

Understanding physiological drivers of resilience in sheep

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Abstract

Grazing sheep undergo seasonal variation in body condition due to changes in pasture growth and nutrient availability. Anecdotal evidence from producers suggests that during these times, individual variation exists in 'resilience' to these sub-optimal conditions. These 'resilient' individuals are able to maintain health and productivity whilst flock mates are unable to. There is little empirical evidence to verify these claims, yet they resound from producers in a wide range of production environments. The aim of this doctorate study was to define 'resilience' in sheep under sub-optimal nutrition, and investigate the physiological causes of variation in the trait.

Three mechanisms to facilitate 'resilience' were proposed, namely that resilient sheep a) commenced the period of nutritional stress in better condition, B) have greater energy intake, or C) have lower energy expenditure when under sub-optimal nutrition. Two separate experiments were conducted to investigate these hypotheses under indoor and outdoor environments. From the results of both experiments, average daily weight gain (ADG) was the most appropriate measure of 'resilience', as it encapsulated hard to measure changes in adipose tissue depots, muscle and organ mass.

Investigation of the effect of body condition and weight on subsequent response to sub-optimal nutrition (Mechanism A), revealed that a sheep's initial body condition did not dictate 'resilience' to the nutritional treatment. This implies that although body reserves can serve as a useful energy reservoir, differences in efficiency do exist.

Investigating the role of feed intake (Mechanism B), revealed a 1.4kg range in voluntary feed intake, which was associated with a 25% range in energy digestibility. As a result of these two factors, daily digestible energy intake accounted for 48.3% of the variance in ADG measured.

In the evaluation of Mechanism B, the use of heart rate (HR) and oxygen pulse (Oxygen uptake per heartbeat) measures to calculate energy expenditure was evaluated. Sixty eight and 92% of the variance in oxygen consumption could be accounted for in experiments 1 and 2 respectively. Body weight, individual sheep differences and the measurement environment all contributed significantly to the variance but most importantly, HR only had a small effect, thus implying that it can be used to oxygen consumption in the field for a given individual. The use of external logging devices to record HR of sheep whilst grazing was then evaluated in experiment 2. A combination of animal movement, rubbing activity, dust accumulation and lanolin and suint content of the fleece and skin between the electrodes and skin contributed to difficulties in measurement. As a result no continuous long term measures of HR were possible. These difficulties may explain the lack of published literature on the use of the monitors in sheep when compared to those using cattle and goats as experimental subjects. Future attempts to use HR as a proxy for energy expenditure in sheep will require novel methods of logging HR which avoid these constraints. No measures of energy expenditure or thyroid hormone activity were correlated with resilience in this study.

Under the *ad libitum* low quality feeding regime implemented in experiment 2, the gross digestible energy intake consumed had the greatest effect on average daily weight gain (ADG) or 'resilience' to nutritional stress. Whether these differences were due to differences in appetite control or rumen microbe populations could not be determined in this study. Further investigation into the causes of individual variation in digestible energy intake and appropriate means of selection is warranted.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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