of discarded weights.

Plotting of group average weight became difficult to follow as heavier animals were removed from the group periodically as they reached a marketable target weight (44 kg live weight) causing the group averages to decrease.

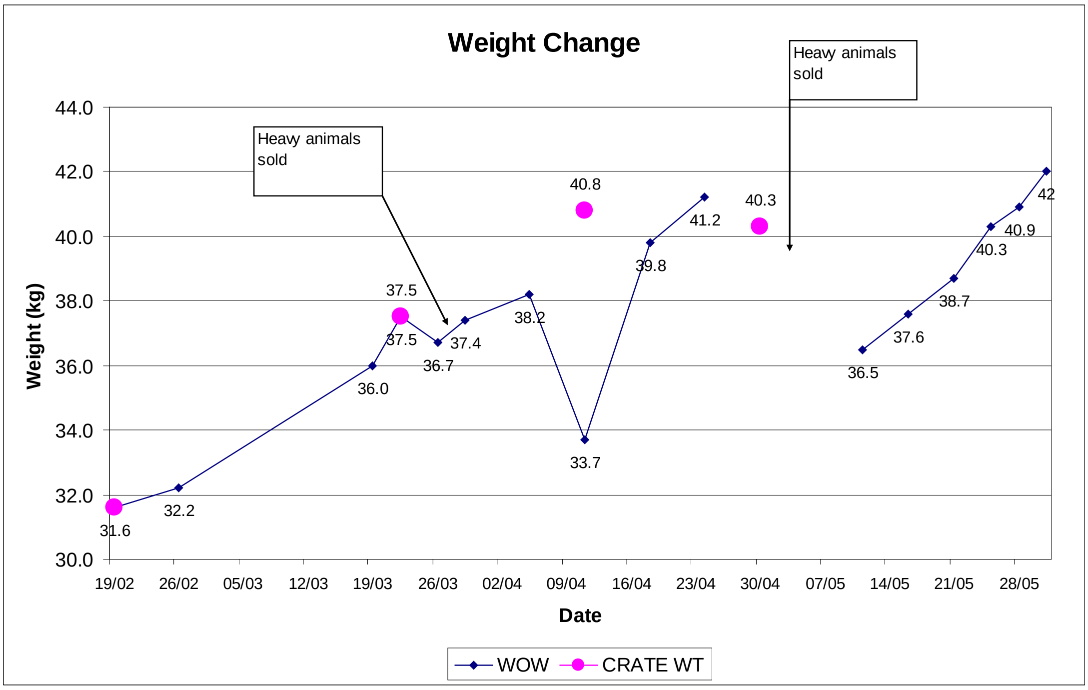


Chart 3. Weight change over full term of trial

Table 2 below shows the statistics for each weight period, based on the processed WOW data, and the reduction in numbers as animals reached target weight.

Table 2. Weight Date Statistics

Date	Count	Min	Max	Mean
19/02/2007	207	19.50	55.50	31.62
26/02/2007	207	18.00	47.44	32.15
19/03/2007	203	18.75	49.25	36.04
22/03/2007	204	21.83	48.50	37.56
26/03/2007	214	22.17	49.88	36.66
29/03/2007	196	24.88	47.61	37.27
05/04/2007	197	25.25	47.80	38.18
11/04/2007	**195**	**23.00**	**42.35**	**33.71**
18/04/2007	196	24.50	46.55	39.82
24/04/2007	195	26.15	49.94	41.24
11/05/2007	32	26.75	51.93	36.49
16/05/2007	35	25.50	52.35	37.57

Table 2.	Weight Date Statistics			
Date	Count	Min	Max	Mean
21/05/2007	31	31.00	52.70	38.70
25/05/2007	33	30.71	54.38	40.30
28/05/2007	30	31.75	54.50	40.86
31/05/2007	31	31.42	60.63	41.96

Weight Prediction

One of the aims of using the WOW system was to generate a steady stream of weight data that could then be used to predict finished weights (or predict dates) that animals would achieve a desired sale/slaughter weight.

