LAMB PRODUCTION BY *FecB* HETEROZYGOUS CARRIER AND NON-CARRIER EWES IN SMALLHOLDER FLOCKS IN MAHARASHTRA STATE OF INDIA

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INTRODUCTION

A breeding program for the introgression of the *FecB* (Booroola) prolificacy gene from the small Garole breed into the Deccani breed and a composite has been established at the Nimbkar Agricultural Research Institute (NARI) at Phaltan in the dry monsoonal climate of southern Maharashtra State of India. The new crossbred type with only Deccani and Garole breeds was termed 'Fecund Deccani' (FD) and the type which also comprised Bannur and/or Awassi breeds was termed 'Fecund Composite' (FC) (Nimbkar *et al*., 2002). Nimbkar (2006) reported that one copy of the *FecB* gene increased litter size per ewe conceived by 0.37 lambs and per ewe lambing by 0.64 lambs in Deccani and crossbred ewes at NARI. The objective of this program is to increase the efficiency and profitability of lamb production in smallholder flocks in this Deccan plateau region. The *FecB* gene was introduced into local smallholder flocks of Deccani sheep through introduction of heterozygous rams, artificial insemination using semen of heterozygous and homozygous rams and introduction of heterozygous crossbred ewes. Rams and ewes of both FD and FC types were used for introduction.

This paper presents preliminary results of the number of lambs born and weaned per ewe lambing for heterozygous and non-carrier ewes introduced into or produced in those smallholder flocks.

MATERIAL AND METHODS

Location.
Phaltan is situated at latitude 18^0 north and longitude 74^0 east.

Ewes.
Lambing records available were of 1055 non-carrier and 28 heterozygous ewes born in 26 smallholder flocks and 59 non-carrier and 59 heterozygous ewes introduced from NARI into 14 of the 26 flocks, about a month and 2.5 months before lambing in 2003 and 2004 (Table 1). The ewes were introduced into 11 flocks within 6 km and three flocks at a distance of 22 km from the Institute's farm near Phaltan. All 118 heterozygous and non-carrier ewes introduced by NARI were crossbred (FD or FC). All 28 heterozygous ewes and twelve of the non-carrier ewes born in smallholder flocks were crosses.

Table 1. Number of ewes and number of lambing records from ewes of different origin and *FecB* genotype in smallholder flocks around Phaltan in Maharashtra State of India

	FecB genotype of ewes					
Origin of ewes	$FecB^+/FecB^+$		$FecB^B/FecB^+$		Total	
	Ewes	Records	Ewes	Records	Ewes	Records
Smallholder flocks	1055	2501	28	35	1083	2536
NARI	59	141	59	138	118	279
Total	1114	2642	87	173	1201	2815

The Deccani ewes already present in smallholder flocks were assumed to be non-carriers of *FecB* based on earlier studies (Pardeshi *et al*., 2005). The ewes introduced by NARI and those born in smallholder flocks were genotyped using the direct DNA test (Wilson *et al*., 2001). Back pedigrees of ewes in smallholder flocks were not available. Forty two of the ewes introduced by NARI (23 non-carriers and 19 carriers) lambed/aborted twice during the calendar year 2005.

Traits recorded and analyzed.
All lambings in 26 smallholder flocks were recorded to 31 December 2005 and lambs were eartagged by NARI staff. There was at least one weekly visit to each flock. The abortions reported by flock owners were recorded but it is possible that some abortions were not detected. All animals in these flocks were weighed every two months. All flocks were grazed by their owners under the traditional sheep-rearing system practised on the Deccan plateau. Some flocks migrated during the dry season between November and June. Some flock owners fed wheat flour dough to all their lambs in some seasons. They cross-fostered twin-born lambs to other ewes in the flock if their dams did not have enough milk. The only management interventions made by NARI were flock vaccination and treatment of sick ewes and lambs.

The ewe traits analyzed using the ASReml program (Gilmour *et al*., 2002) were

1. Total number of lambs born per ewe lambing (TNLB)
2. Number of lambs born alive per ewe lambing (NLBA)
3. Number of lambs weaned (at 3 months) per ewe lambing (NLW)

Abortions and stillbirths were included in the data. TNLB, NLBA and NLW were zero for abortions. The number of stillborn lambs was included in TNLB. The traits TNLB, NLBA and NLW were analyzed as Poisson variables with a log link and only fixed effects were fitted. Fixed effects tested were Lambing year (LYR), Lambing season (LSN), Lambing flock (LFL), Ewe's *FecB* genotype (GTP), Ewe's parity group (PAR), Ewe's breed type (BR), Ewe's genetic origin (ORIG), Natural or induced oestrus (OEST, 2 levels).

