Analysis of ewe body condition scores from selected flocks in the North Island of New Zealand

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Abstract

Ewe body condition score (BCS) is known to be associated with many ewe production traits. Descriptive and multivariate analyses were undertaken on existing datasets comprising 266,405 BCS observations from 86,444 individual two-tooth and mixed-age ewes on six commercially managed sheep farms in the North Island of New Zealand. The BCS observations were collected at pre-breeding, pregnancy diagnosis, set-stocking and weaning between the years 2009-2021. Overall, the majority of BCS observations were 2.5 or 3.0 while 9.7% were BCS <2.5. At the key management times of pre-breeding and set-stocking, when it is recommended that ewes should be BCS 3.0 and above, 39% and 50% respectively of ewes were BCS <3.0. Mixed-age ewes had greater odds of being BCS <2.5 compared with two-tooth ewes, but with variation between BCS observation time, farm and year. While these data are from only six farms, if they are indicative of other North Island sheep farms they demonstrate significant room for improvement in individual ewe BCS for optimal production.

Keywords: sheep; ewe; body condition score; production; welfare

Introduction

Body condition score (BCS) is a standardised assessment of the amount of soft tissue, in the lumbar region, predominantly fat and muscle, that was first described in sheep in the 1960's (Jefferies 1961). It is considered a more useful management tool than live weight to determine the nutritional status and level of body reserves of an animal, as it is not influenced by factors such as skeletal size, breed, gut-fill, fleece weight, fleece saturation and physiological state (Kenyon et al. 2014). BCS in sheep is assessed on a scale of 0 or 1 (extremely emaciated and on the point of death) to 5 (obese) and is usually scored to the nearest 0.5 (Kenyon et al. 2014).

It is well established that BCS is positively associated with many mature ewe production traits including reproductive performance, milk production and lamb growth rates (see review Kenyon et al. 2014), and negatively associated with premature culling and death rates (Flay et al. 2021; 2022). While there is variation in the outcomes from the various studies, as a generalisation BCS shows a curvilinear association with production traits in mature ewes, such that there is a relatively large increase in production as BCS increases from 2.0 to 2.5, a lesser increase in production from BCS 2.5 to 3.0 and then a small to no further gain in production from BCS 3.0-4.0, i.e. it plateaus (Kenyon et al. 2014). Further, Morel et al. (2016) showed that as BCS increases the nutritional requirements for a further increase in BCS was likely prohibitive from a production return per kilogram of feed eaten perspective. That finding, combined with the curvilinear relationship, has resulted in a recommendation, that for optimum flock production, individual ewes should be in a minimum BCS of 2.5 and ideally all ewes within the flock should ideally be in the BCS 3-3.5 range at key times of year such as prior to mating and prior to lambing (Kenyon et al. 2014).

Despite the pre-mentioned plethora of data on the association between BCS and production traits (Kenyon et al. 2014), and education targeted at farmers to promote use of BCS as a flock management tool, it is a tool that appears to be generally under-utilised within the New Zealand sheep industry (Corner-Thomas et al. 2016; Flay et al. 2022). Sheep BCS is also recognised as an indicator of animal welfare (Phythian et al. 2011) and has been trialled as part of welfare assessment on sheep farms in Australia (Doughty et al. 2017; Munoz et al. 2018). The New Zealand Code of Welfare for Sheep and Beef Cattle Minimum Standard 5d states that "If any sheep shows signs of being very thin, or if the body condition score of any sheep falls to 1.0 (on a scale of 0 to 5), urgent remedial action mut be taken to improve condition or the animal must be destroyed humanely" (Anon, 2018).

Interestingly there appears to be no published data describing the 'typical' or expected range of BCS found under commercially managed scenarios in New Zealand sheep flocks, with the available data from either a specific research study or, in the few studies that have reported commercial data, means and standard errors only have been presented (Everett-Hincks et al. 2013; Kenyon et al. 2014). Knowledge of BCS ranges and means under commercial conditions would allow for estimation of the potential economic loss to the New Zealand sheep industry due to below-optimal ewe BCS at key production times. It would also allow targeted research and extension programmes to address any potential industry wide issues. Therefore, the objectives of this study were to provide a descriptive analysis of BCS ranges on commercially farmed ewes in the North Island of New Zealand and to investigate odds of low BCS based on ewe age, BCS observation time, farm and year.

