Comparison of breeding values between sheep ranked for resilience and resistance

M.B. DE LAUTOUR* and H.B. DE LAUTOUR

Tukipo Terraces, P.O. Box 114, Takapau 4243, Hawke's Bay, New Zealand
*Corresponding author: tukipo@xtra.co.nz

ABSTRACT

The sheep industry has put considerable resources into studying selection for resistance by measuring faecal egg count (FEC). Resistance can also have reduced pasture larval challenge as an important spin off. Fewer resources have been put into selecting for increased resilience, animals which are able to grow under challenge, possibly because methods of selecting resilient animals are more labour intensive and difficult to standardise. Te Whangai, which has a flock of 9,000 ewes, 2,500 of which are recorded ewes for breeding industry rams, has been working with AgResearch monitoring resilience and resistance in their flock since 2001. An analysis using data from ram lambs born in 2007 and 2008 found the top ranked animals on resilience had higher than average breeding values for growth and wool weights, whereas the top ranked animals for resistance with a low FEC, had lower than average breeding values for growth and wool weights. In 2007, the average breeding value for eight month live weight for the top 60 resilient lambs was 6.55 kg greater than that for the top 60 resistant rams. These findings suggest caution is advised in selecting animals on FEC. Resilience is likely to be a better alternative.

Keywords: lambs; breeding values; resilience; resistance; production; drench.

INTRODUCTION

Very few breeders in New Zealand have measured and selected sheep for resilience. On the other hand, many breeders are measuring resistance using faecal egg count (FEC) and using breeding values for this trait to assist with their selection decisions. Resilient sheep are defined as those that will have production gains regardless of their parasite challenge. Resistant sheep are those that have naturally lower parasite levels, as measured by faecal egg count. Considerable work on resilience and resistance has been conducted in New Zealand (Bisset *et al*., 1994; Bisset & Morris, 1996; Morris & Bisset, 1996; Morris *et al.*, 1996, 2000, 2004). Results indicate that the productivity of sheep selected for resilience is greater than those selected for resistance. More recent work reported data from two single trait lines selected for resilience and resistance which have been in place since 1994 and 1979, respectively, plus a control line (Wheeler *et al.,* 2008). This trial showed that the liveweight gain between weaning and March for the resilient line was 3.1 kg (62%) greater than for the resistant line.

The farm used for this study is a 1,500 ha commercial sheep farm on poor fertility North Island hill country in Southern Hawkes Bay carrying 6,500 commercial ewes and 2,500 recorded ewes. A continuous screening process takes place between the flocks. Livestock are run at above average hill country stocking rates. Recorded ram hoggets are farmed under the same pressure that exists on a commercial hill country farm. The aim at Te Whangai is to breed sheep that maximise profit on hill country both on the home property and for ram clients based throughout the country. The emphasis on resilience is the main tool for achieving a goal of "maximum per hectare production with minimal labour costs". A policy of minimal drenching has been undertaken for twenty years. Resistance, resilience and production traits have been recorded for a number of years in the recorded flock. This paper will describe work done at Te Whangai on resilience and resistance, and will present an analysis of Sheep Improvement Ltd (SIL) breeding values for production traits on animals ranked high or low for resilience and resistance.

MATERIALS AND METHODS

Establishing feasibility of resilience recording

After discussion with Stewart Bisset (Parasitologist, AgResearch, Wallaceville) at the 1990 Conference of the New Zealand Society of Animal Production, we decided to select ram lambs for resilience as well as low egg count under challenge.

The ram lambs received no drench while suckling their mothers or at weaning: a practice which had been the norm for over 30 years. Lambs remained undrenched until the worm counts averaged over 1,700 eggs per gram (epg). Three healthy ram lambs with faecal egg counts averaging just under 3,000 epg and three ram lambs with low egg counts averaging 416 epg were single-sire mated to mixed age recorded ewes. The progeny of these ram lambs remained undrenched. While some egg counts increased, most had reduced by the beginning of June at 9 to 10 months of age. After considering the results of that first mating it was

decided to follow the resilience path. The measurement process we have followed at Te Whangai for 14 years is explained below and is similar to that described in Bisset *et al.* (1994).

