Estimation of Operator Measurement Bias and Precision from an Animal Production Training Exercise

Department of Agriculture

Introduction

Accurate and consistent assessment of the condition score (CS) of flocks of Merino ewes is a critical activity in a national project. Condition scoring is a manual technique for estimating the fatness of live sheep by feeling an animal's loin and rib area.

On four occasions, subsets of eight operators estimated the CS of a number of sheep three times (runs) (see Tables 1 and 2 for more details). The aim was to correct for differences between operators in condition scoring across the project. Figure 1 shows the CS range of sheep present in the exercises.

Figure 1. Sheep with varying Condition Scores

Table 1. Exercise Details

	Exercise 1	*Exercise 2*	*Exercise 3*	*Exercise 4*
Location	WA	VIC	WA	VIC
Date	Jan-2003	Jun-2003	Jul-2003	Aug-2003
No. Sheep	50	30	28	28

Table 2. Attendance by Operators

Operator	*Exercise 1*	*Exercise 2*	*Exercise 3*	*Exercise 4*
1 (WA)	yes	-	yes	yes
2 (WA)	yes	-	yes	-
3 (VIC)	-	yes	yes	yes
4 (WA)	yes	yes	yes	yes
5 (VIC)	-	yes	yes	yes
6 (VIC)	-	yes	-	yes
7 (WA)	yes	-	yes	yes
8 (WA)	yes	-	yes	-

Estimating Actual Condition Score for each Sheep

A simple average was not appropriate because each exercise was attended by different operators; more operators were present from the host state; and large differences in measurement of CS between Western Australia (WA) and Victoria (VIC) were expected. Instead the CS for each sheep was estimated from the five operators who attended exercises in both states in a way that gave equal weighting to each state:

$$CS_{Act} = [CS_{Operator\ 1,WA} + CS_{Operator\ 4,WA} + CS_{Operator\ 7,WA}] / 6 + [CS_{Operator\ 3,Vic} + CS_{Operator\ 5,Vic}] / 4$$

Some of these operators were absent from the first two exercises, so their estimates of CS were calculated using relationships obtained from the last two exercises.

Fitted Model

Residual maximum likelihood (REML) was used to fit the following linear mixed model to the data:

$$Y_{ijkl} = \mu + \alpha_i + \beta_i X_{jk} + \lambda_j + \varepsilon_{ijkl}$$

where Y_{ijkl} = CS given on run l of exercise j to sheep k by operator i
X_{jk} = estimated actual CS (CS_{Act}) for sheep k in exercise j
μ = overall mean
α_i = effect of operator i
β_i = interaction of operator i with actual CS
λ_j = effect of exercise j
ε_{ijkl} = random error

The covariance structure of the errors was such that var($\underline{\varepsilon}$)=diag(σ_i^2) where σ_i^2 is the residual variance for operator i.

All terms in the model were significant ($p<0.001$) indicating differences between operators and that these differences changed as the level of CS varied.

Figure 2. Operator Condition Score Corrections

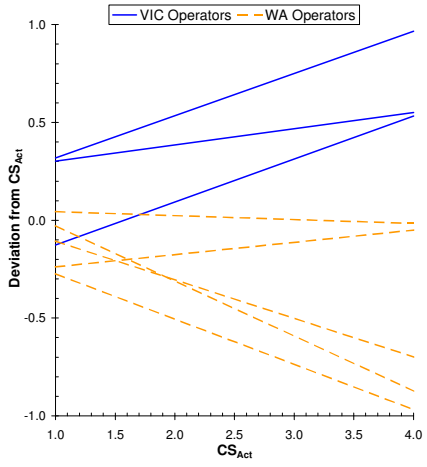
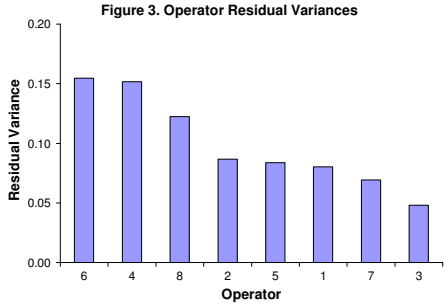


Figure 3. Operator Residual Variances



Interpretation

Correction equations with intercept=$\mu+\alpha_i$; and slope=β_i-1 are illustrated in Figure 2. Each line represents the correction required to bring an operator in line with the actual CS for a sheep. The distance between two lines represents the correction required to bring two operators in line with each other.

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