Materials and methods

Farms and animals

BCS data from individual ewes were extracted from existing datasets collected by researchers between the years of 2009-2021 inclusive, from six sheep farms in the North Island of New Zealand (Table 1). Farms A, B and C are both commercial and research farms owned by Massey University with Farm A and B located in the Manawatu region and Farm C located in the Wairarapa region. Data were collected as described below from all two-tooth ewes (starting from pre-breeding at approximately 19 months of age) and mixed-age ewes present on each farm, for the years shown in Table 1. Farms D, E and F are commercial properties located in the Waikato (Farm D) and Wairarapa (Farms E and F) regions (Table 1) and have been previously described by Flay et al. (2021) and Capdevila-Ospina et al. (2021). On these farms data were collected three to four times per year, as described below, from the 2010-born cohort (Farm D only), the 2011-born cohort (Farms D and E) and the 2014-born cohort (Farm F) and these cohorts were followed throughout their lives to a maximum of six years of age (Flay et al. 2021). The data included in this analysis is that from the age of two-tooth (starting from pre-breeding at approximately 19 months of age) until removal from the flock. In addition, data was also collected from the 2018-born cohort on Farm D for 21-months, from pre-breeding as two-tooths until weaning as four-tooths at approximately 40 months of age (Capdevila-Ospina et al. 2021). Ewe breeds were Romney (Farms A, B, C, E, F) or Coopworth-cross (Farm D) and they were farmed under commercial conditions, outdoors on a solely pasture-based diet with lambing occurring once per year in the spring.

On each farm, BCS of each ewe was undertaken by a trained operator three to four times per year at key management times: pre-breeding (in autumn), pregnancy diagnosis (in winter), at set-stocking (approximately two weeks prior to planned start of lambing, in early spring) and at weaning (in early summer). All BCS observations were undertaken by one of five trained assessors and in general the same assessor did all BCS on an individual farm. While the assessors worked together and checked each other's BCS for alignment on an *ad hoc* basis, there was no formal assessment of inter- and intra-assessor variability in BCS.

All ewes were individually identified with electronic tags and BCS data were entered into a data-logger at the time and then later downloaded into Excel spreadsheets. On each farm ewes were run in mobs and data were collated such that for each farm, in each year individual ewes within each mob had one to four BCS observations (i.e. one to four BCS observations at pre-breeding, pregnancy diagnosis, set-stocking and weaning). BCS data were collected from a total of 86,444 individual ewes (22,238 two-tooth ewes and 64,206 mixed-age ewes; Table 1) resulting in a total of 266,405 BCS observations (73,929 observations from two-tooth ewes and 192,476 observations from mixed-age ewes).

Data analysis

For multi-variate analysis two ewe age groups were formed: two-tooth (from pre-breeding at approximately 19 months of age until approximately 27 months of age) and mixed-age (from pre-breeding as four-tooths at approximately 30 months age and older). Additionally, two ewe BCS categories were formed: –BCS <2.5 and BCS ≥2.5.

A Mantel-Haenszel analysis method was used to estimate the odds ratio (OR) of a mixed age ewe being classed as BCS <2.5 at a BCS observation time compared to a two-tooth ewe, stratifying separately by period, farm, and year. The Mantel-Haenszel OR is a method of estimating the strength of an association between an exposure and an outcome, after adjusting for a confounding variable e.g., period, flock or year, through stratification. The Woolf-test is used to test for the homogeneity of the odds ratios across the stratification levels, if this is not significant then an adjusted Mantel-Haenszel odds ratio is used to summarise the association between the exposure and outcome. However, if the Woolf-test is significant then this indicates that there is an interaction between the exposure variable and the stratifying variable, and so the stratum specific odds ratios are presented instead of an adjusted measure. Mantel-Haenszel estimators provide a method of getting meaningful summary statistics from observational studies where randomisation has not been possible. The analysis was undertaken using the epiDisplay package in R (Virasakdi Chongsuvivatwong 2022).

Table 1 Number of individual ewes from which body condition score observations were collected at pre-breeding (autumn), pregnancy diagnosis (winter), set-stocking (early spring) and/or weaning (early summer), from six sheep farms in the North Island of New Zealand between the years 2009-2021.