Description of protocol

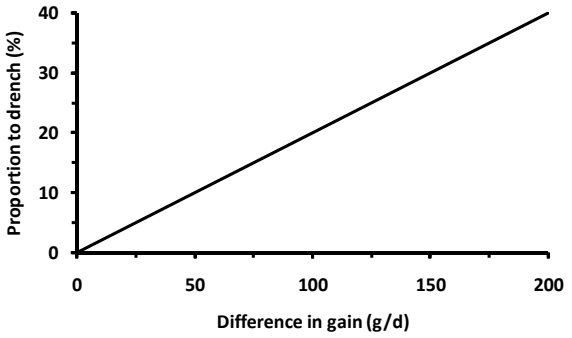
Over the 19 years of selection for resilience there has been some fine tuning in the way the decision is made to drench individual lambs. All lambs are weighed at weaning at approximately 90 days average age, and no drench is administered. Animal health and FEC are monitored carefully until a reasonable level of worm challenge is being experienced and average FEC counts reach approx 1,000 epg. This is based on local veterinary advice that production is compromised from FEC levels of 300 epg upwards. All lambs are weighed again at this time (live weight at first drench, LWD) and FEC samples are taken at this time (FEC1). FEC1 is used as the basis for FEC breeding values.

The aim is to identify the poorest 20 to 25% of lambs on liveweight gain from weaning weight to LWD. A sample of 30 lambs is weighed to establish the trigger level for drenching. A daggy scouring animal will be drenched even if its growth rate is up to 20 g/d higher than the threshold. The issue of when to drench large thrifty lambs not growing at the required rate, independently of parasite effects, is handled subjectively as well. Bisset and Morris addressed this by using the performance rating index combining live weight and weight gain shown below (S.A. Bisset, Personal communication).

Performance rating index
= (PR WtCh x 1.5) + PR Lwt
where: PR WtCh = Number of standard deviations above or below the flock mean weight gain
PR Lwt = number of standard deviations above or below the flock mean live weight

This method requires weighing the test animals, performing the calculation, and then identifying those to be drenched. This was not practical with the large number of animals involved despite the introduction of radio frequency identification tags ten years ago. To monitor the effectiveness of the worm challenge on the recorded animals, a smaller group of 25 similar animals, is now run with the test mob. This control group is drenched at every weighing and drenching session. A guide to the number of animals to be drenched, based on the relationship between the controls and the test animals, is also used (Figure 1) (S.A. Bisset, Personal communication). The weigh and drench process is repeated at approximately 14 day intervals until about the 20 March to the 25 March at which time the data is analysed in time to make sire selections for mating.

FIGURE 1: Percentage of animals in a management group to be drenched based on the difference in weight gain between the parasite-free control group and the test group.



Across-flock analyses

In 1991, Te Whangai joined with four other breeders working with AgResearch at Wallaceville to undertake an exercise to estimate the heritability for resilience and dagginess. Records were taken from 14,000 progeny sired by 213 rams over two years. Sixty four of these sires were from the Te Whangai flock. Heritability estimates for component traits of resilience, as measured in all sire groups, were as follows (Bisset & Morris, 1996; M.B. de Lautour, Unpublished data). Heritability estimates were 0.19 ± 0.04 for the total number of drenches received per individual animal, and 0.14 ± 0.03 for standardised age at first drench. Corresponding estimates for progeny from Te Whangai sires only were much higher at 0.53 ± 0.10 and 0.34 ± 0.07, respectively.

From 1994 to 2002, Te Whangai used the higher heritability estimates from their own flock in the breeding value analyses which were run at Massey University (D.J. Garrick, Personal communication). From 2002 onwards, resilience and FEC1 analyses were processed using the lower "all rams" heritability estimates. The same drenching regime has been used throughout the time period. It appears that the Te Whangai heritability estimates have decreased since 1994, possibly due to the use of more outside sires in the flock.

Statistical analyses

The Te Whangai analyses compare the production performance of ram lambs with a phenotype for resistance and resilience, and ranked by SIL as resistant or resilient. These analyses used two years of breeding value data from 2007-born (n = 1,552) and 2008-born (n = 1,721) home-bred Te Whangai ram lambs. The analysis data were taken from the SIL post-hogget shearing reports run on an across-flock basis within The Wairarapa Romney Improvement Group as provided by The New Zealand Animal Breeding Trust (Palmerston North). Values calculated were the raw means of breeding

TABLE 1: Average SIL Breeding values (BV) for weaning weight (WWT), live weight at 8 months (LW8) and fleece weight at hogget shearing (FWT) for 2007 and 2008 lambs ranked on resilience or resistance. Recorded ram lambs were ranked out of 1,552 for the 2007-born animals and 1,721 for the 2008-born animals. Similar conclusions could be drawn from the results for the Top 200 and Top 25% of the 2007-born animals as for the 2008-born animals.