After processing the WOW data through the Weigh Matrix program, the result files were added to a "Lamb Weight Predictor" model (Richards et al, 2006) to predict a future target weight.

Chart 4 below shows the correlation between crate weights taken on 11/4 and predicted weights for this date using a crate weight on 19/2 and processed WOW weights on 26/2, 19/3 and 5/4.

Chart 4 Predicted weights 11/4.

Chart 5 below shows the correlation between crate weights taken on 30/4 and predicted weights for this date using a crate weight on 19/2 and processed WOW weights on 26/3, 5/4 and 24/4.

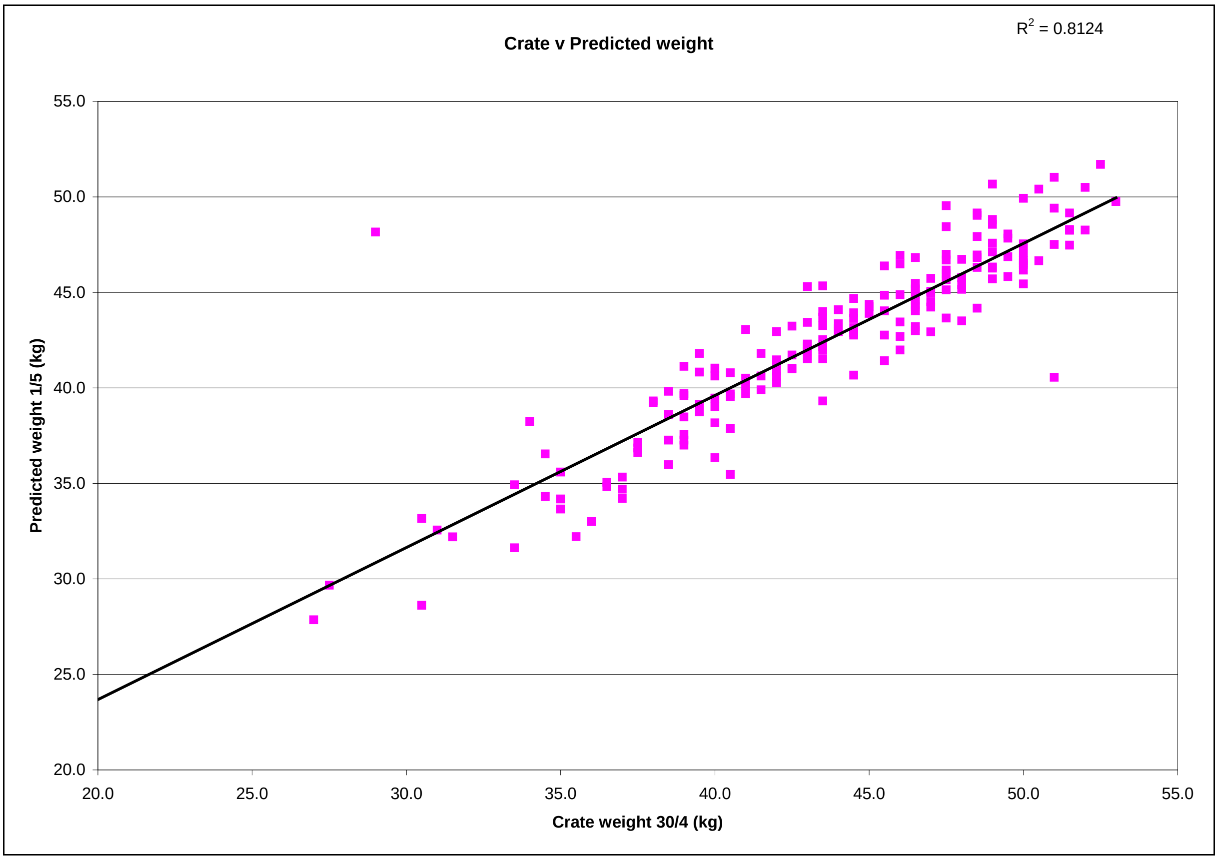


Chart 5 Predicted weights 30/4.

