Flystrike resistance in the breeding programs of ram breeding flocks

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Summary
Ram breeders need to be assisted to include body strike and fleece rot resistance in their breeding objectives. The ability of different methods (economic analysis, desired gains) of including these disease traits into breeding objectives needs study. Wider access is needed to advisers with the skills and software to assist ram breeders to set personalised breeding objectives that include body strike and fleece rot resistance.

A more complete set of genetic parameters is needed (further information on the genetic correlation between the disease traits and the major production traits and indicator traits under natural conditions) to allow estimation of breeding values for body strike and fleece rot resistance and the prediction of response to selection.

Ram breeders need to be encouraged and assisted to be involved in sire evaluation at a suitable level to enable genetic progress in body strike and fleece rot resistance to be monitored. Better reporting of fleece rot information recorded in Central Test Sire Evaluation is needed to allow the identification of superior sires in fleece rot and body strike resistance.

Keywords
Flystrike, body strike, fleece rot, ram breeding, Merino

Introduction

Genetic improvement programs for ram breeders should aim to increase profitability of the stud flock and the flocks of commercial clients. Where the prevention and treatment of flystrike is a cost affecting flock profitability, then flystrike resistance, together with traits that influence returns (such as wool weight and quality, weight and quality of surplus animals), should be included in the breeding program. The relative emphasis to be placed on breeding for improved resistance will vary according to the real or perceived cost of prevention and treatment of flystrike in the commercial flock.

Breeding programs for ram breeders need to:

- include body strike or fleece rot resistance in their breeding objective by defining its economic value or setting a target level for improvement;
- evaluate animals and predict selection responses; and,
- evaluate and use selection strategies for cost-effective progress in the breeding objective.

This review will describe briefly each of these steps and the information available currently to implement these steps in a ram breeding program. Issues affecting the inclusion of flystrike resistance in ram breeding programs will then be identified.

Body strike, as well as its precursor fleece rot, is the only form of flystrike considered in this review, as information on the genetics of other forms of flystrike is limited. If the use of surgical methods to control breech strike is restricted by animal welfare concerns, the genetics of breech strike will need revisiting to allow breeding for breech strike resistance to be included in ram breeding programs.

Rationale

The cost of flystrike to the Australian wool industry is substantial. In 1994, the annual cost was estimated to be $161M (McLeod, 1995). The majority of the total cost was due to control costs

(labour, chemical and other) while production losses (through lost wool production, animal losses and reduced fertility) accounted for only 19% of the total cost. About 70% of flystrike costs were due to labour used in crutching, mulesing and handling of sheep for jetting. An issue for the industry is chemical residues in greasy wool, as it may have marketing consequences for Australian wools (Pattinson, 1995).

Breeding to improve resistance to blowfly strike is a long-term strategy that offers the chance to permanently reduce the susceptibility of a flock to flystrike. With continued selection, the genetic improvements achieved in flystrike resistance will accumulate and enhance the efficacy of other control methods when breeding is integrated into an overall program of flystrike control. Potentially, the need to use other control methods could be reduced. In the short-term, breeding may do little to reduce our reliance on other control methods, particularly chemical treatments.

Body strike.

Body strike occurs mainly on the shoulder and back region but can occur on any part of the body, other than the head, pizzle and breech. Extended periods of heavy rainfall with light or no wind during the warmer months of the year can cause outbreaks of body strike to occur rapidly. Under these conditions, young sheep, of either sex, with 3-6 months of wool growth are most likely to become struck. Observations over a 12-year period on sheep at Trangie have shown that most strikes were body strike (60% of strikes) which occurred predominantly in sheep under 2 years of age (Raadsma, 1991a).

The influence of seasonal conditions on the occurrence of body strike means that there can be great variation in the incidence of body strike between years, varying from no sheep affected in some years to up to 50% of young sheep affected. An incidence of 20% of animals affected by body strike is considered serious as significant costs are incurred due to production and sheep losses and the use of chemical and/or shearing control methods.

Predisposing factors to body strike.

The two major predisposing factors to body strike are fleece rot and lumpy wool (also known as 'dermo' or mycotic dermatitis). These skin diseases lower wool quality and cause wool production losses and animal losses through deaths or the culling of affected animals.

