BRIEF COMMUNICATION: Field test of production traits genetically correlated with zearalenone resistance in sheep

N.C. AMYES and C. A. MORRIS

AgResearch Ruakura, Private Bag 3123, Hamilton, New Zealand

Keywords: sheep, zearalenone, production traits, correlation.

INTRODUCTION

Zearalenone is a naturally occurring toxin from the *Fusarium* fungus which grows on pastures in autumn. The toxin has been found in New Zealand from Northland to Southland (Garthwaite *et al*., 1994), but high concentrations are particularly common in the Gisborne/East Coast region. The toxin interferes with reproductive function in susceptible sheep (Smith *et al*., 1986), reducing fertility, ovulation rates and thus lambing percentages. Under research conditions with Romney sheep at Ruakura Research Centre, we have developed a protocol for challenging lambs or yearlings with zearalenone. We measured urine samples approximately four hours after dosing to determine the genetic resistance/susceptibility of sheep to the toxin. The concentration of zearalenone and its breakdown products (Zen) in urine is an inherited trait with a heritability of 0.32 ± 0.10 (Morris *et al*., 2005a). Zen concentration also appears to be related to ovulation rate in ewes challenged with zearalenone (Morris *et al*., 2005b), with the ewes with lower concentrations having higher ovulation rates. A field test has been developed to evaluate animal resistance/susceptibility in ram-breeding flocks. The present study describes this field test in eight industry flocks, yielding a heritability estimate for Zen concentration in urine. The paper also reports preliminary estimates of genetic correlations with production traits.

MATERIALS AND METHODS

The study was carried out on sheep born in 2004 in five Romney flocks, three of which were related, two Coopworth flocks and one Perendale flock. Techniques were approved by the Ruakura Animal Ethics Committee (RAEC #10305). Sampling took place between 14 July and 21 November 2005. The dates were outside the natural Zen season on pasture. There were in total 1,079 yearling rams and ewes evaluated. They were drawn from 80 sire groups, with 54 of the groups having at least 10 progeny per sire represented.

The test for Zen resistance consisted of measuring concentrations of Zen and creatinine (Cr) in urine after administering a standard dose of zearalenone per animal. Animals used were 11 to 14 months of age and averaged approximately 45 kg live weight. Individual doses were administered orally using a drench gun. Each male sheep was dosed with 6 mg of zearalenone. Initially the females were dosed with 4 mg of zearalenone. In later flocks tested, the dose rate was reduced to 3 mg because of the high urinary concentration of Zen found. The concentration of Zen in urine was determined at Ruakura by ELISA (Garthwaite *et al*., 1994). The concentration of Cr in urine samples was determined in a commercial laboratory, and an approximate adjustment for urinary volume was made by using the ratio, Zen/Cr. Subgroups of about 50 animals per flock were dosed at a time, and urine samples were collected approximately four hours later.

Yearling live weights (LW12) and fleece weights (FW12) were also available through data sent in for these animals to the national flock recording scheme, Sheep Improvement Ltd (SIL). About 71% of the animals dosed were females. Their 2- and 3-year-old "litter size born" data recorded in the SIL database were included in the analysis. Only production data for the animals dosed were analysed. Zen/Cr results were standardised and analysed on a within-subgroup within-flock basis. Animal-model restricted maximum likelihood (REML) analyses were used to estimate a heritability for Zen/Cr and genetic correlations with LW12, FW12 and "litter size born" (Gilmour, 1997), including a relationship matrix. The across-flock genetic links were included for the three related Romney flocks. Data in the REML analysis were adjusted for all known fixed effects after preliminary testing using SAS JMP (1995), and these effects were: flock x mob x gender combination, birth type, age of dam, and date of birth as a covariate.

RESULTS AND DISCUSSION

Heritability estimates for standardised Zen/Cr were 0.32 ± 0.15 in the related Romney flocks, and 0.19 ± 0.07 in all eight flocks combined. For comparison, our previous estimate came from a research flock, and had a value of 0.32 ± 0.10 (Morris *et al*., 2005a). From all industry flocks

combined, preliminary estimates of genetic correlations with Zen/Cr were 0.00 ± 0.21 for LW12, 0.10 ± 0.21 for FW12, and 0.28 ± 0.28 for "litter size born". None of the correlation estimates was significantly different from zero.

