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Cost-benefit analysis of ultrasound scanning in meat breed ram breeding flocks

D.B. BINNIE, J.N. CLARKE AND A.L. RAE[1]

AgResearch, Ruakura Agricultural Research Centre, Private Bag 3123, Hamilton, New Zealand.

ABSTRACT

New software, able to account for the impact of early selection on genetic variances and covariances, was used to evaluate two-stage sequential selection schemes for genetic gains in terminal sire flocks. The objective was to increase carcass lean and decrease carcass fat. Ultrasound scanning of both ram and ewe replacements was financially rewarding. There was little difference between autumn and spring scanning for rams. Ultrasound scanning was significantly more rewarding in the South Island Intensive situation than the North Island Hard Hill Country. The scale of rewards varied significantly with generation interval in the ram breeding flocks.

Keywords: ultrasound; lean; fat; genetic gain; cost-benefit.

INTRODUCTION

The pursuit of faster growth rates, more carcass lean and lower fat have been important objectives for New Zealand ram breeders for a number of years. Over the last decade, the use of ultrasound to assess eye muscle dimensions has been used to assist estimation of breeding values for these objectives. Much of the motivation for the development of ultrasound measurement techniques, and the parameters used in the estimation of breeding values has been based on the work of Waldron *et al.* (1992), who reported the value of carcass eye muscle width, depth and fat as selection criteria for predicting carcass lean and fat. Simm *et al.* (1990) and Cameron and Bracken (1992) report carcass responses in lean and fat to selection based on weight, ultrasound eye muscle depth and fat.

However, there has been no detailed assessment of the costs and benefits of the use of ultrasound in selection programmes for carcass improvement in New Zealand. This paper outlines a study of the economics of a range of selection criteria involving ultrasound for two diverse farming types.

MATERIALS AND METHODS

A Microsoft Excel spreadsheet was developed to interface with a programme that estimates genetic gains from two-stage sequential selection. Known as REVGain, the spreadsheet enables the user to input the following variables:

- the selection objectives chosen from
  - number of lambs born (NLB)
  - weaning weight (WWT)
  - autumn liveweight (LW8)
  - spring liveweight (LW12)
  - carcass lean (LEAN)
  - carcass fat (FAT)
- the types of commercial farms for which the rams are being bred
- the selection criteria to be used at the first and second stages of selection
- the numbers of paternal half sibs available at the first and second stages of selection
- the effective selection intensities at the first and second stages of selection.

The genetic and phenotypic parameters pertaining to ultrasound scanning required for the computation of estimated genetic change have been estimated by Clarke, J.N. (unpublished) from ultrasound scanning, slaughter and pedigree data at AgResearch, Ruakura. Other parameters are as used by Animalplan to estimate breeding values (Waldron *et al.,* 1992; Johnson *et al.,* 1989; Clarke and Binnie, 1994).

For this study a module was developed to examine the net financial rewards resulting from the use of ultrasound measurements to estimate breeding values for Lean and Fat in terminal sire ram breeding flocks.

Profit equations were developed to derive the relative economic values of LEAN and FAT for farm classes 3 (North Island Hard Hill Country) and 7 (South Island Intensive Finishing Farms) as defined by the New Zealand Meat & Wool Boards' Economic Service. Five year averages of commercial farm data were used for the years 1989-90 to 1994-95 (New Zealand Meat & Wool Boards' Economic Service, 1991 to 1996) for this purpose. The relative economic values are given in Table 1.

A representative ram breeding flock was used to evaluate the economics of using ultrasound measurements to estimate breeding values for Lean and Fat. It comprised 100 recorded ewes, producing 140% lambing, with 35

TABLE 1: Relative economic values (cents) of lean and fat for farm classes 3 and 7.

	Farm Class 3	Farm Class 7
REVLEAN	532	708
REVFAT	-460	-613

[1] 14 Wallace Place, Palmerston North, New Zealand.

flock rams being sold per year. Ultrasound scanning fees were 400 cents per animal for eye muscle width (A), depth (B) and fat (C), and 300 cents per animal for eye muscle depth and fat only. The average ram to ewe ratio for commercial farms was 1:64 for farm class 3 and 1:84 for farm class 7. The corresponding average commercial lambing percentages were 92 and 121 respectively.

The financial gains due to the use of scanning were then estimated as:

Number of commercial lambs bred/ram x number of rams sold x increase in value of lambs due to changes in Lean and Fat

The costs of ultrasound scanning were then deducted and the net amount divided by 100 to give a net surplus per stud ewe. These values were then analysed using the JMP v 3.6.1.2 (SAS Institute) software.

RESULTS

Table 2 shows the range of combinations of selection criteria tested for rams, and the resultant genetic changes in Lean and Fat.

The equivalent genetic gains for ewe replacement selection are given in Table 3.

Comparisons of the changes in lean and fat for the 1R selection criteria versus all other ram combinations shows that including compositional indicators improves discrimination of lean from fat. By defining the breeding goal as +1.15Lean - 1.00Fat (Waldron, 1991), the combined effects of changes in Lean and Fat can be compared. In all cases, a higher aggregate return results from reducing fat change at the expense of pursuing maximum Lean improvement. A similar conclusion can be derived from a comparison of the 1E selection criteria with 2E and 3E.,

However, the selection criteria necessary for reducing Fat change involve the extra expense of ultrasound scanning. The net outcomes of extra income available in genetically improved commercial lambs less the extra expense from ultrasound scanning in the ram breeding flock are presented in Tables 4 (North Island Hard Hill country) and 5 (South Island Intensive Finishing Farms).

