

**REPRODUCTIVE PERFORMANCE OF INDIAN CROSSBRED DECCANI EWES  
CARRYING THE *FecB* MUTATION**

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**SUMMARY**

This paper presents the results of introgression of the *FecB* mutation influencing prolificacy from the small Garole sheep of West Bengal into the Deccani sheep of the dry, monsoonal Deccan plateau. It was found in the breeding program at the Nimbkar Agricultural Research Institute (NARI) that one copy of the mutation increased the number of lambs born alive per ewe lambing (NLB) by 0.54. The effect of the mutation on NLB appeared to be almost completely dominant. The number of lambs alive at 3 months per ewe lambing increased by 0.41 with one copy of the mutation and the total weight of 3-month old lamb produced increased by 17%. Heterozygous and homozygous ewes tended to have lower weights as they were not subjected to much selection pressure for body weight or growth. The performance of *FecB* carrier ewes born in local smallholders' flocks following the introduction of carrier rams produced in the NARI breeding program is currently being evaluated.

**INTRODUCTION**

The Deccani is an indigenous sheep breed reared in three southern Indian States with a total population of about 20 million. Deccani sheep are maintained by smallholders (flock size ranging from 20 to 200), grazing them on crop residues, fallow lands and hilly areas. These sheep have an average litter size of 1.02. They are kept mainly for lamb production and lambs are sold at the age of 3.5 to 4 months at weights ranging from 10 to 15 kg.

The *FecB* or Booroola mutation in sheep is an autosomal dominant mutation that has a large effect on ovulation rate. *FecB<sup>B</sup>* is the allele at this locus promoting higher fecundity while *FecB<sup>+</sup>* is the wild type allele. The *FecB<sup>B</sup>* allele does not exist in the Deccani breed (Pardeshi *et al.* 2005). It has been introduced from the small prolific Garole sheep breed into the Deccani breed at the Nimbkar Agricultural Research Institute (NARI) in southern Maharashtra State. The aim is to improve the productivity and efficiency of Deccani sheep to improve the standard of living of the smallholders who rear them and to increase meat production in accord with Indian Government priorities. Two *FecB* carrier crossbred types are being developed – one involving only the Deccani and Garole breeds and the other including Bannur and/or Awassi breeds in addition. The breeding program is being implemented rigorously at NARI. In addition, rams carrying the *FecB* mutation have been introduced into local smallholder shepherds' flocks under NARI supervision. There are now about 150 *FecB* carrier adult ewes in 15 local flocks linked to the program.

Diallel crossing for breed evaluation was carried out at NARI from 1996-99 using Garole, Deccani and Bannur breeds. Backcrossing of these F1 ewes with Deccani rams was started in 2000 as the Garole is small, has an inferior mothering ability to that of the Deccani and it is not adapted to the

sheep rearing conditions of Maharashtra. The tropical Israeli dairy Awassi breed was imported into India by NARI and has been used in the breeding program from 2001 to develop a fecund composite type. The direct DNA test for the *FecB* mutation became available to the breeding program in 2001.

This paper aims to assess the profitability of introduction of the *FecB* mutation by analyzing the reproductive performance of *FecB* carrier and non-carrier ewes that lambed at NARI from 2001-06.

## MATERIALS AND METHODS

**Location, climate and animal management.** The region where the work was carried out is at latitude 18° north and longitude 74° east. It is situated on the Deccan plateau and has a dry monsoonal climate. Ewes were herded for grazing by the day in one or more flocks and housed in open-sided sheds at night. Lambs of ewes which did not secrete sufficient milk were cross-fostered for the first 3 months to ewes with ample milk or those which had aborted or otherwise lost their lambs. The number of such lambs was small and there was no consistency in cross-fostering. Ewes and all lambs were given supplementary feed from 2001 and 2003 onwards respectively.

**Traits analyzed.** Traits analyzed were number of lambs born alive (NLB), number of lambs alive at 3 months (NLW) and total weight of 3-month old lamb produced (WNWT) per ewe lambing. Only lambings with at least one live lamb born were considered for the analysis. The total number of records was 2161 with 1542 records of non-carrier ewes, 601 of heterozygous and 18 of homozygous ewes. Out of these, 1799 records were of single births, 332 of twin births (38 born to non-carrier ewes, 284 to heterozygous ewes and 10 to homozygous ewes) and 30 of triplet births (1 born to a non-carrier ewe, 27 to heterozygous ewes and 2 to homozygous ewes). Mortality to 3 months of age among single, twin and triplet lambs was 8%, 16% and 22% respectively.