Thus we have found no evidence in the industry animals of favourable or unfavourable genetic correlations with resistance to Zen although, for "litter size born", data only for 2- and 3-year-olds are available at this stage. Earlier work with research animals had suggested a favourable relationship between resistance to Zen and ovulation rate (Morris *et al*., 2005b). Two of the four years of data collection on the research station involved some degree of natural Zen challenge at pasture during the matings which led to the "litter size born" data.

In the absence of any significant genetic correlations between Zen/Cr and production traits, the only use in selecting to change Zen/Cr would be to change levels of resistance in sheep grazing areas of the country where the toxin is a problem.

Currently there is no commercial service available to analyse zearalenone concentrations in suspect pastures. We had insufficient funds to monitor the paddocks of the eight farms. Another trial would be required to partition measured production traits into records with or without zearalenone toxin intake. The size of the genetic correlation estimates may be affected by the toxin levels.

In a recent review (Smith & Morris, 2006), it was noted that "the terms 'resistant' and 'susceptible', as defined by urinary Zen/Cr ratio, still need clarification with further experimentation, in order to determine whether animal variation in Zen/Cr is principally the result of differences in gastrointestinal absorption rate, metabolic breakdown rate, partitioning differences between the urinary and biliary routes for excretion, or numbers/affinity of available receptors." In addition, one of the breakdown products of zearalenone, (α-zearalenol), is more toxic (oestrogenic) than zearalenone itself (Galtier, 1999), in monogastric animals. The consequence is that an animal's ability to break down other fungal toxins rapidly, which is probably desirable, may be seen as negative in the case of the Zen toxin.

ACKNOWLEDGEMENTS

We thank the eight farmers involved in the study, and Mr Cowley Harris and Ms Jan Sprosen for technical assistance. Funding was kindly provided by Meat and Wool New Zealand's farmer initiated technology transfer (FITT) funding scheme, and by the Gisborne Veterinary Club Charitable Trust.

REFERENCES

Galtier, P. 1999: Biotransformation and fate of mycotoxins. *Journal of toxinology – toxin reviews* **18(3 & 4)**: 295-312.

Garthwaite, I.; Sprosen, J.; Briggs, L.; Collin, R; Towers, N.R. 1994: Food quality on the farm: immunological detection of mycotoxins in New Zealand pastoral agriculture. *Food and agricultural immunology* **6**: 123-129.

Gilmour, A.R. 1997: ASREML for testing fixed effects and estimating multiple trait variance components. *Proceedings of the Association for the Advancement of Animal Breeding and Genetics* **12**: 386-390.

Morris, C.A.; Amyes, N.C.; Sprosen, J.M.; Hawkes, A.D.; Finch, S.C.; Miles, C.O. 2005a: Zearalenone challenge in sheep: Urine sampling to measure response. *Proceedings of the New Zealand Society of Animal Production* **65**: 316-319.

Morris, C.A.; Amyes, N.C.; Smith, J.F.; Sprosen, J.M.; Towers, N.R. 2005b: Zearalenone challenge in sheep: Variation in ovulation rate. *Proceedings of the New Zealand Society of Animal Production* **65**: 320-323.

SAS. 1995: JMP version 3. SAS Institute Inc., Cary, North Carolina, USA.

Smith, J.F.; di Menna, M.E.; McGowan, L.T. 1986: Effect of *Fusarium* culture and zearalenone on the reproductive performance of ewes. *Proceedings of the New Zealand Society of Animal Production* **46**: 255-258.

Smith, J.F; Morris, C.A. 2006: Review of zearalenone studies with sheep in New Zealand. In: Morris, C.A. Myotoxins in New Zealand livestock production. *Proceedings of the New Zealand Society of Animal Production* **66**: 300-324.