While it is important to be able to predict “Finishing Date”, it is equally as important to be able to give some prediction of “Late Finishing”. If it is possible to identify “Late Finishers” early, they can be removed from the feedlot, thereby reducing feed costs from animals taking a long time to finish.

The weight changes on the final 33 animals, those not suitable for sale by 30/4, were monitored. The data was re-processed through Lamb Weight Predictor model to examine the predicted finishing time. This was done by processing WOW weights from 19/2, 26/2, 19/3 and 26/3 and looking at the predicted weights on 1/5. The table below summarises the actual number of animals drafted into groups based on a crate weight on 30/4, and the predicted draft groups based on the 4 WOW weights up to 26/3.

Draft Range		Crate	WOW
1	Less than 38 kg)	34	35
2	38.1 – 43.9 kg)	68	77
3	Greater than 44 kg	97	87
	Total	199	199

This demonstrates that even from a relatively early stage, about 1 month into the feeding process, by monitoring growth, we can fairly accurately predict finishing time. More importantly of the 34 animals that were in the final draft group

- 21out of 34 were correct

- 3 did not have enough WOW data for prediction
- 5 were within 2kg of 38 kg cut-off
- 3 had at least 1 WOW weight that was either too heavy/light which affected the prediction
- 2 had an incorrect crate weight and were drafted incorrectly (animal not on scales correctly)

Appendix A

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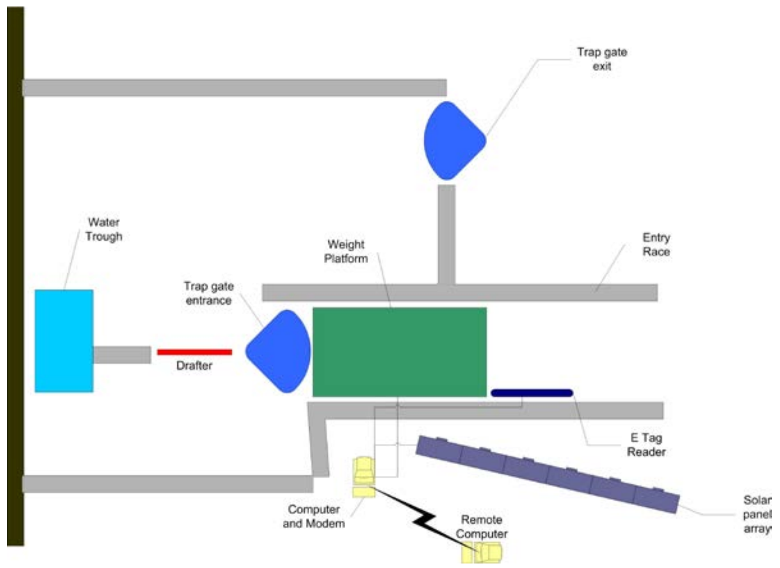
SETTING UP WALK OVER WEIGHING SYSTEMS



EQUIPMENT REQUIRED:

- Two 80watt solar panels
- Two deep cycle batteries
- 15 or 30 amp solar regulator
- Terminal strip
- TRUTEST XR3000 indicator with WOW activated
- Load bars
- EID reader
- Rack for panels
- Box for electronics
- 1.5m weigh platform
- Two spear gates
- Panels to form race over platform

PUTTING IT TOGETHER

The physical design is really quite simple and is flexible in that all that is required is to provide one way in and one way out of the water point and to direct animals over the platform (as per the above diagram). Since the animals are entering by choice, a "force" area is not required. If possible don't allow sheep access to wires as they will chew them.

ELECTRICAL WIRING

Wire solar panels in parallel and then connect into the appropriate terminal in the regulator. Follow same procedure for the batteries.