Year of birth	Group	Trait	WWT BV (kg)	LW8 BV (kg)	FLW BV (kg)	Resilience rank	Resistance rank
2007	Top 60	Resilience	1.93	5.28	0.18	30	1,041
	Top 60	Resistance	-0.75	-1.27	-0.37	1,272	30
	Low 60	Resilience	-0.66	-1.88	-0.35	1,416	262
	Low 60	Resistance	1.67	3.03	0.24	948	1,417
2008	Top 60	Resilience	1.27	4.35	0.14	30	1,347
	Top 60	Resistance	-0.48	-1.07	-0.44	1,545	30
	Low 60	Resilience	-0.67	-1.88	-0.03	1,689	97
	Low 60	Resistance	1.72	4.31	0.25	737	1,689
	Top 200	Resilience	1.09	3.57	0.06	100	1,206
	Top 200	Resistance	-0.15	-0.33	-0.32	1,363	100
	Low 200	Resilience	-0.05	-1.41	-0.22	1,618	306
	Low 200	Resistance	1.50	3.74	0.22	527	1,618
	Top 25%	Resilience	1.03	3.18	0.04		
	Top 25%	Resistance	0.03	0.18	-0.24		
	Low 25%	Resilience	-0.19	-0.46	-0.16		
	Low 25%	Resistance	1.22	3.21	0.18		

values for weaning weight, eight-month live weight, and yearling fleece weight, or ranks of predicted resilience or predicted resistance, for animals in the "top" group or "low(est)" group of 60, 200 or 25%, for predicted resilience or predicted resistance. Predicted resilience consists of a combination of weaning weight, liveweight gain, standardised age at first drench and dag score.

RESULTS AND DISCUSSION

After six years of monitoring resilience and resistance, which followed on from ten years of measuring weight gain under nematode challenge, large differences in production breeding values are emerging between those animals gaining weight under challenge (resilient) and those with low faecal egg count (resistant) for weaning weight, eight-month live weight, and yearling fleece weight (Table 1).

Our analysis comparing the highest ranked resilient animals and the highest ranked resistant animals showed very similar breeding value comparisons to other work (Wheeler *et al.*, 2008). This is despite the fact that the farm has a very low level of drenching and the ram hoggets are farmed under the pressure that exists on a commercial hill country farm. Considerable links are maintained in the Wairarapa Romney Improvement Group through artificial insemination and exchange of sires. This has diluted some of the gains in resilience achieved through past selection at Te Whangai since the same selection pressure for resilience had not been applied in all the linked flocks.

Te Whangai has been measuring and selecting sheep for 19 years on the basis of resilience breeding values. In theory, a breeding objective could combine resilience and resistance. However, in a commercial situation production is paramount. Research has shown that the major contributor to reduced production in gastrointestinal nematode infections is the host immune response, rather than the damage from the parasite *per se* (Greer *et al.*, 2005). This supports the concept that the best breeding objective might be for a highly productive animal with a mild or passive immune response to internal parasites.

Sires at Te Whangai whose progeny have high rankings for resistance as well as resilience, generally have lower production. After 20 years or more of low drench levels, which may have caused young sheep to shed larger numbers of eggs, there does not appear to be any requirement to drench more often. Nor are FEC breeding values rising in the recorded flock; in fact they are remaining low which is desirable. While Te Whangai sires with low breeding values for resistance ranked among the top animals for resistance in a Sustainable Farming Fund trial which tested over 20,000 lambs for FEC1, the progeny of these sires are not exhibiting high production.

The average eight month live weight breeding value over the two years for the top 60 resilient lambs was 5.98 kg more than the eight month live weight breeding values for the top 60 resistant lambs (Table 1). Resistant lambs were less likely to be among the top performing animals in the flock with only 18 lambs of the top 200 lambs ranked on breeding values for live weight at eight months among the top 25% of resistant lambs. On the other hand 84 were listed among the bottom 25% of resistant lambs. When comparing the top-ranked 25% of the 2008-born hoggets for resistance, we found an average breeding value for eight month live weight of just 0.18 kg compared to the average live weight breeding value of 1.84 kg for the whole mob. Similarly for wool weight: the resistant mob had an average breeding value of -0.24 compared to -0.02 for the mob.

