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Flight speed and agitation in weaned lambs: Genetic and non-genetic effects and relationships with carcass quality

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ABSTRACT

By identifying sheep with a genetic or environmentally-induced propensity for higher responses to stress, it is possible to manage or select against those sheep to improve the welfare and ease of handling of the entire flock. Previous studies have reported variable estimates of heritability and non-genetic influences on flight speed and agitation, two measures of behavioural reactivity used in Australian sheep research. While the relationships between these tests and a number of aspects of productivity, including maternal performance, wool and milk production and fattening performance, have been assessed, no such investigation has been made of relationships with carcass quality.

This study investigated the 2008–2010 cohorts of the Information Nucleus. Eight flocks totalling 11,047 lambs were tested. Flight speed and agitation were measured at 2–6 weeks post-weaning. Lambs were slaughtered between 5 and 14 months of age, with kill dates staggered to reach target carcass weights of 21 kg.

Low to moderate heritabilities of flight speed (0.11 ± 0.02) and agitation (0.19 ± 0.02) indicate that while there is an inherent component to behaviour as measured in these tests, that component is small. Phenotypic and genetic correlations between flight speed and agitation were low (0.06 ± 0.01 and 0.20 ± 0.10 respectively).

Heavier and female lambs were more reactive in both behavioural tests than lighter and male lambs. First cross terminal breed × Merino type lambs were faster in the flight speed test than other types. In one flock, younger lambs were more reactive in the agitation test. The two behavioural traits varied independently within flocks such that flocks with high average flight speeds did not necessarily also have high average agitation scores.

Phenotypic and environmental correlations between behaviours (flight speed and agitation) and carcass traits were very weak or non-significant, indicating that stress responses measured during handling shortly after weaning may not be relevant to stress responses at slaughter several months later. Genetic correlations were mostly non-significant or weak, suggesting that selection based on improving behavioural reactivity of lambs should have little to no impact on carcass quality.

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1. Introduction

Behavioural reactivity is an animal's behavioural response to stress. This is underlain by a pattern of neuro-endocrine system responses which may be controlled by genetics, and permanent and temporary environmental effects (Dodd et al., 2012). By identifying sheep with a

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genetic or environmentally-induced propensity to react negatively to stress, it is possible to manage those sheep to minimise stress, or to select against them during breeding to improve the welfare and ease of handling of the entire flock (Burrow, 1997).

Agitation and flight speed are objective behavioural tests which have been used in Australian sheep research. Previous work has revealed variable effects of breed, sex and liveweight on these tests (Blache and Ferguson, 2005; Pajor et al., 2008). These studies have found no significant effects of birth and rearing type, lamb age or faecal worm egg counts on agitation and flight speed (Blache and Ferguson, 2005; Newton et al., 2011; Pajor et al., 2008). Heritability estimates for flight speed range from 0.07 ± 0.02 to 0.21 ± 0.04 and those for agitation from 0.16 ± 0.03 to 0.21 ± 0.05 (Blache and Ferguson, 2005; Hocking Edwards et al., 2011; Newton et al., 2011; Plush et al., 2011). Genetic correlations between the flight speed and agitation are consistently reported to be weak with high standard errors, ranging from 0.20 ± 0.26 to 0.26 ± 0.23 (Hocking Edwards et al., 2011; Newton et al., 2011; Plush et al., 2011). The variability of reported effects on flight speed and agitation and of heritability estimates highlights an existing gap in our understanding of these behavioural traits. It is important that these aspects are well understood if these traits are to be useful in identifying elevated levels of stress in sheep.