Take power from the load output of the regulator to a terminal strip which should have multiple outlets wired in parallel. One of these powers the weighing indicator and the other the tag reader. As the system grows you will need to power a modem and draft gates as well.

INDICATOR

The most important thing is to ensure that WOW is activated on your indicator. If not speak to your TRUTEST representative. After turning on indicator, do the following. (After *each step press ESC*)

1. Press SETUP then LIFEDATA. Ensure that EID is ticked and has a length of 16. Other fields are not important ant this stage so just ignore them.
2. Press SETUP. Ensure that EID is ticked in the right hand column and that no other fields are ticked in either left or right hand column. Press FILEDATA and activate DATE and TIME STAMPING.
3. Press SETUP then SYSTEM.
4. Make DAMP SYSTEM “Walk-Over”
5. WEIGHT RECORDING “Auto”
6. RESOLUTION “0.5”
7. Also ensure that ID ENTRY CREATES FILE RECORD and DISABLE POPUPS are ticked.
8. Press ESC and SETUP together then DAMPING and set MIN WEIGH TIME to “0.5”.
9. Press SETUP then SERIAL. Ensure that both CON 1 and CON 2 are activated for EID and that they are set for a minimum number of characters of 16 or less.

Plug the load bar leads and connect power to the indicator. Then connect the EID reader communications cable into either CON 1 or CON 2.

TRAINING ANIMALS

In order for Walk Over Systems to be effective, animals must be prepared to use them. As labour input is minimal we need to train animals to effectively use WOW systems.

Fundamentally we need to create a non threatening system for sheep movement. Our experience would suggest that the follow may help in this process.

- Never force animals through the system. Sheep are inquisitive animals and if given an opportunity will explore novel additions to their environment.
- Ensure that animals have a clear view through the system.
- If animals are reluctant to enter incentives such as supplementary feeds may be used to entice them through the system.

Note: Before the race is in place leave it near the sheep, for them to investigate.

Given that the system has several components it is both possible and practical to build it over a few days so that the sheep can gradually get used to the whole system. An example of how this might be done and one that has worked for us is:

- Session 1: Build trap yards in away that allows free access to water. When you are confident that sheep are all watering introduce the next stage.
- Session 2: Add trap gates but leave them fully open.
- Session 3: Gradually close the gates to restrict access and exit to the system. This has taken us up to three days. Do not progress until sheep are freely entering and exiting the system.

- Session 4: Add the race without electronics turned on as beeping may distract some animals.
- Session 5: Activate the system and collect data.

The photographs below show a walk over weighing platform set up in a feedlot and the electronics control box.

Appendix B

DATA FROM WALK-OVER WEIGHING – WHERE ARE WE AT?

J.S. RICHARDS[A], *K.D. ATKINS*[A], *T. THOMPSON*[B] *and W.K. MURRAY*[A]

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Walk-over weighing (WOW) utilises the concept of remote individual animal management (RIAM). It monitors sheep without human intervention by electronically capturing and recording an individual sheep's tag and weight as it passes over weigh scales on its way to feed or water. It is well suited to pastoral settings where labour is scarce and the stress and cost of mustering sheep are important factors. It can also be used in feedlot or rotational grazing systems where regular monitoring of a sheep's weight applies.

WOW incorporates a set of trap yards and a race so the sheep's weight can be recorded as part of its natural movement to feed or water. Capturing weights of animals by walk–over weighing is achieved through animals with a radio-frequency identification (RFID) tag in their ear having the tag scanned and their weight recorded as they walk over a weighing platform. These individual weights can vary dramatically according to the animal's position on the platform and how long the animal remained there. A single weight measurement using this method could be inaccurate. By using a number of repeated weights over a specified time period an accurate weight measure of each particular animal can be achieved.