The lambing years were 2003, 2004 and 2005 and lambing seasons were cool dry (November to February), hot dry (March to May) and hot wet (June to October). There were 26 lambing flocks. Ewe's genotype was heterozygous or non-carrier and ewe parity was divided into three groups – first, second and third or higher. The three classes of breed group were, Deccani, FD and FC. The genetic origin of ewes was either smallholder flocks or NARI.

The survival up to three months of 28 lambs could not be recorded as the work in five flocks had to be stopped due to unforeseen circumstances. One hundred and seventy two of the lambs were younger than three months at the end of 2005 so NLW records of their dams were not available. There were only eight triplets among second and higher parity heterozygous ewes.

RESULTS AND DISCUSSION

Significance of fixed effects.
The significance levels of fixed effects are reported in Table 2. GTP was highly significant for TNLB and NLBA but not significant for NLW. LYR and PAR were significant for NLBA and NLW. None of the two-way interactions between fixed effects was significant.

Table 2. Significance of fixed effects for the traits analyzed

Effect	TNLB	NLBA	NLW
Fixed effects	Probability (P) values		
Lambing year (LYR)	0.177	**0.044**	**0.002**
Lambing season (LSN)	0.593	0.592	0.431
Lambing flock (LFL)	0.997	0.990	0.995
Ewe's *FecB* genotype (GTP)	**< 0.001**	**< 0.001**	0.261
Ewe's parity group (PAR)	0.110	**0.051**	**0.020**
Ewe's breed type (BR)	0.986	0.875	0.322
Ewe's genetic origin (ORIG)	0.417	0.681	0.795
Natural or induced oestrus (OEST)	0.346	0.151	0.183

Note: P values considered significant are in bold.

Least squares means of TNLB, NLBA and NLW for the significant fixed effects are reported in Table 3. One copy of *FecB* increased TNLB by 0.49, NLBA by 0.32 and NLW by 0.09. This lower-than-expected increase in NLW was due to high lamb mortality of twins (29%) and triplets (53%) among live lambs born to introduced carrier ewes. However, genetic group and possible differences in the treatment of ewes by flock owners rather than type of birth might be possible explanations of this mortality as there was only 5% mortality among live twin lambs born to non-carrier ewes. Almost an equal number of heterozygous (60) and non-carrier (64) ewes had live twin lambs although twin lambings as a proportion of total lambings differed vastly (35% vs. 2%) between the two genotypes. BR and ORIG were not significant probably because they were partially confounded with GTP. There were only 35 records of heterozygous ewes born in smallholder flocks, nine of which were abortions, 17 single births and nine twin births. NLW records were available for only five of the nine twin lambings and both lambs survived for all these. The introduced ewes were at least 25% Garole and negative direct and maternal effects of the Garole on lamb survival and weight have been reported (Nimbkar, 2006). Introduced ewes had not been subjected to much selection either. There was higher mortality (13%) also among singles born to introduced heterozygous ewes compared to 5% among lambs of non-carrier ewes.

Table 3. Least squares means (LSM) and standard errors (SE) for TNLB, NLBA and NLW for significant fixed effects (n = number of records)

		TNLB	NLBA		NLW
***FecB* genotype**	n^A	LSM ±SE	LSM ±SE	n^A	LSM ±SE
$FecB^+/FecB^+$	2642	0.98±0.02	0.93±0.02	2458	0.85±0.02
$FecB^B/FecB^+$	173	1.47±0.09	1.25±0.09	157	0.94±0.08
Overall SE of difference (SED)		0.07	0.07		0.09
Lambing year					
2003	985	not significant	1.13±0.05	985	0.95±0.05
2004	932		1.10±0.05	930	0.95±0.05
2005	898		1.00±0.05	700	0.79±0.04
SED			0.05		0.05
Parity group					
First	404	not significant	0.98±0.06	378	0.79±0.06
Second	542		1.14±0.06	503	0.96±0.06
Third and higher	1869		1.12±0.06	1734	0.93±0.04
SED			0.06		0.07

CONCLUSION

Introduction of *FecB* heterozygous ewes in smallholder flocks increased lambing rate significantly but within manageable limits. Number of lambs weaned was only marginally higher. The lower survival of lambs born to heterozygous ewes was partly attributed to the ewes being introduced into these flocks, with associated problems such as adaptation and acceptance by flock owners. Dissemination of an improved breed in subsistence situations should be made through introduction of rams or artificial insemination. More lambing and survival data from *FecB* heterozygous ewes born in smallholder flocks will reveal whether the introgression of the *FecB* gene will have overall positive effects on lamb production.

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