**Models of analysis.** The linear model used for all 3 traits was as follows:

$$y = \mu + Xb + W_1g + S_1h + Z_1a + Z_2pe + e$$

where  $y$  is a vector of observations on the ewe,  $\mu$  is the overall mean,  $b$  and  $g$  are vectors of fixed effects and direct breed effects respectively,  $h$  is a vector of fixed heterosis effects,  $a$  and  $pe$  are vectors of random additive genetic effects of the ewe and permanent environmental effects of the ewe (where ewes have more than one record) and  $e$  is a vector of residuals.  $X$  is the incidence matrix of fixed effects,  $W_1$  is a matrix of breed proportions and  $S_1$  is a matrix of overall heterosis coefficients. Breed effects for Garole, Bannur and Awassi breeds were fitted so they could be compared against the Deccani breed. Individual heterosis coefficients were calculated as the expected proportion of loci with alleles from any two different parental breeds out of Deccani, Garole, Bannur and Awassi.  $Z_1$  and  $Z_2$  are incidence matrices relating observations to the associated random effects. The pedigree of each animal was traced as far back as known and all pedigree relationships were used in the analysis. The ASReml program (Gilmour *et al.* 2002) was used for the analysis. The traits were analyzed separately in univariate models.

**Fixed effects.** The fixed effects tested and included in the models if significant were, ewe's *FecB* genotype, year and season of lambing and parity group (Model 1). Ewe parity ranged from 1-10 and was divided into 4 groups: first, second, third (parities 3-5) and fourth (parities 6-10). A regression on the age of the lamb at weighing was included in the model for WNWT. A separate model (Model 2) was run for WNWT with NLB as a fixed effect instead of the ewe's genotype to estimate the effect of NLB on WNWT independent of *FecB* genotype. Significant two-way interactions between fixed effects and fixed effects and breed proportions were fitted. However, some interactions arose between

ewe genotype and year of lambing, season of lambing and parity group with few observations per subclass for *FecB<sup>B</sup>* homozygous ewes and complete lack of observations on homozygous ewes in 2001. It was considered appropriate not to fit these interactions.

**RESULTS AND DISCUSSION**

Fixed effects significant for all three traits were ewe’s *FecB* genotype, year of lambing and parity group. Garole, Bannur and Awassi breed effects were significant only for WNWT. Garole and Bannur breed effects were negative while the Awassi breed effect was positive. Heterosis was not significant for any of the traits. The additive genetic effect of the ewe improved the likelihood of the model significantly for NLB and WNWT while the permanent environmental effect of the ewe was significant only for NLB. The estimated heritability and repeatability of NLB were 0.05±0.03 and 0.11±0.04 respectively while the estimated heritability of WNWT was 0.07±0.02. Least squares means (LSM) for the three traits for the effect of ewe’s *FecB* genotype (Model 1) are given in Table 1. The LSM for the fixed effect of NLB estimated using Model 2 are shown in Table 2.

**Table 1. Least squares mean (LSM) and standard error (SE) of NLB, NLW and WNWT (kg) for ewe’s *FecB* genotype estimated using Model 1**

Ewe’s <i>FecB</i> genotype	Number of records	NLB		NLW		WNWT	
		LSM	SE	LSM	SE	LSM	SE
<i>FecB<sup>+</sup>/FecB<sup>+</sup></i>	1542	1.03	0.01	0.95	0.01	11.15	0.22
<i>FecB<sup>B</sup>/FecB<sup>+</sup></i>	601	1.57	0.02	1.36	0.02	13.01	0.29
<i>FecB<sup>B</sup>/FecB<sup>B</sup></i>	18	1.75	0.08	1.40	0.10	11.88	1.15
Overall SED		0.07		0.08		0.96	

**Table 2. LSM and SE of WNWT (kg) for the fixed effect of NLB estimated using Model 2**

NLB	Number of records	LSM	SE
Single	1799	11.21	0.19
Twin	332	15.64	0.42
Triplet	30	20.25	1.33