Results from walk-over weighings include many sets of weights for each animal which need to be analysed in a way that producers can use the data to better manage their flocks. An Excel-based program has been developed to calculate an average weight for each animal over a specified weighing period. Data with no linked RFID tag or animals recorded as having a zero weight are removed and the remaining data are entered into the program. An "acceptable" weight range is established based on a starting weight value for each animal and a fixed range either side of this value. An average of these "accepted" weights is used as the weight of that animal. The starting weight can be an earlier weight using conventional weighing or a processed walk-over weight relying on both the current set of data and any previous data on the individual animals as well as the whole flock. The result is a list of estimated weights for each animal for each weighing period. The growth rates for the mob or for quartiles within the mob can be calculated and reported to determine how the animals are performing.

A trial was conducted at Bourke, NSW, where about 200 animals were weighed over a time period of 2 months (with some gaps), separated into 4 arbitrary periods of 1-2 weeks each. After ignoring zero weights or those without any associated animal identity, there was an average of 39.8 weight records per animal over the 48 days of recording. After data analysis, 75% of all records (a range of 69 to 78% across time periods) were included in the liveweight estimation for each animal in each time period. The average weight of the mob in each time period was estimated with a standard error of less than ±0.5 kg with a mean of about 55 kg.

Information on individual animal performances was the most significant outcome. Average correlations among animal weights across time periods were all very high (0.89 to 0.93) but substantial differences between groups of animals within the mob were apparent. The average growth rate of the mob was a loss of 26 g/day (-1.7 kg over the whole experimental period). When the data were split into quartiles according to liveweight gain over the 2 months, the top quartile had an average gain of +33 g/day (+2.1 kg gain in liveweight over the whole period) whilst the bottom quartile were losing weight at a rate of 90 g/day (-5.1 kg loss in liveweight). Even though the growth was negative for this trial there was still an obvious difference between the top and bottom quartiles of animals within the flock. This is useful information to the producer to either identify the lowest ranked animals to sell before losing more money, or to identify those for differential management to the rest of the animals (e.g. health or nutritional management). It also allows identification of animals for different target markets depending on their weight and growth rates.

The use of walk-over weighing has the potential to allow producers to obtain simple weight measurements of their flock and improve their flock management without high labour costs normally associated with mustering and weighing. This will reduce the stress on animals as well as improving the options for management.

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Appendix C

Data Retrieval from Walk-Through-Weighing

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Abstract

Walk-through-weighing systems have been developed as a means of easily capturing weights of individual animals without the need for mustering. The precision of an individual weight will be lower in such systems but compensated for by many repeat observations. A process of screening recorded weights is currently being investigated using data from a pastoral grazing property in Bourke, NSW. The opportunities of using such data for management decisions are discussed.

Aims

Walk-through-weighing is a system for capturing weights of individual animals as they walk over a weighing platform to get to water or some other incentive. The Sheep CRC has developed a prototype walk-through-weighing system by modifying commercially available hardware. Such systems are being evaluated in a number of commercial trials. The aim of this paper is to discuss potential ways information from walk-through-weighing could be used to enhance management decisions.

method

Data from a walk-through-weighing system set up on a pastoral grazing property in Bourke, NSW, was retrieved and used for analysis. There were a total of 629 animals in the trial. The results were divided into four weighing periods ranging from early January to late February 2005. The data contained a radio frequency identification (RFID) tag number and a single weight for each weighing. There were on average 3200 recorded weights for each weighing period (after any nil weights were removed and any weights with no linked RFID tag number). Two mustered weights were taken to ensure the correct range in weight values were being achieved during the screening process.

The screening process involved removing weights of 0 kg and then an average weight was taken from weights within an acceptable range for each animal at each weighing period. This information was then examined to determine what benefits could be achieved with having these multiple weights of each animal for management decisions. Observations can be made about their growth rates over time.

results

The raw weights ranged from 0kg to 115.5 kg (SD=14) and after the average weight per animal calculation the weights ranged from 14 to 70 kg (SD=9). The earlier results were more variable, but improved in later weighing periods. A settling period is needed for the animals to adjust to the new environment so they move more freely through the system and more accurate weight measurements can be taken. Adjustments were made to the system and setup as problems occurred, which reduced the variation in the data. While the data editing process is still being refined, initial results from the whole mob over time are summarised in table 1.

