Small Ruminant Research 143 (2016) 8–14

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Live weight and body composition associated with an increase in body condition score of mature ewes and the relationship to dietary energy requirements

P.C.H. Morel[a,*], N.M. Schreurs[a], R.A. Corner-Thomas[a], A.W. Greer[b], C.M.C. Jenkinson[a], A.L. Ridler[a], P.R. Kenyon[a]

[a] International Sheep Research Centre, Massey University, Palmerston North, New Zealand
[b] Faculty of Agriculture and Life Sciences, Lincoln University, Lincoln, New Zealand

ARTICLE INFO

Article history:
Received 29 April 2016
Received in revised form 19 August 2016
Accepted 20 August 2016
Available online 21 August 2016

Keywords:
Sheep
Body
Condition
Score
Composition
Energy

ABSTRACT

The body condition score (BCS, on a 0–5 scale) for sheep was developed in the 1960s as a management tool to quickly assess body nutrient reserves. To quantify how live weight, chemical body composition and energy partitioning changes as BCS increases in mature ewes, a total of 28 mixed-age Romney-cross ewes were slaughtered at different BCS (1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5) and the whole body chemical composition (skin, head, organs and carcass) was determined. The live weight increased linearly with BCS with an extra unit of BCS requiring 7.74 kg in live weight. The concentration of protein and inorganic matter in the whole body did not differ between BCS groups ($P > 0.05$). The concentration of water, fat and energy in the whole body increased as the BCS increased ($P < 0.0001$). As expected, the amount of energy required to gain one unit of BCS increased at a non-linear rate ($P < 0.01$), such that more energy was required at higher BCS to gain an additional unit of BCS. Increases in BCS above 3.5 are associated with increased heat energy loss and only a small proportion of energy is retained. The data indicated that from an energetic efficiency perspective there is little advantage in gaining BCS above a BCS of 3.5.

1. Introduction

Body condition score (BCS) is assessed by the palpation of the lumbar vertebrae (spinous and transverse processes), immediately caudal to the last rib and above the kidneys to examine the degree of sharpness or roundness which indicates the degree of tissue (fat and muscle) coverage (Jefferies, 1961; Kenyon et al., 2014). BCS is a means of subjectively assessing the degree of fatness, lean tissue or body reserves of a live animal (Russel, 1984a) and compared with live weight, is not influenced by skeletal size, physiological state (i.e. pregnancy), gut fill, fleece length or fleece wetness (Jefferies, 1961; Kenyon et al., 2014; Russel, 1984a,b).

The BCS system for sheep was first published by Jefferies (1961), based on a 0–5 scale, using whole units with Russel et al. (1969) introducing 0.5 and 0.25 units. Jefferies (1961) proposed that BCS could be used to: (1) control the condition/nutrition of sheep, so that available food supplies were utilised more efficiently; (2) detect small differences in body condition not noticeable by outside appearance; (3) allow farmers to be immediately aware of major losses in body condition; (4) follow trends in nutrition and body weight. The BCS of the ewe at mating has been related to reproductive performance, lamb survival, ewe milk production and lamb growth rate to weaning (see review of Kenyon et al., 2014). Implementing target BCS at specific points in the production cycle is considered to be a key management tool for the performance of breeding ewes (Kenyon et al., 2014).

The method of body condition scoring is considered to be easily learned and a useful mechanism for farmers to monitor the condition of their flock and to estimate the level of feeding required (Kenyon et al., 2014). A gain of one kilogram of live weight is considered to require 25–55 MJ of metabolisable energy (ME) depending on the animal type and the composition of the gain (Nicol and Brookes, 2007) and an additional unit of BCS equates to 5–10 kg in live weight (Kenyon et al., 2014). The variation in live weight equating to a unit of BCS reported between studies is likely to be a consequence of a non-linear relationship between BCS and live weight (Teixeira et al., 1989), variation in animal frame size, differences in the composition of deposited body condition at different BCS start points and different studies considering a shift in BCS across different parts of the BCS scale. An increase in body con-

* Corresponding author.
E-mail address: p.c.morel@massey.ac.nz (P.C.H. Morel).

http://dx.doi.org/10.1016/j.smallrumres.2016.08.014
0921-4488/

dition produces a heavier animal that is likely to be closer to its mature size. As an animal approaches its mature size the fat in the tissue deposition increases (Wood et al., 1980; Owens et al., 1993) and greater fat in the body tissue gain requires more feed energy per unit of tissue deposited (Nicol and Brookes, 2007).

The variability in live weight associated with an increase in body condition and differences in the composition of condition gained across the BCS scale makes it difficult to relate feed requirements to BCS gain and limits the usefulness of body condition scoring as a mechanism to manage feeding levels. To overcome this limitation, an investigation to directly link the feed requirement to a change in BCS across the entire BCS scale is required. Therefore, the current study was undertaken to determine (i) the percentage of body fat per unit of BCS, (ii) the gain in live weight required to gain BCS and (iii) the level of dietary energy required to gain BCS in ewes, across the entire BCS scale.

2. Materials and methods

2.1. Experimental design and animal management

Utilisation of animals in this study was approved by the Massey University Animal Ethics Committee and the animals were managed according to the New Zealand Code of Practice for the Care and Use of Animals for Scientific Purposes.