Results also showed that resistant sheep (low FEC breeding values) required drenching earlier than the resilient sheep (Table 2). With the exception of the second drenching date, it was clear that the highly ranked resistant sheep are more frequently represented in the early drench mob. While it would also have been useful to be able to test the larval content of pasture at this stage, there is no practical means of doing this (Litherland *et al*., 2008).

The positive relationship between high resilience and desirable, low dag scores (Bisset & Morris, 1996) suggests that greater resilience in a flock would result in a lower labour requirement. This positive relationship between resilience and low dag score also indicates that an easy way of selecting more resilient sheep would be to keep dag scores on all recorded stock and cull on breeding value for dag score. In the case of commercial non-recorded sheep, culling of daggy sheep could achieve some increase in resilience. However, selecting against a single trait such as "dag score" may also lead to unexpected results. In practice these potential side effects would need to be investigated before such a recommendation was made.

TABLE 2: Average breeding values (BV) for faecal egg count (FEC) by drench date for 2008-born lambs. More negative values indicate more resistant animals.

Drench date	FEC BV
10 February 2009	-3.23
24 February 2009	5.87
7 March 2009	3.02
21 March 2009	6.19
Undrenched	8.80

The Te Whangai data confirm that higher productivity is likely under commercial conditions from the progeny of resilience-selected sires than progeny of resistance-selected or single-trait production-selected sires, as has been reported earlier by Howse *et al*. (1995) in fleece-weight selected versus control Romney sheep; Morris *et al*. (1996) in weight-selected versus control Romney sheep; Morris *et al*. (2004) in industry comparisons across 15 flocks recording resilience and resistance; and Wheeler *et al.* (2008) in comparing AgResearch's single-trait selection lines for resilience or resistance.

Our results suggest that industry promotion of resistance rather than resilience carries the risks of lowering production and increasing labour requirement, hence reducing profit. This is also supported by work carried out at Wallaceville and Ballantrae (Wheeler *et al.*, 2008) comparing production in resistant versus resilient animals which showed that production gains of nearly 4 kg greater liveweight gain during summer and autumn, and 0.44 kg more wool weight over twelve months, in resilient lambs compared to resistant lambs. This equates to approximately $6 per lamb if slaughtered in autumn at current prices, or an extra 30 days on farm to reach the same weight.

CONCLUSION

Our main purpose in presenting this paper was to alert the industry to the risks of using FEC rankings for culling decisions without careful reference to growth and wool weight, since the most productive sheep are likely to be among those with poorer rankings for FEC. Our results showed that if Te Whangai were to select higher ranked resistant sheep and cull the lower ranked ones, we would be culling a considerable number of the most productive sheep.

These results suggest that caution is advised in making culling decisions based on FEC values and indexes with FEC breeding values included. Though the method described in this paper for testing resilience using frequent weighing overcomes any problems with animal ethics and is clearly selecting sheep that continue to grow under challenge we feel that more research needs to be carried out in the area of resilience and resistance.

Areas for further work could include:

- The effects of pasture larval infection in young resilient lambs shedding greater numbers of eggs than resistant lambs, taking into account the normal practices of rotating different stock types and noting that a simple pasture test is often impractical for farmers (Litherland *et al.,* 2008).

- A comparison of worm burdens between resilient and resistant lines of breeding ewes.
- The development of a DNA test for resilience which would reduce the labour requirement for measuring the age at first drench and gain by the current method. This would help breeders who do not want to stress stud sheep.

ACKNOWLEDGEMENTS

We would like to acknowledge the following people and organisations: the MAF Sustainable Farming Fund for assisting with funding for this research from 2001 to 2007; Chris Morris and Neville Amyes, of AgResearch for the six years of study in the Sustainable Farming Fund project (2001-2007); Stewart Bisset, AgResearch, for guidance in the early 1990s in working out procedures for identifying resilient sheep and continuing to give advice as systems were refined; Dorian Garrick, Massey University and Clare Callow, New Zealand Animal Breeding Trust, for incorporating resilience breeding values into our selection lists from 1995 until 2001 and Clare Callow, New Zealand Animal Breeding Trust, for helpful suggestions in preparing this paper.

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