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GENETIC PROGRESS IN THE T13 MERINO BREEDING PROGRAM

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SUMMARY
The Towards 13 Micron (T13) breeding program was established by a consortium involving CSIRO Livestock Industries together with six ram breeders, with the objective of developing an ultrafine Merino flock capable of consistently producing wool at the finest end of the national wool clip. From the first mating in 1998, the flock has been selected on a high micron premium breeding objective (currently 30%). Between 1998 and 2003, the cumulative gain in the aggregate genotype of the breeding objective was approximately $40/ewe/year. The largest contribution to this improvement came from fibre diameter, which has been reduced by 2 microns. After an initial increase in clean fleece weight principally brought about by the capture of between bloodline genetic differences in the foundation animals, clean fleece weight has reduced at the rate of 1.7% per year in yearlings, and 1.1% per year in adults.
Keywords: Merino, fibre diameter, selection response

INTRODUCTION
For many years there have been substantial price premiums for fine wool, which can be very large although volatile at the finest end of the Australian clip (Purvis and Swan 2000). While the demand for finer wool is essentially driven by consumer demand for lighter weight fabrics, ultra fine wool also faces strong competition from other apparel fibres, particularly cotton, cashmere, and synthetic microfibres. These factors provided the stimulus to initiate the Towards 13 Micron breeding program, with the objective of demonstrating to the Merino breeding industry that it was possible to significantly reduce fibre diameter in existing fine wool flocks without compromising fleece value. In 2000, a consortium involving CSIRO and 6 superfine ram breeders was formed to take ownership of the breeding program. In this paper we report selection responses observed in the program between 1998 and 2003.

MATERIALS AND METHODS
The T13 consortium. The consortium partners include CSIRO Livestock Industries, which runs the central nucleus flock of 400 breeding ewes, and six ram breeders who have devoted a proportion of their breeding flocks to the consortium (in most cases 150 ewes). The seven flocks are linked through the use of common sires.

Origin and formation of the central flock. In this paper we present results only from the central flock run by CSIRO in Armidale NSW. This flock of 400 ewes was derived from the CSIRO Fine Wool Project, which was a randomly bred resource flock of 2200 ewes maintained between 1990 and 1997 (Swan *et al.* 2000b). The first T13 mating took place in 1998, when approximately 300 ewes and 8 rams were screened on a 17% micron premium index, with high emphasis on fibre diameter while maintaining fleece weight. The index values were derived from a BLUP analysis of all Fine Wool Project animals.

Breeding program in the central flock. The ewes and rams selected for the first mating were mated again in 1999. On the formation of the consortium in 2000, the ewe flock was increased to 400 with the introduction of 1998 drop T13 ewes, and selected 1997 drop ewes from the New England Sire Evaluation flock, which were owned by CSIRO. From the 2000 mating onwards, 8 rams have been mated to 400 ewes annually using AI, with insemination taking place in early March. The rams have been selected by the consortium members, and typically comprise 6 young rams from the central flock (15 months at the time of selection), an older ram to strengthen links to the previous drop, and an outside ram. In total, four outside rams have been used: one identified from Central Test Sire Evaluation, used in 1999 and 2000, and three high performing rams from consortium members' flocks used in 2002, 2003 and 2004. The rate of inbreeding has been limited initially by imposing an arbitrary rule that four grandsires be represented in each drop. Mating of selected rams and ewes was at random until 2003, when mating pairs were allocated to minimise the average inbreeding of the progeny. In the 2004 mating, the TGRM^{TM} software package (Kinghorn *et al.*, 2002) was used to optimise selection and minimise inbreeding.

Selection methods in the central flock. Selection in the central flock is based on an index combining estimated breeding values (EBV's) from a BLUP analysis using all available pedigree. The traits included in the BLUP analysis include greasy and clean fleece weights, mean fibre diameter, coefficient of variation of fibre diameter, staple strength, and body weight, recorded at the yearling and first adult shearings. The genetic parameters used in the analysis were derived from the Fine Wool Project flock. Prior to 2001, the selection index incorporated a 17% price premium for fibre diameter. From the 2001 mating onwards, the consortium decided to increase the emphasis on fibre diameter while maintaining or slightly improving staple strength, and to this end, the fibre diameter premium was increased to 30%, and a 5% staple strength premium was introduced (Swan et al. 2000a). Rams and ewes are first mated at 18 months of age. Apart from those chosen as across-year link sires (primarily on merit), rams are only kept for one mating. Following a light physical cull, ewes are selected on index without a fixed age structure.

Estimation of genetic trends. Genetic trends were estimated by averaging the index values and EBV's within year groups. Although there was no control flock, phenotypic means for each sex are also presented, adjusted for birth effects.

RESULTS

Genetic trend estimates for the current breeding objective (with 30% micron premium), mean fibre diameter and clean fleece weight are shown in Figure 1. Substantial gains have been made in both the aggregate genotype of the breeding objective and in fibre diameter. The initial screening of animals into the T13 flock resulted in large one-off gains of approximately 1 micron in fibre diameter and 5% in clean fleece weight, as shown in Figure 1 by the change between the 1997 and 1998 drops. These gains reflect the capture of genetic differences between the Fine Wool Project bloodlines. With little further selection taking place in the next two matings, the gains from 1998 to 1999 were smaller. From 1999 onwards, linear regressions of average trends on time were \$6.0 (± 0.5) per year in the aggregate genotype of the breeding objective, –0.28 (± 0.05) and –0.29 (± 0.05) microns per year for yearling and adult fibre diameter respectively, and –1.7 (± 0.35) and –1.1 (± 0.43) percent per year for yearling and adult clean fleece weight respectively.