Flock	Location	Years data available for	Two-tooth ewes	Mixed-age ewes
A	Manawatu	2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021	1,006	4,437
B	Manawatu	2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021	4,622	11,315
C	Wairarapa	2009, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021	4,577	27,558
D	Waikato	2012, 2013, 2014, 2015, 2016, 2019, 2020	6,968	11,771
E	Wairarapa	2012, 2013, 2014, 2015, 2016	3,684	8,535
F	Wairarapa	2016, 2017	1,381	590
Total			22,238	64,206

Results

In both two-tooth and mixed-age ewes, at all BCS observation times, the majority of observations were BCS 2.5 or 3.0 (Fig. 1, 2). A total of 25,748 of the 266,405 BCS observations (9.7%) were categorised as BCS <2.5, and the majority of these were BCS 2.0. BCS 1.0 or 1.5 were recorded infrequently, comprising only 252 (0.1%) and 2595 (1.1%) of the 266,405 BCS observations, respectively.

At pre-breeding and set-stocking approximately 39% and 50% of BCS observations were BCS <3.0, respectively (Figs. 1, 2).

Multivariate analysis

The overall odds of a mixed-age ewe being categorised as BCS <2.5 was 1.22 times higher than that of a two-tooth ewe (OR 1.22, 95% CI, 1.18-1.26). For BCS observation time, farm and year the test for homogeneity was significant (P<0.001), indicating that the odds of a mixed-age ewe compared to a two-tooth ewe being classified as BCS <2.5 differed for all of these variables.

At pre-breeding, pregnancy testing and set stocking the odds of a mixed-age ewe being categorised as BCS <2.5 were 1.49 (95% CI, 1.4-1.59), 1.09 (95% CI, 1.03-1.15), 1.46 (95% CI, 1.37-1.56) times that of a two-tooth ewe, respectively. However, there was no difference in the odds of being BCS <2.5 at weaning for mixed age and 2-tooth ewes (P=0.27).

For farms A and B, the odds of a mixed-age ewe being categorised as BCS <2.5 were 2.38 (95% CI, 2.02-2.82) and 2.02 (95% CI, 1.89-2.16) times that of a two-tooth ewe, respectively. For farms D, E and F the odds of a mixed-age ewe being categorised as BCS <2.5 were 0.69 (95% CI, 0.65-0.74), 0.89 (95% CI, 0.82-0.97) and 0.32 (95% CI, 0.19-0.52) times that of a two-tooth ewe, respectively. On farm C there was no difference (P=0.47).

Figure 1 Distribution of body condition scores for 22,238 two-tooth ewes at a. pre-breeding; b. pregnancy diagnosis; c. set-stocking; d. weaning on six sheep farms in the North Island of New Zealand over two to ten years.