One copy of the *FecB* mutation increased NLB by 0.54 and NLW by 0.41 and the second copy added 0.18 to NLB and 0.04 to NLW. This increase in NLB due to the *FecB* mutation is modest and manageable in smallholder flocks. Genes other than *FecB* from any of the other breeds including the Garole did not contribute significantly to differences in NLB as indicated by the non-significance of breed effects for NLB. The increase in NLB with one copy in this study is slightly higher than the increase of 0.45 in heterozygous Assaf ewes in Israel reported by Gootwine *et al.* (2003). However, it is substantially lower than the figure of 0.9 reported for Merinos in earlier publications (Davis *et al.* 1982; Piper *et al.* 1985). The effect of the *FecB* mutation on NLB appears to be almost completely dominant although this needs to be confirmed after more litter size records of homozygous ewes become available. This is similar to the conclusions of Davis *et al.* (1982) and Gootwine *et al.* (2003).

Twin-bearing ewes produced 4.4 kg (40%) more weight of lamb than single-bearing ewes and triplet-bearing ewes produced 4.6 kg (30%) more than twin-bearing ewes. Heterozygous ewes

produced 1.9 kg (17%) more weight of lamb than non-carrier ewes. They gave birth to only about half a lamb more and weaned 0.41 of a lamb more. *FecB<sup>B</sup>* homozygous ewes produced 0.7 kg more weight of lamb than non-carrier ewes. The number of homozygous ewes in this study is too small to arrive at a firm conclusion about the extra benefit of the second copy of *FecB<sup>B</sup>*.

The study of Meyer *et al.* (1994) also found a two kg increase in the weight of lamb weaned per ewe weaning lambs for *FecB<sup>B</sup>/FecB<sup>+</sup>* ewes compared to non-carrier ewes. However, in their study, the *FecB* mutation caused a large increase of 1.1 in litter size leading to more multiple births and higher lamb mortality. This study found a modest increase in litter size and therefore a limited but important increase in lamb weight produced by heterozygous ewes. The results of this study are encouraging in view of the fact that non-carrier ewes were subjected to a much higher selection pressure for body weight while heterozygous ewes were subjected to only 10% selection pressure since the priority was to build up their numbers and homozygous ewes were not selected at all. Performance of heterozygous and homozygous ewes can be expected to improve with selection. In this study lambs of all birth types were given supplementary feeding from 2003 to maximize lamb survival. The economic benefits of multiple births can be maximized by giving supplementary feed to only multiple-born lambs that need it.

#### **CONCLUSIONS**

One copy of the *FecB* mutation led to an increase of 0.54 in the number of live lambs born, 0.41 in the number of lambs weaned and a 17% increase in the weight of lamb produced per ewe lambing. The increase in litter size brought about by the second copy (0.18) is also modest and manageable in smallholder flocks. Heterozygous and homozygous ewes in this study were not subjected to much selection pressure for body weight. Improved management and feeding of pregnant and lactating ewes and lambs would reduce lamb mortality in a cost effective manner and increase the weight of lamb weaned by twin- and triplet-bearing ewes.

#### **ACKNOWLEDGEMENTS**

This research was funded by the Australian Centre for International Agricultural Research from 1998-2007 under projects AS1/1994/022 and AH/2002/038.

#### **REFERENCES**

- Davis, G. H., Montgomery, G. W., Allison, A. J., Kelly, R. W. and Bray, A. R. (1982) *N.Z. J. Ag. Res.* **25**:525.
- Gilmour, A. R., Gogel, B. J., Cullis, B. R., Welham, S. J. and Thompson, R. (2002) ASReml User Guide Release 1.0. VSN International Ltd., Hemel Hempstead, U.K.
- Gootwine, E., Rozov, A., Bor, A. and Richer, S. (2003) In Proc. "Int. workshop on major genes and QTL in sheep and goat". Toulouse, France. CD-ROM communication n°2-12.
- Meyer, H. H., Baker, R. L., Harvey, T. G. and Hickey, S. M. (1994) *Livest. Prod. Sci.* **39**:191.
- Pardeshi, V.C., Sainani, M. N., Maddox, J. F., Ghalsasi, P. M., Nimbkar, C. and Gupta, V. S. (2005) *Curr. Sci.* **89**:887.
- Piper, L. R., Bindon, B. M. and Davis, G. H. (1985) In "Genetics of Reproduction in Sheep", p.115, editors R. B. Land and D. W. Robinson, Butterworths.