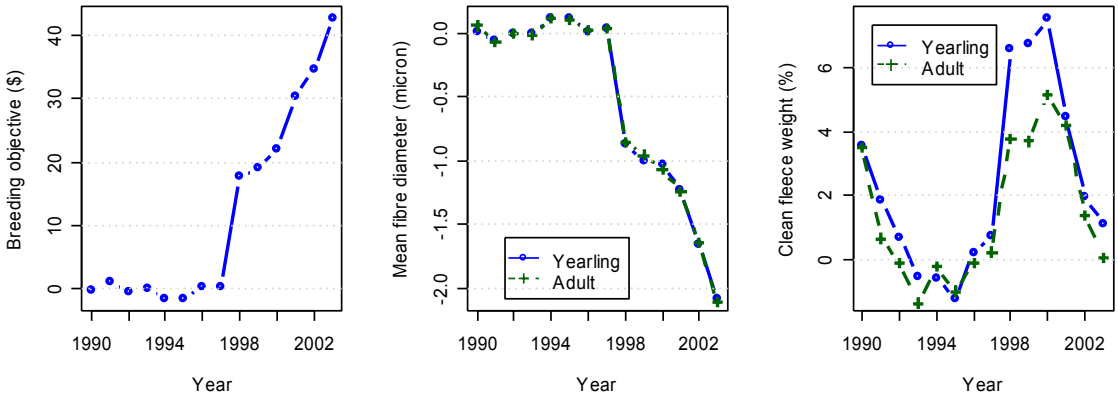

Figure 1: **Genetic trends in the Fine Wool Project (1990 to 1997) and T13 (1998 to 2003) flocks for the breeding objective, mean fibre diameter and clean fleece weight.**

Average inbreeding coefficients by year of birth are shown in Figure 2. There has been a steady increase in inbreeding since the formation of the T13 flock, averaging 0.20 ± 0.14 % per year. With a generation interval in the flock being between 3 and 4 years, the rate of inbreeding has to date therefore been less than 1 % per generation. It should be noted that the mate allocation for the 2003 drop progeny optimised average inbreeding, which does not necessarily reduce the rate of inbreeding over time. Use of TGRM in subsequent years will operate on the co-ancestry of the parents, which is a better method to control the rate of inbreeding.

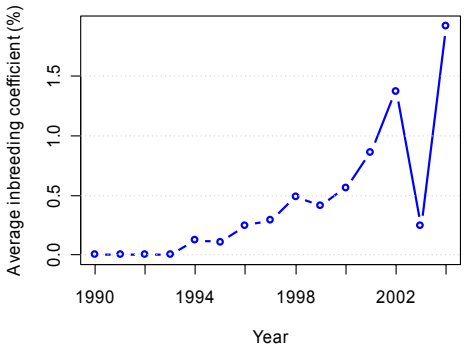

Figure 2: Average inbreeding coefficients by year of birth in the Fine Wool Project (1990 to 1997) and T13 (1998 to 2004) flocks.

Phenotypic means for fibre diameter by year of birth and sex are shown in **Error! Reference source not found.** (means for rams' adult fibre diameter are not shown because the majority of rams are

Table 1: Adjusted phenotypic means by year of birth (drop) and sex for yearling and adult fibre diameter (micron).

Drop	Yearling FD		Adult FD
	Rams	Ewes	Ewes
1998	15.3	15.5	17.6
1999	15.5	15.8	17.3
2000	15.8	16.1	17.0
2001	15.0	15.3	17.3
2002	16.0	16.2	16.8
2003	14.3	14.5	

culled at 15 months of age). The genetic trends in Figure 1 show reductions of the order of 1 micron in both yearling and adult fibre diameter from 1998 to 2003. The phenotypic performance realised in the flock under the environmental conditions experienced over that time has shown a similar reduction (table 1), although the absence of a control flock makes this comparison difficult.

DISCUSSION

Substantial progress has been made in the breeding objective of the T13 flock, principally through a cumulative genetic reduction of around 2 microns in fibre diameter between animals born in 1998 and 2003. After an initial lift in clean fleece weight when establishing the flock, fleece weight has declined to the level of the 1997 drop. This reduction in fleece weight does not match expectations based on the genetic parameters estimated from the Fine Wool Project flock: Swan *et al.* (2000a) predicted that use of a 30% micron premium index with staple strength at 5% premium would lead to virtually no change in fleece weight and a 3 micron reduction in fibre diameter over the life of a 10 year breeding program. However, it should be noted that these predictions were based on within flock genetic parameters, and a proportion of the genetic change occurring in the flock is the result of across flock selection.

The T13 consortium has demonstrated that rapid genetic progress in developing an ultrafine Merino flock is possible. With ongoing use of appropriate genetic technologies, we expect the flock to continue reducing fibre diameter at a rate comparable to the first 6 years of the program.

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