In selecting sheep based on behavioural reactivity it is also important that the subsequent impact on other aspects of productivity is understood. Previous studies using flight speed and agitation have found weak or no relationships between these tests and maternal performance (Hocking Edwards et al., 2011; Murphy et al., 1994; Plush et al., 2011), wool production (Plush et al., 2011) and milk production (Murray et al., 2009), and variable relationships to fattening performance and feed efficiency (Amdi et al., 2010; Pajor et al., 2008). No assessment has yet been made regarding the relationship between flight speed, agitation and carcass quality traits in lambs. Studies in cattle have found significant relationships between behavioural reactivity and many aspects of carcass quality, including carcass weight, fatness, muscling, pH decline, ultimate pH, marbling, cooking loss (Cafe et al., 2011), meat colour (Cafe et al., 2011; Kadel et al., 2006), tenderness (Cafe et al., 2011; Fordyce et al., 1988; Kadel et al., 2006) and bruising (Fordyce et al., 1988).

This paper presents heritability estimates for flight speed and agitation and assesses the impact of non-genetic factors on these behavioural measures. Correlations between flight speed, agitation and a range of carcass quality traits are evaluated in a dataset containing 11,039 lambs born between 2008 and 2010 from eight flocks around Australia.

2. Methods

2.1. Animals

This study investigated the 2008–2010 cohorts of the Cooperative Research Centre for Sheep Industry Innovation's "Information Nucleus" lambs. The Information Nucleus is a series of eight flocks located around Australia at key sites to cover the full spectrum of sheep production environments. These flocks utilise Merino (Merino and Poll Merino), Maternal (Border Leicester, Corriedale, Bond, Booroola, Prime SAMM, Dohne Merino, Dorper and White Dorper) and Terminal (Poll Dorset, Suffolk, White Suffolk, Southdown, Texel and Ile de France) breed types. One hundred key industry sires are mated each year by artificial insemination to approximately 4500 Merino and Maternal Merino crossbred ewes to produce Merino, Maternal Merino, Terminal Merino and Terminal × Maternal Merino progeny. Sires are mated across the flocks to evaluate genetic by environmental interactions. The progeny are evaluated for a wide range of growth, carcass, meat, wool, reproduction and parasite resistance traits. The full structure of this flock has been described by Fogarty et al. (2007) and van der Werf et al. (2010).

2.2. Measurements

Lambs were weaned at 12–13 weeks of age. Flight speed and agitation were measured on lambs at 2–6 weeks after weaning. Prior to the measurement, lambs were handled by humans no more than four times (birth, marking, weaning and one other instance for husbandry purposes). Flight speed is the average speed at which a lamb crosses a 1.7 m distance. Flight time is measured using infra-red start and stop beams set 1.7 m apart and attached to a timer. This time is then divided by distance to yield flight speed. Flight speed is measured as the lamb exits the weigh crate of its own accord, without coaxing from handlers.

Agitation is measured using an isolation test. The lamb is restrained within a fully enclosed box with dimensions 1.5 m × 0.7 m × 1.5 m. The number of vibrations caused by movement and vocalisation of the lamb over 30 s are measured using an agitation meter. The agitation meter is calibrated using a standard "electro-sheep" (Plush et al., 2011). During both flight speed and agitation testing, external noises are minimized and no dogs are permitted near the sheep to reduce the impact of these stressors on the behaviour of the sheep.

2.3. Data

In 2008 a total of 3991 lambs were measured, with 3834 lambs in 2009, and 3214 lambs in 2010. Records for each of these animals included behavioural measures, weights and demographics such as age, sire and dam breeds, management group, flock and year of birth (Table 1). Across the three years approximately equal numbers of male (5599) and female (5440) lambs were measured. Lambs represented the full range of birth and rearing types (Table 2). A pedigree was available with up to three generations of data plus source genetic groups for most animals.

Lambs were slaughtered between 5 and 14 months of age, with kill dates staggered to reach target carcass weights of 21 kg. On the day prior to slaughter, lambs were weighed after a 6–18 h feed and water curfew and transported to abattoir lairage. Carcasses were electrically stimulated; details of the stimulation systems at each of the five abattoirs at which lambs were slaughtered are

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