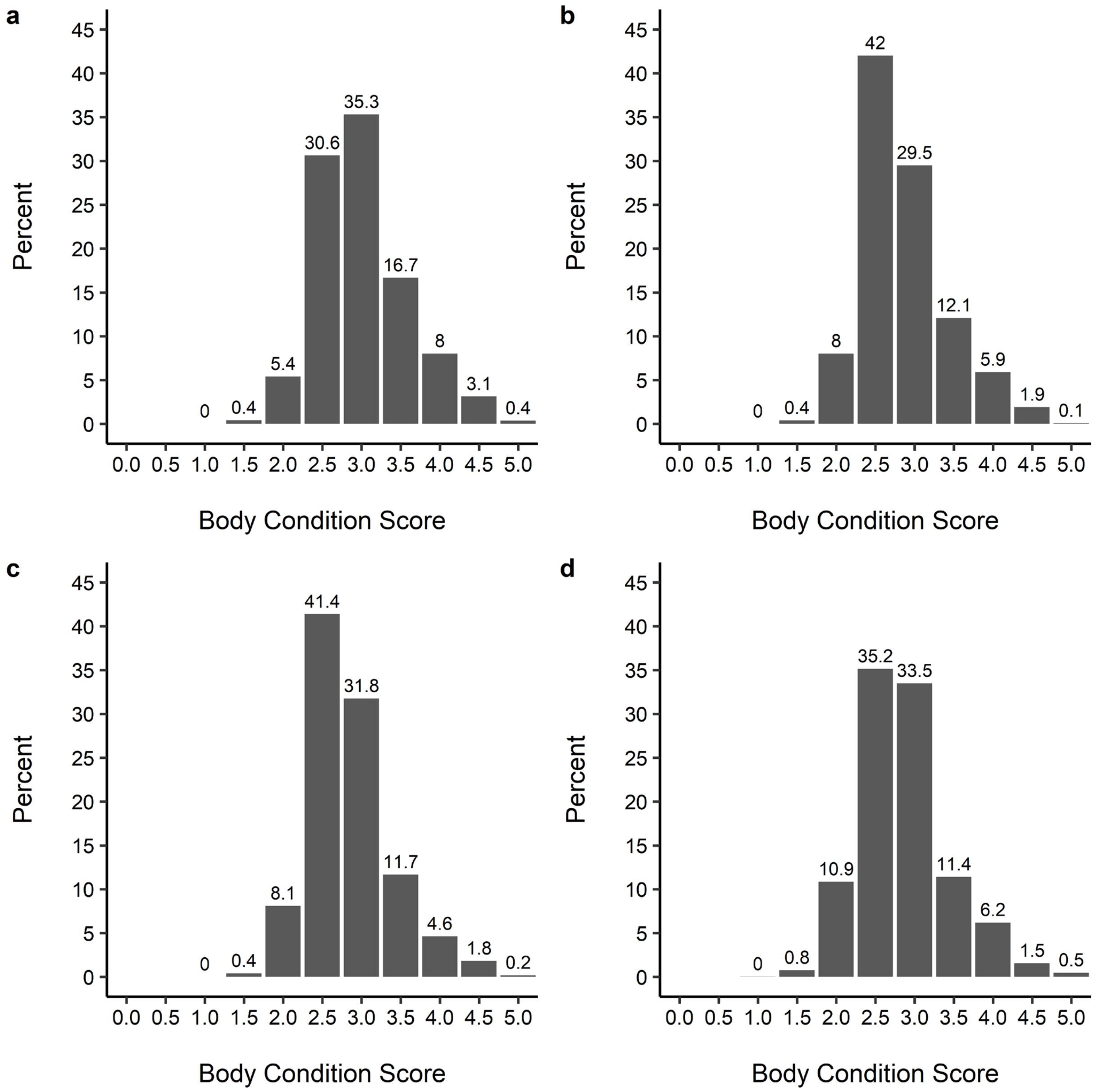
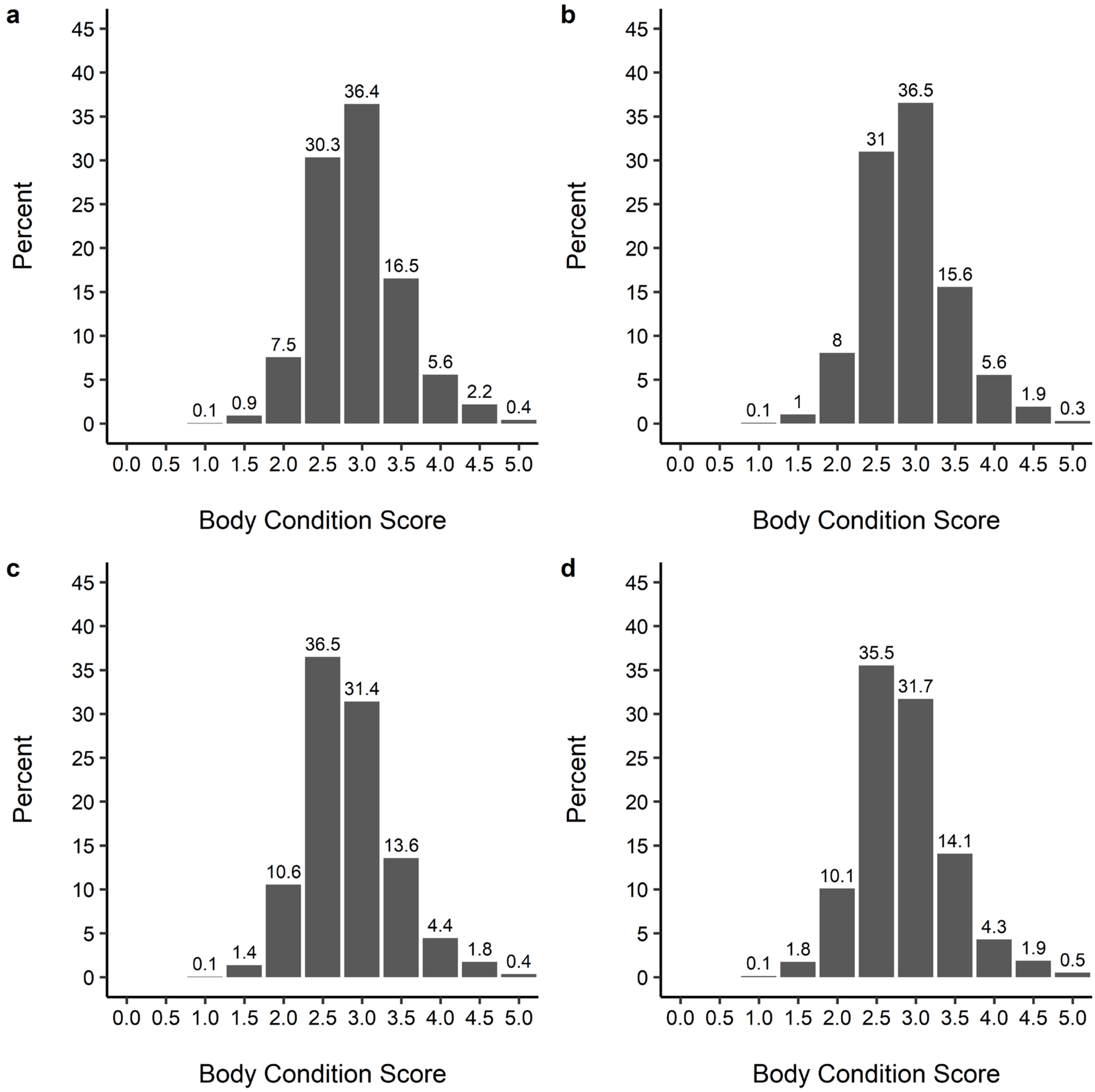