Table 1: Average weights over time

	8/1/05-24/1/05	24/1/05-26/1/05	26/1/05-12/2/05	10/2/05*	12/2/05-17/2/05	19/4/05*
Average wt (kg)	38.6	41.2	39.7	45.3	45.3	42.3
SD of wt	9.5	8.1	9.9	8.8	8.8	6.9

*****Mustered weights

The average growth rate of the mob up to 10/2/05 was 168 g/day reflecting the feed available after a long period of destocking with some modest summer rainfall at Bourke. Between 10/2/05 and 19/4/05 the mob average declined by 49 g/day as the region slipped back to drought conditions. Over the whole period of observation the average growth rate was only 25 g/day. Simply separating the mob into two groups on growth rate showed that the top 50% grew at 85 g/day whilst the bottom 50% lost 36 g/day over the whole period.

discussion and implications

Within such an extensive grazing system in the Bourke area, effective animal performance data has not previously been possible. It is too difficult, costly and time consuming to muster the animals to obtain even irregular information on the animals. Even if this event is attempted it is unlikely to obtain all animals in one muster. Using this walk-through-weighing system all animals will eventually need to come for water and so a record of every animal will be obtained with little time and labour from staff and with little stress on the sheep to monitor their performance. The development of suitable software will be required to process the information and so aid in management decisions on farm.

Initially the data is useful to monitor the whole flock. The weights can be used to identify when the sheep require moving to another area of feed. Individual growth rates can be used to aid in the detection of ill health in a group of animals and can also be used to make predictions on their future growth and therefore weight. The predictions would be used to determine when animals will meet the market specifications (target weight) or can be used to predict what weight the animal is likely to be on a certain date. This is useful for producers in determining when to order a truck for slaughter and how many animals will be ready on this date. From the animals that do not meet market specs on the predicted date it is useful to see whether they will meet the target within the specified period or whether early sale might be required to reduce costs.

If sold early they may not achieve a high market value but it may still be an advantage to reduce the cost of maintaining them when pastures are limiting. Without individual records, these animals may go unnoticed as they never reach the target saleable weight. This animal performance information can be used in combination with pasture assessment. Growth rates of the animals can be used to determine, under the current nutritional conditions, how long this number of animals can be retained, or it can be used to determine how many may need culling to reduce the need for hand feeding when feed is limiting. In this case the animals needing to be culled can be identified to ensure the animals retained are the most suitable. If the same number of animals are to be retained their growth rates can be used to determine how long the current feed will last and how much feed will need to be brought in if they continue to grow at the current growth rate.

As the walk-through-weighing system continues to be improved a drafting capacity will be developed. This will achieve an even greater benefit as the animals can be selected on these growth rates and drafted off into a holding yard for trucking to slaughter or for treatment if the drafter detects a reduction in growth of the animals. It may also be useful to draft off the animals that are identified as losing condition to give them supplementary feed whilst the heavier animals do not get access to the additional feed, saving money by only feeding the animals that need it. Only treating animals that need to be treated (such as identified as losing weight) will also reduce costs.

This paper has looked at the benefits of walk-through-weighing in an extensive grazing system where it was previously impractical to collect weights of animals. The benefits were clearly shown in this situation and there may be benefits in other systems not discussed here, such as lamb finishing. In these more intensive grazing systems regular weights are usually collected to monitor the lambs progress and "readiness" for slaughter. Walk-through-weighing would provide a system for capturing these weights without the need for regular mustering. This would reduce labour and potentially improve growth by not holding in yards for extended periods of time. Potential benefits have been noted for two sheep systems, there would be similar benefits in many other systems.

Key words

Walk-through-weighing, data management

acknowledgments

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