Analysis of variance showed that generation interval and farm class were highly significant effects (P<0.0001). For rams, all scanning strategies were significantly better than no scanning (P<.0001). Autumn scanning without eye muscle width (R5) was more profitable than both strategies that included spring scanning (3R and 4R). (P<.016 and P<.019 respectively) Autumn scanning including eye muscle width was intermediate, and not significantly different to the other scanning strategies.

For ewes, scanning was more profitable than not scanning (P<.0001), but there was no significant difference between the two scanning strategies.

Whereas Tables 2 and 3 show the genetic changes per generation, Tables 4 and 5 take account of generation interval to show net income per year. The influence of generation interval when selection intensity is maintained at a constant level overstates the likely real situation by 5-10%, since shortening the generation interval by $1^1/_2$ years usually necessitates selecting a higher proportion of replacements. However, the differences in net surplus between 2.0 and 3.5, and 3.5 and 5.0 years far exceed 10%, leaving generation interval in the stud as a major influence on genetic change and profitability.

Furthermore, the relatively high profitability offered by short generation intervals suggests that some sacrifice of accuracy from doing without spring scanning in order to achieve very short generation intervals would be worthwhile.

A comparison of the South Island Intensive Finishing Farms and North Island Hard Hill Country situation shows a significantly (P<0.001) higher surplus in the former.

TABLE 2: Genetic gains from different combinations of selection criteria for rams.

	Selection Criteria									
	1R		2R		3R		4R		5R	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
NLB	✓		✓		✓		✓		✓	
WWT	✓		✓		✓		✓		✓	
LW8		✓		✓	✓		✓			✓
A8				✓			✓			
B8				✓			✓			✓
C8				✓			✓			✓
LW12						✓		✓		
A12						✓		✓		
B12						✓		✓		
C12						✓		✓		
PHS (no.)	70	49	70	49	70	49	70	49	70	49
Selection intensity %	70	10	70	10	70	10	70	10	70	10
Genetic change/generation:										
Lean (kg)	0.533		0.489		0.478		0.489		0.496	
Fat (kg)	0.275		-0.034		-0.023		-0.128		-0.007	
Index (cents)	0.338		0.596		0.573		0.690		0.563	

TABLE 3: Genetic gains from different combinations of selection criteria for ewes

	Selection Criteria					
	1E		2E		3E	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
NLB	✓		✓		✓	
WWT	✓		✓		✓	
LW8		✓		✓		✓
A8				✓		
B8				✓		✓
C8				✓		✓
LW12						
A12						
B12						
C12						
PHS (no.)	70	63	70	63	70	63
Selection intensity %	90	40	90	40	90	40
Genetic change/generation						
Lean (kg)	0.296		0.270		0.273	
Fat (kg)	0.152		-0.023		0.000	
Index (cents)	0.188		0.334		0.314	

TABLE 4: Net income ($ per stud ewe) from the use of different ultrasound scanning strategies and generation intervals for North Island Hard Hill Country.

		Selection Criteria Strategy				
		1R	2R	3R	4R	5R
1E Generation						
Interval	2.0 yrs	18.79	26.15	25.30	26.98	25.47
	3.5 yrs	10.74	14.10	13.62	13.49	13.92
	5.0 yrs	7.52	9.28	8.95	8.10	9.30
2E Generation						
Interval	2.0 yrs	21.56	28.79	27.94	26.92	28.11
	3.5 yrs	11.24	14.53	14.05	13.92	14.35
	5.0 yrs	7.11	8.83	8.49	7.65	8.85
3E Generation						
Interval	2.0 yrs	21.49	28.72	27.88	29.55	28.04
	3.5 yrs	11.47	14.76	14.28	14.16	14.58
	5.0 yrs	7.46	9.18	8.84	8.00	9.20

This is due to more lambs being bred per flock ram sold (102 *versus* 59 lambs/year) and, to a lesser extent, a higher percentage of lambs being slaughtered directly from the

TABLE 5: Net income ($ per stud ewe) from the use of different ultrasound scanning strategies and generation intervals for South Island Intensive Finishing Farms.

		Selection Criteria Strategy				
		1R	2R	3R	4R	5R
1E Generation						
Interval	2.0 yrs	43.59	62.81	60.60	60.86	68.00
	3.5 yrs	24.91	35.05	34.00	33.94	36.94
	5.0 yrs	17.44	23.95	23.36	23.17	24.51
2E Generation						
Interval	2.0 yrs	52.96	72.18	69.97	70.23	77.37
	3.5 yrs	29.18	39.32	38.27	38.21	41.21
	5.0 yrs	19.67	26.18	25.59	25.40	26.75
3E Generation						
Interval	2.0 yrs	51.99	71.20	69.00	69.26	76.40
	3.5 yrs	28.90	39.04	37.99	37.93	40.92
	5.0 yrs	19.66	26.17	25.58	25.39	26.74

farm of birth rather than being sold store (96% *versus* 54%), thereby attracting a higher price per kilogram.

Scanning of ewe lambs to aid selection is worthwhile ($P<0.002$), although there is little effect of including or excluding eye muscle width. The extra cost of rescanning 70% of the rams in spring offset much of the extra income earned by the genetically superior offspring relative to the offspring of the rams scanned in the autumn only.

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