Figure 2 Distribution of body condition scores for 64,206 mixed-age ewes at a. pre-breeding; b. pregnancy diagnosis; c. set-stocking; d. weaning on six sheep farms in the North Island of New Zealand over two to ten years.



Discussion

This study describes the distribution of BCS within ewe flocks at key management times. To optimise production Kenyon et al. (2014) has recommended that individual ewes should be BCS 2.5 or greater at key management times (pre-breeding, during pregnancy and prior to lambing) and data from the present study shows that the vast majority of observations fitted those criteria at these times. Further, the New Zealand Code of Welfare for Sheep and Beef Cattle specifies that if sheep are BCS 1.0 or below then immediate action or euthanasia are required (Anon, 2018). In this dataset only 0.1% of BCS observations were 1.0, suggesting that it is rare to have ewes at this very low BCS. Additionally, only 1.1% of observations were BCS 1.5. Therefore, it could be suggested that from a nutritional perspective on these six farms the vast majority of ewes were well managed.

However, it has also been stated that ewes should preferably be BCS 3-3.5 at pre-breeding and set-stocking to maximise performance (Kenyon et al. 2014), whereas in this study approximately 39-50% were BCS <3.0 at these key times. Additionally, 9.7% of total BCS observations were BCS <2.5 and significant production losses would be expected in individual ewes at these low BCSs. Assuming these data are indicative of other North Island sheep farms, they demonstrate significant room for improvement in individual ewe BCS for optimal production. Rectifying this would require BCS of all individual ewes to identify those in low BCS and appropriate management of these to gain condition prior to the key management event. For Romney ewes an additional 220MJ of energy above the maintenance energy requirement is required to increase BCS from 2.0 to 3.0 (Morel et al. 2016), thus depending on the feed quantity and quality offered to ewes it would be expected to take weeks to achieve this. From a total flock feed intake perspective, targeted feeding of ewes in low BCS is the most efficient approach rather than feeding all ewes to gain BCS (Kenyon et al. 2014).

Overall, as might be expected, mixed-age ewes had higher odds of being categorised as BCS <2.5 compared with two-tooth ewes. On many North Island sheep farms the two-tooth ewes are kept as a separate mob and preferentially fed and in this study the two-tooth ewes on all farms were kept separate until approximately 27 months of age. However, the odds varied by BCS observation time, farm and year and on three of the farms the two-tooth ewes had higher odds of being thin compared with mixed-age ewes. This indicates room for improvement in the nutritional management of two-tooth ewes, particularly as Romney ewes of this age are still growing (Semakula et al. 2020).

The data presented are from only six farms in the North Island of New Zealand and due to the farms' involvement in research it is possible that their management differed from 'typical' New Zealand sheep farms. Hence it is not possible to extrapolate the findings to all North Island sheep farms. However, it comprises a large dataset with over a quarter of a million BCS observations collected four times a year across a number of years. In common with the majority of North Island sheep farms, the ewes were fed entirely on pasture so variation in weather conditions between years and seasons will have impacted on their nutrition and BCS. Additionally, the research on Farms D, E and F consisted of observational ewe wastage studies only, that required no changes to the usual farm practices (Flay et al. 2021; Capdevila-Ospina et al. 2021), while on Farms A, B and C the ewes were only occasionally involved in research studies. Therefore, while the findings cannot be extrapolated to all sheep farms, they are likely to be a reasonable approximation of North Island flocks.

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