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Determinants of cashmere production: The contribution of fleece measurements and animal growth on farms

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Abstract

To identify fleece and animal growth characteristics that are associated with cashmere production, the magnitude and direction of factors affecting cashmere production using fleece and live body weight measurements available to the cashmere producer were modelled. Data was collected from 11 Australian commercial cashmere farms. Following log transformation of clean cashmere weight, the best general linear model for predicting clean cashmere weight included: farm, mean fibre diameter, fibre diameter standard deviation, cashmere fibre curvature and fibre curvature standard deviation, cashmere staple length, clean washing yield, live body weight, live body weight change, and interactions between these parameters. The best general linear model did not include variables for age and sex cohorts. The variance accounted for was 67.6%. The residual standard deviation was 0.115. A majority of the variation regarding clean cashmere production (58%) was related to farm, staple length and mean fibre diameter. To obtain an understanding of how the responses of clean cashmere weight to fleece and growth measurements varied with farm, regression coefficients in the general linear model were modelled as possibly correlated random effects, using REML mixed model analysis. On a typical farm, greater clean cashmere weight was associated with longer staple length, greater mean fibre diameter, greater fibre diameter standard deviation, greater fibre curvature, greater fibre curvature standard deviation and greater live body weight. Farms recorded responses varying from negative to positive for washing yield and live body weight change. It was concluded that fleece characteristics and animal growth (but not age and sex) are primary determinants of cashmere production. However, the way these characteristics affect cashmere production varies from farm to farm.

Keywords: Cashmere; Fibre diameter; Staple length; Farm; Fibre curvature; Variation

1. Introduction

The Australian cashmere industry was established in the late 1970s following the discovery of cashmere on feral goats (Anonymous, 1981). Since then genetic and certain environmental factors impacting on the production and quality of Australian cashmere have been evaluated at research institutes (Holst, 1990; McGregor, 1990; Restall and Pattie, 1991; McGregor and Couchman, 1992; McGregor, 1998). There has however been little cashmere production research since that time (Anonymous, 2001). In Australia, only a few studies regarding the productivity of commercially managed cashmere goats have been published (Couchman and McGregor, 1983; Couchman, 1984; McGregor, 1997). Recently, it has been shown that cashmere production from commercial farms in Australia has not increased

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substantially over the past 25 years (McGregor and Butler, 2008a).

Since 1989, however there has been widespread culling of cashmere goats in response to decreasing prices, a focus on higher quality fleeces, in particular reduced mean fibre diameter, and the use of more accessible and cheaper objective fleece testing services following the commercialisation of OFDA100 and Laserscan computer-operated fibre testing technology. The new fleece testing technology provides objective measurement of certain important attributes of animal fibres that until recently were known to be important but not feasibly measured. So, for example, Martindale (1945) demonstrated that fibre diameter variation affected processing performance of wool. However the cost of measuring this attribute was prohibitive until computer aided laboratory equipment was developed. While the heritability of cashmere production attributes has been known for some years (Bigham, 1990), and indexes have been developed for the selection of cashmere goats (Pattie and Restall, 1991) there has been little application of these indexes. The development of these indexes predates the widespread availability of objectively measured cashmere fibre attributes such as fibre diameter variability and fibre curvature.

The impact of farm, age and sex on cashmere production and fleece attributes have only recently been quantified for Australian cashmere goats, as these factors are generally the only information available to farmers attending animal sales on or off farms (McGregor and Butler, 2008a). It was found that within individual farms, cashmere production generally increased with age of the animal, as seen with Inner Mongolian Albas goats (Zhou et al., 2003), but the sex of the goats had no effect. This study investigates the fleece characteristics and animal growth determinants of cashmere production within and between farms, and whether these determinants can explain the age effects.

2. Materials and methods

2.1. General management

Cashmere goats from 11 farms in 4 different States of Australia (McGregor and Butler, 2008a) were monitored for live body weight (LW; kg) each month (December 2002–June 2003 – just prior to shearing), although some producers were unable to weigh each month (e.g. during mating in autumn). Generally all goats in the flocks were monitored but in some larger flocks 10 randomly selected does from a range of age groups or all their 15-month-old does were monitored. Age at shearing (years) was used as a quantitative variate. Live body weight change (LWC; kg) was determined as the difference between the first (initial LW) and last live body weight recorded – the most general being: January live body weight – June live body weight. At shearing, greasy fleece weight (g) was measured and fleeces were grid sampled (McGregor, 1994; Anonymous, 2001). Cashmere fibre staple length (SL) was measured after shearing to the nearest 0.5 cm using a ruler (McGregor and Butler, 2008a,b). Shearing at different farms occurred between 31st May and 7th August.

2.2. Fibre testing

Fleece samples were sent to a commercial fibre-testing laboratory. Following aqueous scouring to determine the clean washing yield (CWY, %, w/w, IWTO-19, 1995) all samples were mini-cored twice, conditioned and for each sub-sample over 6000 counts recorded, using the optical fibre diameter analyser OFDA100 (IWTO-47, 2002) and the average diameter determined. Measurements recorded were mean fibre diameter (MFD; μm), fibre diameter standard deviation (FDSD; μm), fibre curvature (FC; °/mm) and fibre curvature standard deviation (FCSD; °/mm), using a fibre diameter cut-off of 35 μm for cashmere. Clean cashmere yield (CCMyld, %, w/w) was determined as: CWY × OFDA100 cashmere yield (%, w/w, determined using fibre diameter profiles) (Peterson and Gheradi, 1996). Clean cashmere production (CCMwt, g) was determined as: greasy fleece weight × CCMyld.

2.3. Statistical analysis

The final database for fibre attributes ($n = 1244$) included wethers from 4 farms ($n = 98$). A preliminary model was developed as a general linear model with normal errors to determine the relationship between the logarithm of clean cashmere production and any other potential determinant (Payne, 2005). The best model was developed with terms being added or rejected on the basis of *F*-tests. This model included additive linear responses to MFD, FDSD, FC, FCSD, SL, CWY and LWC that differed with the farm. A further model for clean cashmere production was then developed using restricted maximum likelihood (REML) mixed model analysis (Payne, 2005), by replacing the between farm component of the responses to MFD, FDSD, FC, FCSD, SL, CWY and LWC with (possibly correlated) random effects, but leaving the remaining effects from the general linear model as fixed effects. Terms were included or rejected on the basis of a change in deviance test. This allowed a systematic examination of the between farm component responses to MFD, FDSD, FC, FCSD, SL, CWY and LWC. The REML model had 3 outliers deleted that were included in the general linear model. The observational unit for the analysis was an individual goat.

It was necessary to use random coefficient regression (i.e. REML) models, so that the within farm relationship of cashmere production with fleece attributes and animal growth on a farm population basis could be determined. If only models with fixed effect regression coefficients (the next simplest type of analysis were used), then the results would only apply to