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Liveweight loss associated with handling and weighing of grazing sheep

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ABSTRACT

Sheep liveweight and liveweight change are important data both for research and commercial farm management worldwide. However, they can contain errors when procedures in collection are not standardised, including when weighing occurs around other husbandry tasks resulting in varying time delays between removal from grazing and weighing. This research had three stages with different objectives: 1) a liveweight loss study, to quantify liveweight and liveweight change over three and six hours of delay prior to weighing within a handling facility, and to develop a correction equation for delayed liveweights; 2) a validating process, to examine the correction ability of the equation by using it on a different set of delayed liveweights collected under a range of situations; and 3) a management simulation, to explore what impact delayed and corrected delayed liveweights could have when liveweight change was used to assign ewes to feeding levels. Results from each stage showed that: 1) ewes lost a significant amount of liveweight after three (1.8 ± 0.5 kg or 3.5 ± 0.8% liveweight) and six (2.9 ± 0.6 kg or 5.6 ± 1.0% liveweight) hours delay during a practical handling operation ($p < 0.001$). The following equation was developed to correct delayed liveweights: $y = 100\ (x/(100 + (-0.9301\ t + 0.07106)))$ where y, x and t are corrected liveweight (kg), delayed liveweight (kg) and time delayed in decimal hours, respectively; 2) the correction equation provided a more accurate and precise estimate of liveweight than a delayed liveweight alone; and 3) use of delayed liveweights, to determine liveweight change over a two month period, resulted in significantly more animals being assigned wrongly to higher feeding levels ($p < 0.001$), than if the delayed liveweights had been corrected by time elapsed since gathering from grazing fields. To conclude, a short-term delay prior to weighing associated with a practical handling operation significantly reduces the numerical liveweight recorded for each sheep. Using variably delayed liveweights in research and on commercial farms will have significant consequences for research results and management practices globally. Therefore collection of liveweights should occur without delay. However, when this is not feasible delayed liveweights should be corrected and in the absence of locally formulated correction equation, the one presented in this paper could be used.

1. Introduction

Liveweights are indicative of an animal's current and changing physical state and measuring changes in liveweight is useful in assessing how an animal is responding to its current situation (Baker et al., 1947). As liveweight is affected by: growth, nutrition, health, stress, pregnancy and genetics (Brown et al., 2015; Coates and Penning, 2000), research exploring these areas in sheep can use liveweight as an important variable. Liveweights are one of the most frequently utilised measurements in livestock research worldwide due to: ease of collection and understanding; comparability within and between animals; changes in response to a range of stimuli; flexibility of quantitative data produced for statistical analyses; and the potential application of methods for monitoring and managing liveweights on commercial farms (Brown et al., 2015; Coates and Penning, 2000).

Liveweight recording and associated management decisions have been identified as key elements for improving productivity and efficiency on commercial sheep farms in Australia and the UK (Brown et al., 2015; Wishart et al., 2015; Young et al., 2011). New applications are being made possible through advances in commercially available weighing equipment. Radio Frequency Identification (RFID) chips within each animals ear tag and readers within the weigh crate allow liveweights to be easily collected and utilised on an individual animal basis (Morgan-Davies et al., 2015). Research and application in the field

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of Precision Livestock Farming (PLF), which uses technology to manage animals in a more precise individual manner (Banhazi et al., 2012), is expanding. Such weighing equipment has the potential to allow new management systems to be developed using sheep liveweight to aid decision making (Brown et al., 2014; Wishart et al., 2015).

Most research and commercial use of liveweight data involves making comparisons between liveweights at different time points within and between animals and groups. To be able to produce reliable, comparable liveweights the variation and error associated with these data needs to be understood and controlled.

Liveweight is a measure of body mass which is composed largely of muscle, fat, bone and organs. All of these have a relatively stable weight over a short period of time, such as a day, but alter over longer periods in response to environmental and biological conditions (Coates and Penning, 2000). Changes in weight of these components are of most interest within research and industry. However, body water and the fluids and digesta of the gastrointestinal tract (known as gut-fill) also make up total body mass. Levels of these change over the day and result in fluctuations in liveweights being observed. While this is an issue with weighing all animals, gut-fill needs greater consideration with ruminants as the contents of the rumen can account for 10–23% of total liveweight (Hughes, 1976).

The short-term liveweight fluctuations in ruminants are affected by: feed and water consumption (Whiteman et al., 1954); time since last meal (Hughes, 1976); quality and quantity of feed available (Hughes and Harker, 1950); age and size of the animal (Lush et al., 1928); time of day relative to sunrise (Gregorini, 2012); ambient temperature (Lush et al., 1928); and individual differences in grazing behaviour (Hughes and Harker, 1950).

