THE IMPACT OF RECORDING PERFORMANCE CRITERIA ON INDEX ACCURACY IN TERMINAL SIRE SHEEP BREEDS FOR A RANGE OF BREEDING OBJECTIVES

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SUMMARY
The relationships between performance records, EBV accuracy and index accuracy are explored with a view to comparing the profitability of various performance recording regimes for particular breeding objectives.
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INTRODUCTION
SheepObject is a software package under development for the definition of breeding objectives for all sectors of the sheep industry. Through careful economic analysis, optimised indexes can be determined. The package will allow for industry indexes to be updated as required, and for customised indexes to be available to individual breeders or groups.

The establishment of a performance recording regime is ideally driven by the breeding objective, involving consideration of the costs and the expected benefits from recording a particular trait. A breeder will need to determine whether a trait is worth recording, what measurement time/s will give the greatest accuracy while not interfering with other tasks, and what group/s should be recorded.

Simulation tools (e.g. ZPLAN, Karras *et al* 1993) have been used to assess the economic impact of particular measurement regimes in beef cattle (Graser *et al* 1994, Nitter *et al* 1994) and dairy cattle (Kahi and Nitter 2002). However with SheepObject supporting many indexes and customised breeding objectives, general indications from less demanding techniques would be a significant advantage.

The problem may be broken down in to several parts:

i) The cost of measurement. Generally this is easily determined.

ii) The effect on EBV accuracy. With multi-trait BLUP evaluation, any change in performance recording may affect the accuracy of many EBVs. Addition of pedigree information will increase EBV accuracies but these improvements are difficult to quantify in typical flock data because of the distribution of family size gives a distribution of EBV accuracies.

iii) The impact of EBV accuracy on index accuracy. This is difficult to predict because of the unknown off-diagonal components of EBV accuracy. In flock data with pedigree information, the EBV and index accuracies will be unique for each animal, so that the index values of a group are not normally distributed, making any statistical inference difficult.

iv) The economic value of genetic change attributable to a change in index accuracy. This is quite easily determined for an index on the currency scale from $R = is_I$ where i is selection intensity and s_I is the index standard deviation; for a given i, R a s_I.

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In this paper a simplified case is presented to show the effect of various measurement regimes on EBV and index accuracy. Information on relatives and contemporary group size are known to influence EBV accuracy. By excluding pedigree and contemporary group effects on accuracy, sets of EBVs are determined which provide for sets of index values to be calculated which are members of a single distribution. The observed index variance can then be taken as a measure of index accuracy. Examining a range of breeding objectives will provide guidance as to the sensitivity of index accuracy to changing trait emphases.

MATERIALS AND METHODS

LAMBPLAN EBVs and their approximate accuracies were extracted from the OVIS (Brown *et al.* 2000) output for a flock cohort of 207 Poll Dorset ram and ewe lambs, with data adjustments for birth type, rearing type, age, dam age, and a liveweight adjustment for carcase traits. Sex was part of the contemporary group classification fitted by trait. There was no pedigree information. The OVIS runs were repeated with various combinations of performance records included, to assess the impact on the accuracy of EBVs. Subsequently, the Carcase Plus index was computed from each set of EBVs. The Carcase Plus index was designed to give 60% of selection emphasis to liveweight, 20% to eye muscle depth and 20% to reducing fatness, at a post-weaning age.

Further indexes were calculated to represent a range of economic breeding objectives. From SheepObject, it was determined that trait economic values (discounted and cumulative) for sale weight (kg), eye muscle depth (mm) and carcase fat depth (mm) in the ratio of 1:1.15:-2.22 were implied by the Carcase Plus index. For each of these three objective traits in turn, the relative economic value was increased and decreased by 20%, to produce a set of six indexes diverging from Carcase Plus. While comprehensive SheepObject breeding objectives will also include other traits, live weight, muscle and fat are likely to be the main traits in most terminal sire cases.

RESULTS

Contemporary group size had a direct effect on EBV accuracy, and this was most apparent for small groups of less than ten individuals. However the greatest increase in EBV accuracy between a group size of 10 and the largest groups in the data (ranging from 55 to 67 for birth and post-weaning records) was 0.02. To remove the effects of group size, contemporary groups of fewer than 10 were discarded, as were animals which had discontinuous records, leaving 201 animals with observations at birth, of which 168 had weaning records, 153 had post-weaning records, 146 had a repeat measure of post-weaning weight, and 37 had a yearling record. Table 1 shows the patterns of EBV accuracy produced by OVIS for each scheme of performance recording. Among 82 000 records for 2001 born animals in the LAMBPLAN terminal sire database, 18% showed measurement option 10 (part requirement for gold data quality grade), 16% showed option 9 (part requirement for bronze or silver data quality grade) and 8% of records had weaning weight only (option 2). Measurement options 1, 3, 4, 5, 6, 7 and 12 each represented 4 to 7% of field data; together the 12 options were represented by 77% of field data.

For all animals in the LAMBPLAN terminal sire database, the greatest EBV accuracies for pwt, pemd and pcf were 0.99, 0.99 and 0.98. Animals born in 2002 were examined separately to determine the highest EBV accuracies for animals without progeny records: 0.76, 0.75 and 0.69 for the same EBVs.