In eastern Australia, fleece rot is the most important predisposing factor to body strike (Belshner, 1937; Watts *et al*., 1979). Lumpy wool has a minor role in the development of body strike as its incidence is believed to be low on most properties. In southern and western Australia, lumpy wool is often the major predisposing factor to body strike (Edwards *et al.,* 1985).

Fleece rot can also be artificially induced using a wetting technique and then the animals scored for fleece rot (Raadsma *et al.,* 1988). Induction of fleece rot allows animals to be screened for fleece rot when environmental and/or management conditions are not conducive to its development. Also, induction of fleece rot can be used to increase its incidence. However, the use of the wetting technique would require animal welfare issues to be addressed.

From a breeding point of view, the available evidence suggests that fleece rot and body strike can be considered to be closely related as there is a very strong genetic correlation, greater than 0.75 (Atkins and McGuirk, 1979; Atkins and Mortimer, 1988) between the natural expressions of the two diseases. Also, Raadsma *et al.* (1989) have shown that there are strong genetic correlations between the induced expressions of fleece rot and body strike. A reduction in the susceptibility of sheep to fleece rot through breeding should result in a genetic decrease in susceptibility to body strike. In the case of lumpy wool this relationship has not yet been established. Lumpy wool should not be regarded as a selection criterion in seeking to eliminate the susceptibility of sheep to body strike.

Grading animals for fleece rot and body strike.

Fleece rot can be scored, provided sheep have been exposed to enough rain to allow the disease to develop. Each sheep is examined along the backline over the wither, mid-back and loin for

signs of fleece rot. The fleece is opened from the staple tip to the skin and inspected for signs of discolouration and crusty banding. A score for each animal can be based on the presence or absence of fleece rot or a severity range of 0-5, depending on the degree of fleece rot development (Murray and Mortimer, 2001*)*. Using similar methods for inspection, animals can be scored for the presence or absence of body strike.

Body strike and fleece rot resistance in Merino breeding objectives

The objective of breeding is to increase net profit in future. Ram breeders can do this by identifying those traits that contribute to profitability and can be changed genetically to either increase returns or reduce costs. The level of emphasis to be given to each trait relative to other traits in the breeding objective then needs to be defined. All characters that contribute to returns and costs need to be considered for inclusion. Body strike and fleece rot resistance can be included in a breeding objective by using an economic analysis or a "desired gains" approach.

Body strike and fleece rot are known to incur costs in a flock through (Atkins 1987):

- deaths;
- wool production losses due to treatment of a strike and the debilitating nature of the condition;
- labour and treatment costs associated with preventative and treatment measures; and,
- discounts on tender and discoloured wool at sale as a result of fleece rot.

In future, additional costs may arise because of discounts to wool values due to chemical treatments for flystrike leaving residues in wool. Consumer concern over residues may affect the marketability of woollen products reducing demand and value in the apparel textile market (Pattinson, 1995).

Using economic analysis to include body strike or fleece rot resistance into a breeding objective means that an economic value must be given to the character. Economic value is the change in profit associated with a unit change in a character, assuming that all other characters in the objective remain at a constant level. Economic values have been calculated for body strike by Ponzoni (1984) and for fleece rot by Ponzoni (1984), Atkins (1987) and Cottle (1996). There are some difficulties with determining an economic value for body strike and fleece rot (Ponzoni, 1984), but Atkins (1987) showed that by using a realistic industry model that it was possible to calculate an economic value for fleece rot.

The desired gains approach may offer an alternative means of including body strike and fleece rot resistance into a ram breeder's breeding objective. Woolaston (1994) has evaluated this approach for the case of including internal parasite resistance in Merino breeding objectives. Within the NEMESIS program, it is now used as the method to include internal parasite resistance into a ram breeder's breeding objective.

Genetic influences on body strike and fleece rot.

For body strike and fleece rot to be included in a breeding program, the degree of inheritance of these traits and their genetic relationships with other breeding objective traits need to be known. Also, if an indicator trait is to be used as a selection criterion for body strike and fleece rot, then the genetic relationships between the indicator trait and all traits, not just body strike, in the breeding objective need also to be known.