Robust methodology is required to reduce variation in liveweights between animals and weigh points to ensure liveweight data collected are comparable. This requirement becomes more essential as on-going improvements in weighing equipment, software and data management is resulting in liveweight data having greater use in research and management on farm. Methodologies to reduce variation include: fasting prior to weighing (Coates and Penning, 2000); standardising weighing procedure (Watson et al., 2013); taking an average of multiple liveweights across a number of successive days (Koch et al., 1958); weighing at a specific time relative to sunrise (Hughes and Harker, 1950); standardising feed before weighing (Meyer et al., 1960); increasing the number of animals (Hughes, 1976); and repetitions of the study (Lush et al., 1928). However, there is evidence that such methodologies to reduce variation are not being considered or used in research. To illustrate this we examined 35 recent peer-reviewed papers (from Small Ruminant Research 2014, all issues of volume 120) and revealed that of the 11 papers involving liveweights, only 2 clearly stated the method used to control liveweight variation.

Reasons why variation reduction methodology is not being followed may be that: broader methodology has not caught up with the improved weighing technology now available; people collecting liveweights are simply not aware of the problem; or such methodologies are not practical when liveweight collection (research or commercial) is carried out in farm situations.

Consideration of the on-farm situation raises concern that not only is variation in liveweight not being controlled but procedures in weighing could also be adding systematic error to the data. On a research or commercial farm, weighing of sheep is likely to occur alongside other husbandry or research procedures. On a large farm, many animals may be gathered from fields of varying distances to be handled and weighed on the same day. Inevitably, this results in delays, where groups of sheep are removed from pasture and then wait varying lengths of time, without access to food and water prior to weighing.

Delays in weighing leads to gut-fill weight loss, with previous literature reporting losses of 0.5–2 kg after six hours and 1–4 kg after 12 h (Hughes, 1976). Indeed fasting (removal of feed and water) is well documented as a suitable method to reduce variation in liveweight, where feed and water are removed for fixed long periods of time prior to weighing (e.g. Coates and Penning, 2000; Shrestha et al., 1991; Wilson et al., 2015). Our review of the literature found that only research carried out by Wilson et al. (2015) considered the impact of removal of feed and water for less than six hours; however, this was with the focus of fasting to reduce variation in gut-fill between animals or weigh points. Adjustment of liveweights has previously been used as a method to reduce errors: by Scott (2011), via a moving average of mean liveweights; and by Kane et al. (1987), using assumptions of feed intake and quality. However, both these methods are unsuitable or challenging for single weighings in a grazing sheep system. We found no published studies that attempt to develop a correction equation for liveweights with a known short-term period of delay prior to weighing as a result of a gathering and handling procedure of six or less hours.

The aims of this paper are 1) to determine the extent of liveweight loss in sheep, in a practical environment, as a result of delayed weighing over three and six hours; 2) to explore whether this information can be used to produce a methodology to reliably correct delayed liveweights across different situations; and 3) to demonstrate the potential consequence of not correcting delayed liveweights.

2. Materials and methods

Data for this research were collected from Scotland's Rural College (SRUC), Hill and Mountain Research Centre, Kirkton and Auchtertyre Farms in the West Highlands of Scotland. All work involving animals was carried out in accordance with EU Directive 2010/63/EU and was approved by SRUC's Animal Welfare and Ethical Review Body.

This research was carried out in three stages:

a A liveweight loss study: to quantify liveweight and liveweight loss over three and six hours delayed weighing within a handling facility and without access to feed or water. Then to use these findings to develop a correction equation for delayed liveweights.
b A validating process: to examine the precision and accuracy of the correction equation by using it on different sets of delayed liveweight data collected under a range of situations.
c A management simulation: to explore what impact delayed and corrected delayed liveweights could have when liveweight change is used to assign ewes to feeding levels.

2.1. Animals

All three stages of this research used the same base flock from which sheep and liveweight data were selected. The role of this flock was the long-term recording of 600 Scottish Blackface and 300 Lleyn ewes and their lambs (further details of the flock and research can be found in Morgan-Davies et al., 2015 and Umstätter et al., 2013).

2.2. Weighing facility

The following weighing setup was used to collect all liveweights discussed in this paper. A Prattley Auto Drafter (Prattley Industries, Temuka, New Zealand), with Tru-Test™ MP600 load bars and XR3000 weigh head (Tru-Test Group, Auckland, New Zealand) recorded all sheep liveweight data automatically. They were then downloaded onto a computer for analysis.

The weigh head and weigh bars collected liveweights at a resolution of 0.1 kg for weights between 0 and 50 kg; weights between 50 and 100 kg were recorded to 0.2 kg. The weigh head was set to use the inbuilt system: Superdamp III (Sheep) (Tru-Test Group, Auckland, New Zealand). This used a damping algorithm to allow accurate liveweights to be collected from sheep in the weigh crate standing still or moving, with the liveweight automatically recorded when within tolerance (TruTest XR3000, Tru-Test Group, Auckland, New Zealand).

The liveweights were recorded in the weigh head against each ewe's