Table 1. Approximate EBV accuracy achieved by measurement regime

	EBV Accuracy									
	bwt	**wwt**	**pwt**	**ywt**	**pemd**	**yemd**	**pcf**	**ycf**	**mbwt**	**mlwt**
Measurement regime Heritability:	0.14	0.17	0.27	0.25	0.33	0.27	0.16	0.32		
1. Birth weight	0.42	0.14	0.12	0.11	0.01	0.01	0	0	0.20	0.02
2. Weaning weight	0.17	0.48	0.35	0.34	0.01	0.01	0.01	0	0.02	0.19
3. Birth and weaning weights	0.42	0.48	0.35	0.34	0.02	0.02	0.01	0.01	0.20	0.19
4. Postweaning weight	0.17	0.42	0.57	0.45	0.03	0.05	0.02	0.01	0.01	0.01
5. Weaning and postweaning weights	0.19	0.51	0.57	0.46	0.03	0.06	0.02	0.01	0.02	0.19
6. Birth, weaning & postweaning weights	0.42	0.51	0.58	0.47	0.03	0.06	0.02	0.01	0.20	0.19
7. Postweaning weight, fat, muscle depth	0.17	0.42	0.58	0.45	0.56	0.35	0.41	0.30	0.02	0.01
8. 7 + yearling weight	0.17	0.44	0.58	0.55	0.56	0.36	0.41	0.30	0.02	0.02
9. 2 + 7	0.19	0.51	0.58	0.47	0.56	0.35	0.41	0.30	0.02	0.19
10. 3 + 7	0.42	0.51	0.58	0.47	0.56	0.35	0.41	0.30	0.20	0.19
11. 3 + 7 + repeat postweaning weight	0.42	0.51	0.58	0.47	0.56	0.35	0.41	0.30	0.20	0.19
12. 3 + 7 + yearling weight	0.42	0.51	0.58	0.56	0.56	0.36	0.41	0.30	0.20	0.20

b = birth, w = weaning, p = post-weaning, y = yearling, wt = liveweight, cf = fat depth scanned at the C site, emd = scanned eye muscle depth, mbwt = maternal birth weight, mlwt = maternal live weight.

The index standard deviation was calculated for each index under each measurement regime. In Table 2 these results are presented relative to the standard deviation achieved from post-weaning records alone.

Table 2. Index standard deviation relative to post-weaning records only (measurement regime 7)

	Index standard deviation							
Measmt regime	**Carcase Plus**	**CP +weight**	**CP -weight**	**CP +muscle**	**CP -muscle**	**CP +fat**	**CP -fat**	**Approx s.e.**
1	0.15	0.16	0.15	0.15	0.16	0.15	0.15	0.01
2	0.42	0.43	0.41	0.41	0.43	0.42	0.42	0.02
3	0.41	0.42	0.40	0.40	0.42	0.41	0.41	0.02
4	0.97	0.99	0.94	0.95	0.99	0.97	0.97	0.05
5	1.06	1.08	1.02	1.03	1.08	1.06	1.06	0.06
6	1.05	1.07	1.02	1.02	1.07	1.05	1.05	0.06
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.06
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.11
9	1.08	1.09	1.08	1.08	1.08	1.08	1.09	0.06
10	1.08	1.08	1.07	1.08	1.07	1.07	1.08	0.06
11	1.20	1.21	1.19	1.20	1.20	1.20	1.21	0.07
12	1.08	1.08	1.08	1.08	1.08	1.07	1.08	0.12

DISCUSSION

Contemporary group size for unpedigreed data was found to be an important factor on EBV accuracy only for very small groups. Where group size was at least ten individuals, further increases had negligible effects on the accuracy of an individual's EBVs.

In general the addition of new information is seen to increase index variance and accuracy. The addition of birth and weaning weights to post-weaning records had a relatively small but consistent effect. These early weights are particularly important for determining lambing ease and, as shown in Table 1, the maternal components, which are not part of the indexes used here. The early records would also make other indirect but critical contributions to the accuracy of evaluation, such as accounting for early culling.

Some comparisons between measurement options produce unexpected or illogical results. The addition of yearling live weight records had no discernible impact on index accuracy, while a repeat measure of post-weaning weight had a larger than expected impact. This contrast was in part due to the small number of yearling records in the data, the genetic correlation matrix, and the impact of some selection prior to yearling age in masking any accuracy effect.

The relative index standard deviations for measurement options 4, 5 and 6 are unreasonably high and give the impression that measurements of muscle and fat depth are of little value. This is misleading and underlines the caution required in interpreting these results, due to chance effects in the data. If this study were performed upon larger or multiple data sets then the results in Table 2 could be expected to show greater consistency within columns and possibly also greater variation within rows.

The effect of changes in measurement regime on index variation is observed to be quite uniform across the substantial range of breeding objectives tested. The base index variance will vary according to the particular objective, but the results of changes in performance recording appear not to be highly sensitive to the index composition. This indicates that there may be scope to use general results to make recording recommendations across a range of closely related breeding objectives.

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REFERENCES

Brown, D.J., Tier, B., Reverter, A., Banks, R.B. and Graser, H.-U. (2000). *Wool Tech. Sheep Breed.* **48:**285.

Graser, H.-U., Nitter, G. and Barwick, S.A. (1994). *Aust. J. Agric. Res.* **45**:1657.

Kahi, A.K. and Nitter, G. (2002). *Proc. 7th Wld. Congr. Genet. Appl. Livest. Prod.* CD-ROM communication n° 23-13.

Karras K., Niebel, E., Nitter, G. and Bartenschlager, H. (1993). ZPLAN – a PC computer program to optimise livestock selection programs. (University Hohenheim: Hohenheim)

Nitter, G., Graser, H.-U. and Barwick, S.A. (1994). *Aust. J. Agric. Res.* **45**:1641.