Under natural conditions, the heritability of body strike incidence is of the order of 5-30% (Atkins and McGuirk, 1979; Raadsma, 1991b) and for fleece rot incidence is of the order of 15-40%, varying with average incidence (James *et al.*, 1983; McGuirk and Atkins, 1984; James *et al.*, 1987; Atkins and Mortimer, 1988; Cottle, 1996; Li *et al.*, 1999). Similar levels of heritability are reported for the induced expressions of these traits (Atkins and Mortimer, 1988; Raadsma *et al.*, 1989). For fleece rot resistance, the few available estimates of genetic correlations with fleece weight are low but unfavourable and with fibre diameter are low but favourable (Atkins and Mortimer, 1988; Raadsma, 1985; Li *et al.*, 1999). However, our knowledge of the genetic

parameters and their reliability is limited, making it possible to make general points only about including body strike and fleece rot in a breeding objective.

Direct selection for resistance to body strike and fleece rot can be effective. This has been demonstrated in lines jointly selected on natural and artificial expressions of body strike and fleece rot at Trangie. Annual changes of 1.4% in natural fleece rot incidence and 0.2% in natural body strike incidence were reported in these lines by Mortimer *et al.* (1998). Mean values for natural fleece rot and body strike incidences were 23.5% and 5.8% respectively. The Susceptible line had higher incidences of natural fleece rot (37% versus 10%) and natural body strike (8% versus 3%) than the Resistant line (Mortimer *et al.* 1998). In this study, the responses in fleece weight and fibre diameter in these lines confirmed the unfavourable and favourable genetic relationships of these traits respectively with fleece rot resistance.

Fleece rot in the selection index: evaluation of animals and selection responses

A selection index, combining information on objectively measured traits, is the most efficient means of selecting replacement animals in a breeding program. Fleece rot resistance can be selected for by:

- direct selection, where the index includes information on whether an animal has evidence of fleece rot or not;
- indirect selection, where the index includes information on one or more traits that are genetically related to fleece rot for use as indicator traits; and,
- combined selection, where the index includes both information on fleece rot and the indicator traits to obtain extra response in fleece rot resistance.

To illustrate the effect of including fleece rot in a selection index, Atkins (1987) has calculated the genetic gains in fleece rot incidence after 10 years of selection for these three scenarios for a flock where the average incidence of fleece rot in hoggets was 15%.

Direct selection.
Genetic reductions in fleece rot of the order of 1-2% over 10 years were possible depending on the breeding objective for fibre diameter (see Table 1). Where fleece weight (greasy or clean) and fibre diameter only are included in the index, ignoring fleece rot resulted in small increases in susceptibility so that the potential responses from direct selection were quite significant and efficient. In comparison, if the objective was increased fleece rot resistance alone, then responses of only about 3% would be possible. Also, the inclusion of fleece rot on potential responses in clean fleece weight or fibre diameter had quite minor effects on likely responses, amounting to 2-5% reductions.

The index operated by reducing the index value of an animal if it had fleece rot. For this example of direct selection, any ram with fleece rot had its index value reduced by the equivalent of 7% clean wool percentage or almost 2 microns in fibre diameter. Because of this, direct selection was relatively efficient as most selected rams would be free of fleece rot and a ram with fleece rot was unlikely to be selected as a potential sire.

Expected response rates were influenced only to a small extent by differences between years in average fleece rot incidence. Selection efficiency was little affected provided that account was taken of variation in the weighting factors in the index. For a lower fleece rot incidence of 5%, direct selection after 10 years yielded no change in fleece rot when the breeding objective maintained fibre diameter and about a 1% reduction in fleece rot susceptibility when the breeding objective reduced fibre diameter.

Table 1. Genetic gains in fleece rot incidence (%) after 10 years of selection from alternative indexes for two breeding objectives including fleece weight and fibre diameter.

Selection criteria*	FD maintained	FD reduced
Index		
CFW + FD	+1.8%	+0.8%
GFW + FD	+0.8%	-0.5%
Direct selection		
CFW + FD + ROT	-1.3%	-2.2%
Indirect selection		
CFW + FD + SL	+0.8%	-0.5%
CFW + FD + WAX	+1.3%	0.0%
CFW + FD + COL	+1.5%	+0.3%
CFW + FD + SL + WAX	0.0%	-1.3%
Combined selection		
CFW + FD + ROT + SL	-1.8%	-2.8%
CFW + FD + ROT + WAX	-1.8%	-2.8%
CFW + FD + ROT + COL	-1.5%	-2.3%
CFW + FD + ROT + SL + WAX	-2.5%	-3.5%

* CFW, clean fleece weight; GFW, greasy fleece weight; FD, fibre diameter; ROT, fleece rot incidence; SL, staple length; WAX, wax content; COL greasy wool colour.

