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Review

Measures of behavioural reactivity and their relationships with production traits in sheep: A review

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ABSTRACT

This paper defines the concept of temperament and discusses the use of behavioural reactivity testing in sheep. The range of behavioural tests used in sheep are categorised and the aspects of behaviour reflected by each type of test discussed. The activation of nervous and endocrine pathways is reviewed as the underlying physiological basis of behaviour. Factors that affect behavioural reactivity are described, and the relationships between reactivity and productivity examined. There is some evidence that behavioural reactivity has an economic impact on sheep production in regards to growth and maternal traits. As in cattle, intensive training appears not to have any significant effect on behavioural reactivity in the long term. Although few measures of heritability of behavioural reactivity have been made in sheep, those tests which have been assessed exhibit moderate heritability and thus behavioural reactivity should respond to selection. Selection on reactivity may be useful where it is related to traits that are not highly heritable or difficult to measure, and additionally to improve ease of handling and welfare of the sheep. Before behavioural reactivity can be effectively used as a selection criterion, further work must be done to investigate the nature and magnitude of these relationships. A standardised scoring system for temperament must also be established to allow comparisons across breeds and production systems.

Contents

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1. Introduction

The concept of temperament is a hypothetical tool used to understand behaviour. This concept can be defined on three levels. The most common of these is surface behaviour, an individual's behavioural response to stress (Bates et al., 1995; Burrow, 1997). Underlying this, temperament is the pattern of neuro-endocrine system responses to stress. At the third level, temperament is defined as an animal's inherent potential to respond in a particular way to a stressful stimulus. Inherent temperament is determined by genetic and permanent environmental effects such as early life experience and does not change over time, but its expression is influenced by the animal's temporary environment (Bates et al., 1995) and physiological status (Viérin and Bouissou, 2001). The expression of temperament in an animal is its behavioural reactivity, and this is the trait which researchers aim to measure.

Highly reactive livestock have reduced productivity (decreased growth rates, etc.) and increased costs of production compared to less reactive stock in the same conditions (more feed required, greater incidence of illness) (Burrow, 1997). Animals which are highly reactive to humans and handling are poorly adapted to their captive environment and experience a great deal of stress, reducing their level of welfare (Bickell et al., 2009). Veissier and Boissy (2007) suggest that good welfare and stress, or poor welfare, exist on a continuum whereby in a state of good welfare an animal can adapt to its environment to maintain homeostasis with minimal effort and in a state of poor welfare the animal fails to adapt and suffers. Increasingly, animal welfare considerations are also important in livestock enterprises, with greater consumer focus on this than ever before (Colditz et al., 2006). Management practices are being reviewed and modified to reduce stress on farm animals, and pharmacological means of stress management are being investigated. However, another option is to improve the ability of livestock to cope with handling procedures. This may be achieved genetically, through selection of stock with good temperament and environmentally by positive handling and training programs for the stock.

The purpose of this review is to summarise existing methods for measuring behavioural reactivity in sheep, and to investigate factors which may modify behavioural responses. The relationships between sheep behaviour and production will also be explored, and the possibility of using temperament as a selection trait assessed.

2. Physiological basis of behaviour

The way an animal reacts behaviourally to a stressful stimulus is controlled by underlying physiological cues, including activation of endocrine and nervous pathways and changes in hormone secretion (Bates et al., 1995). The perception of the level of control that the animal has when presented with a stimulus alters the patterns of neuro-endocrine activation, as shown in Fig. 1 (Henry, 1992). The defence response is activated when the animal is challenged but perceives control of the situation. In this circumstance the animal adopts an active response, and may display aggression or attempt to escape. As the level of effort required to maintain control increases, the animal moves to a state of striving and the endocrine profile alters. With loss of control and the perception of helplessness, the animal shifts to a passive coping response, with an emphasis on self preservation and a loss of sexual and maternal drives (Henry, 1992).

During acute stress, an immediate behavioural or short-term physiological response from the animal is needed to avoid negative consequences (Moberg, 2000). Kilgour and de Langden (1970) classify any situation in which the animal is secreting adrenocorticotrophic hormone (ACTH) as stressful, with the severity of stress determined by the slope of the decline of cortisol to basal levels after its peak 30–40 min after the onset of the stressful stimulus. Elevation of glucocorticoids in the blood can only be detected after a delay of a few minutes from the onset of a stressful stimulus, and this response can be maintained for around an hour after the termination of the event (Mormède et al., 2007). Glucocorticoid (cortisol) and catecholamine (epinephrine and nor-epinephrine) production can be used to monitor the physiological response to stress, and differences are seen between individual animals in regards to latency to production and peak levels (Kilgour and de Langden, 1970). This results in behavioural differences between animals, but the collection of plasma samples to measure circulating glucocorticoids and catecholamines will often elicit a stress response, confounding the result (Coburn et al., 2010). Faecal samples are used in a variety of species, as collection is non-invasive, to monitor glucocorticoid metabolites but it is not yet possible to identify specific metabolites and thus absolute levels should be treated with caution and are not comparable across studies (Coburn et al., 2010). Detection of cortisol peaks due to short term stress requires frequent faecal sample collection as metabolites are only present in faeces excreted over a short period (Möstl and Palme, 2002). The timing of