Twenty-eight 4–6 years old shorn Romney-cross ewes with a mean live weight (LW) of 54.4 kg ± 6.4 kg (SD) and a body condition score of 1.5 were obtained from a commercial farm and transported to Massey University where they were fed to gain body condition. The ewes had been through a dry summer period after the weaning of their lambs. This did not allowed them to re-gain condition. They were all checked by a veterinarian before the start of the experiment to ensure there were no health issues causing the low body condition. Ewes were shorn prior to the start of the experiment.

The ewes were randomly allocated to one of seven target BCS groups and slaughter occurred at the point of the ewe achieving its allocated target BCS of 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 or 4.5 (n = 4 per group). Those ewes allocated to the target BCS of 1.5 were slaughtered at the start of the experiment. The live weight and body condition score of the ewes were recorded on a weekly basis. Body condition score was evaluated by a single assessor using the 0–5 scale of Jefferies (1961). There is a significant variation between assessors (Kenyon et al., 2014), so for consistency just one experienced assessor was used. This assessor had many years of experience and had assessed 1000's of sheep, previously.

Ewes were housed indoors in individual pens (1.80 m × 1.08 m). Ewes were offered lucerne-based pellets ad libitum (65% lucerne, 30% barley with limestone, molasses and trace elements; Camtech Nutrition Ltd., Hamilton, New Zealand). To ensure sufficient effective fibre, the diet was supplemented with 800 g per day of an ensiled lucerne and timothy forage-mix (FiberEzy, Fiber Fresh Feeds Ltd., Reporoa, New Zealand). One week after the start of the study, when ewes had become habituated to the pelleted concentrate, the ensiled forage-mix offered was reduced to 400 g per day. Forage and pellet intakes were recorded daily. The ensiled forage and concentrate pellets were sampled four times during the experimental period, freeze-dried and then ground to pass through a 1 mm screen for chemical composition. Samples were weighed before and after freeze-drying to determine dry matter content.

2.2. Slaughter, carcass and non-carcass tissue measurements

On the day prior to slaughter, feed was withdrawn from the ewes for 18 h. On the day of slaughter the ewes had their live weight recorded. Ewes were stunned using captive bolt, exsanguinated, skinned, eviscerated and the head was separated from the carcass.

The head, skin, full gastrointestinal (GI) tract and hot carcass weight were recorded. The GI tract was emptied of its digestive contents and the empty GI tract was weighed, which allowed gut fill to be calculated. Total organ mass was weighed and then the liver with gall bladder attached, spleen, kidney, perirenal fat and omental fat dissected out and weighed individually. Eight ewes were randomly selected and the head and a skin sample (5 cm × 5 cm) from these ewes collected and frozen at −20 °C to provide an estimate of the chemical composition for the head and skin of all ewes.

Carcass length was measured along the spine following the curvature of the body from the first cervical vertebrae to the first sacral vertebrae. The hind leg length was measured as the distance along the lateral curvature of the leg from the distal end of the tarsal bone to the anterior edge of the aitch bone. The total soft tissue depth (GR), an indication of the fat content, was measured over the 12th rib, 110 mm from the midline.

The carcass was split down the midline and the left half of the carcass and all internal organs were frozen at −20 °C. The head from the eight randomly selected ewes and organs and half carcass from all ewes were minced so that the tissue passed through a 3 mm hole-plate. The minced tissue from the head, carcass and organs was sub-sampled and freeze-dried for chemical analysis. The skin samples (50 × 50 mm) were frozen, cut in small pieces (4 × 4 mm), freeze-dried and ground with a coffee grinder. Samples were weighed before and after freeze-drying to determine dry matter content.

2.3. Chemical analyses

The ensiled forage, pelleted concentrate feed, carcass, organ, head and skin samples were analysed for: dry matter by drying at 105 °C in a convection oven by the method 930.15 of the Association of Official Analytical Chemist (AOAC, 2005). Total dry matter in the feed and tissue samples was calculated by considering both the dry matter obtained from freeze drying and lab analysis of the freeze dried sample. Ash (inorganic matter) were determined by total combustion at 550 °C (AOAC, 2005; method 942.05) and total nitrogen determined by combustion (AOAC, 2005; method 968.06) using a Leco CNS 200 Analyser (Leco Corporation, St. Joseph, MI, USA). Crude protein was calculated from the nitrogen values by multiplying by a factor of 6.25.

In addition, the feeds were assayed for neutral detergent fibre (with heat stable amylase; NDF) and acid detergent fibre (ADF) following the method of Van Soest et al. (1991) and using the Tecator Fibretec System (AOAC, 2005; method 2002.04). In vitro dry matter digestibility (DMD) and organic matter digestibility (OMD) were measured on the feeds using the pepsin-cellulase method of Roughan and Holland (1977). The digestible organic matter in the dry matter (DOMD) was calculated from the organic matter percentage in the diet multiplied by the OMD. The metabolisable energy of the diets (MJ ME/kg DM) was calculated as DOMD × 0.163 (Roughan and Holland, 1977). The carcass, organ, head and skin were also analysed for their fat content using a Soxhlet ether extraction (AOAC, 2005; method 991.36).

2.4. Calculations for body composition

The empty body weight less blood (EBW) was calculated as the sum of the weight of the head, skin, carcass and organs. The weight of the blood was calculated as the difference between the live weight prior to slaughter and the EBW plus full GI tract.

The water, inorganic matter, protein and fat composition in the whole body was calculated as the sum of the water, ash, protein or