Indirect selection.

Staple length, wax content, fibre diameter variability and greasy wool colour have appeared the most promising of the many traits suggested as means of improving the efficiency of selection for increased resistance to fleece rot. A definitive analysis of the influence of these and other indicator traits on expected responses is not possible as yet, as we have poor estimates of the genetic correlations of the indicator traits with fleece rot, body strike and other production traits. This deficiency needs to be addressed by analysing existing data sets to obtain the necessary genetic parameters.

Compared to direct selection, expected responses in fleece rot resistance from indirect selection were quite inefficient (see Table 1) except at very low incidences. Results for fibre diameter variability are not shown in the table as this trait was more accurate in predicting fleece weight and fibre diameter and led to an increase in fleece rot susceptibility. Greatest response occurred when staple length and wax content were combined under indirect selection. However, using indirect selection in this way was more efficient than direct selection only where average fleece rot incidence was less than 5%.

The inefficiency of indirect selection was due partially to all the traits examined having slight unfavourable correlations with clean fleece weight. The correlations between the indicator traits and fleece weight and fibre diameter were as critical to the effectiveness of indirect selection as the correlation between the indirect traits and fleece rot. It would seem that visually appraised indicator traits are also likely to be relatively inefficient means of selecting indirectly for fleece rot resistance. The other reason for the inefficiency of indirect selection is that although direct selection was not very efficient in itself, where the primary selection is for wool traits, direct selection for the secondary trait, fleece rot, was much more efficient.

Combined selection.

Combining both fleece rot and indicator traits in the index did give some extra response over that possible from direct selection for all indicator traits examined here except greasy wool colour (see Table 1). Including staple length or wax content with fleece rot incidence in the index increased responses by about 0.5%. Both indicator traits together with fleece rot incidence increased response by about 1% over direct selection alone.

Conclusion.

Methods of including body strike resistance in Merino breeding objectives need study to allow genetic evaluation of animals and prediction of selection responses. This will require a more

complete set of genetic parameters to allow estimation of genetic merit for body strike and fleece rot resistance.

Monitoring of genetic progress in the breeding objective

The rate of progress in the ram breeding flock will be determined by the efficiency of the breeding program. It is important for the ram breeder to monitor the selection process and the resultant progress towards the stated breeding objective. This information is of use to the ram breeder and his commercial clients. Two methods of measuring rates of gain are available: analysis of selection emphasis and sire evaluation.

Analysis of selection emphasis.
The selection emphasis is the percentage of the total selection differential applied to the measured traits in an index of a stated breeding objective. Using information on the young animals selected, the actual selection differentials achieved for measured traits can be compared with the potential selection differentials if animals had been selected only on index rank. As selection decisions will also be influenced by unmeasured traits, selection will never be based solely on index rank. The selection emphasis then gives a measure of the importance of the objectively measured traits in the selection process. The relationship between achieved selection and the components of the objective can be monitored.

Sire evaluation.
A measure of actual genetic progress with time can be obtained by combining progeny test information across years. This procedure is best suited to monitoring long-term changes, as information across a number of years is needed to obtain reliable estimates. This is likely to be a more practical method of monitoring genetic progress in body strike and fleece rot resistance. As well, the progeny test information could be used to increase the accuracy of assessing resistance when environmental and management influences in the ram breeding flock lower the occurrence of body strike and fleece rot.

Central Test Sire Evaluation

Central Test Sire Evaluation (CTSE) allows ram breeders to identify superior sires for their breeding programs (Atkins *et al.* 1999). Results can be used to assist in the selection of sires suitable to a range of breeding objectives, as the genetic performances of sires in a large number of traits important to breeders are assessed in CTSE sites located across Australia. At some sites, performance in fleece rot resistance is among the additional traits assessed on a sire's progeny (AE Casey *pers. comm.*). This information could be used by ram breeders to access outstanding sires in fleece rot resistance identified by CTSE for use in their own flocks. The results for fleece rot resistance are not widely available as the information is presented in individual site reports but not the combined reports across sites. To allow ram breeders to capture superior genes for fleece rot resistance, better analytical methods and wider reporting are needed in future.

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