A Comparison of the Growth Performance and Worm Resistance of Lambs Produced by Diallel Crossing of Three Indian Sheep Breeds

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ABSTRACT: As part of a project aimed at increasing the efficiency of sheep meat production in Maharashtra state, rams of the Deccani (D), Bannur (B) and Garole (G) breeds were mated to D and B ewes in an incomplete diallel design over a 3 year period. Progeny were evaluated for growth rate and resistance to gastrointestinal nematodes. The Deccani is the local woolly meat sheep, the Bannur a hairy meat sheep and the Garole a small but highly fecund woolly meat sheep. Lambs sired by D and B rams had higher birthweights and growth to 6 months than those sired by G rams. Lambs sired by G and B rams were more resistant to naturally acquired worm infections and to artificial challenge with *Haemonchus contortus* than those sired by D rams.

Key Words: Lambs, Indiaan Sheep breeds, Worm Resistance, Cross Breeding, Growth Performance

INTRODUCTION

On the semi-arid Deccan plateau of Maharashtra State of India, about 3 million Deccani sheep are reared for meat. Sheep rearing is the traditional way of life for the 'Dhangar' community but sheep are also reared by disadvantaged sections of other communities who are either landless or have soils too poor for remunerative crop cultivation. About 70% of the flocks are seasonally migratory. Sheep occupy a special niche in the agricultural production system.

To meet the increasing demand for sheep meat and skins, there is a need to improve the economic efficiency of sheep production (Rath, 1992). Prolificacy is an important trait in meat producing sheep (Greeff *et al*., 1995) and Deccani sheep usually have a single lamb. Breeding a woolless sheep is a high priority since the returns from sale of the Deccani's coarse wool do not cover the cost of shearing. Genetic resistance to worms is also important since indiscriminate use of anthelmintics is increasing in India and emergence of resistance to dewormers in *H. contortus* has been reported (Singh *et al*., 1998). Genetic variation in resistance to gastrointestinal nematode infection is widespread in sheep and is used in sheep breeding programs outside India (Gray, 1995).

With the aim of introducing prolificacy, better carcass conformation and woollessness into Deccani (D) sheep, NARI imported the prolific but small Garole (G) breed of woolly meat sheep from West Bengal State and the Bannur (B) breed of hair sheep which has excellent carcass conformation, from adjoining Karnataka State. The range of mature liveweights in NARI flocks of the three breeds is 25 to 38 kg, 23 to 35 kg and 12 to 20 kg and the average litter size is 1.04, 1.01 and 1.74 for the D, B and G respectively. The G sheep are native to Sunderban, the humid and swampy delta area of the river Ganga. It was, therefore, felt that the G might be more resistant to gastrointestinal nematodes than the D or B.

This paper reports the results of 3 years of crossbreeding aimed at determining the most appropriate cross to achieve the objective of efficient meat production in the Maharashtra sheep production system.

MATERIALS AND METHODS

1. Experimental design

A complete diallel breeding design with the D, B and G breeds could not be achieved because of insufficient numbers of G ewes. Consequently an incomplete diallel design was used with pure G ewes not included. The incomplete diallel breeding was carried out once each year for three years from 1996 to 1998 inclusive. The number of lambs born to the different genotypes is given in Table 1 below.

Table 1. Number of lambs born each year classified by genotype

Sire	Dam	1996	1997	1998	Tot.
Garole	Deccani	20	21	24	65
	Bannur	13	12	23	48
Bannur	Deccani	21	20	39	80
	Bannur	15	12	21	48
Deccani	Deccani	22	21	34	77
	Bannur	13	11	21	45

2. Location and ewe management

The work was carried out at NARI, 110 km SW of Pune on the Deccan plateau. The average annual rainfall in this area is 500 to 600 mm and 80% of it falls between August and October. Inseminations were arranged so that lambs were

born between November and January. This was at the beginning of the dry season which lasts for 7-8 months. The difference in age between the youngest and the oldest lamb in any one year was not more than 50 days.

Sheep management was kept as similar to that of local non-migratory shepherds' flocks as possible. Sheep were grazed on native and improved pastures, sometimes irrigated, and seasonally on crop residues in harvested fields and in pomegranate orchards. They were housed every night apart from the summer when they were folded on empty fields.

Because of the small size Garole rams cervical artificial insemination (A.I.) was adopted as the method of breeding. Ewes were inseminated at natural oestrus (detected by vasectomised teaser rams) for a period of two oestrus cycles during June to August each year with fresh, diluted semen. All pregnant ewes were subsequently run together in one flock.

3. Lamb management and weight recording

Lambs were identified with ear tags at birth, weighed and their pedigrees, descriptions and birth weights recorded. Thereafter, they were weighed every month on electronic weighing scales. Lambs were stall-fed with green *Leucaena leucocephala* leaves until the age of one month when they went out to graze with their dams. Male lambs were castrated at the age of 2.5 to 3 months, using either elastrator rings or a Burdizzo's castrator.

All lambs were grazed in the same flock as their mothers at all times apart from the first month after weaning. In 1996 and 1997, lambs were weaned at the age of 2.5 to 3 months. In 1998, they were weaned when they reached 14 kg weight or 4 months of age. The average age at weaning in 1998 was 112 days which is similar to the age at which local shepherds wean and sell male lambs. Female lambs for replacement in village flocks are not weaned and they are always in the same flock as their mothers.

4. Monitoring of faecal worm egg count (FEC) and packed cell volume (PCV)

FEC of lambs was measured monthly from the age of 3 months. Lambs born in 1997 did not develop sufficient FEC from natural challenge to allow comparison of different genotypes. Lambs born in 1998 developed higher counts and FEC and PCV was measured on three occasions, 15 days apart. In both 1997 and 1998 lambs were also artificially challenged with a local strain of *Haemonchus contortus* isolated and multiplied at NARI. The 1997 lambs were each drenched with 10,000 L-3 larvae on two separate occasions while the 1998 lambs received 4,000 L-3 once due to reduced availability of larvae. FEC was determined at day 21 and 28 post infection.

After determination of FEC, the faecal samples were pooled and cultured. L3 stage larvae were harvested from the culture, killed and stained with Gram's iodine and the morphology of at least 100 larvae was studied for species differentiation. Larval species were identified by observation of the head and tail pieces of the larvae. Exsheathing of larvae was done if necessary for species identification.

The packed cell volume (PCV) of lambs born in 1998 was determined using the microhaematocrit method.

5. Statistical analysis

All data were analysed using general linear modelling procedures (SuperANOVA, Abacus Concepts Inc., CA). Lamb weight and growth data were examined by fitting the fixed effects of sex, year of birth, breed of sire, breed of dam, parity and significant first order interactions among fixed effects. Weaning efficiency was defined as the weight of lamb weaned per weight of ewe joined. This was analysed within the Deccani breed only so that the effect of type of birth could be fitted. Weaning age was used as a covariate for this analysis.

FEC data for natural infection in 1998 lambs were cube root transformed ($FEC^{0.33}$) and analysed using repeated measures analysis. The fixed effects fitted were sex, breed of sire and breed of dam with age of lamb as a covariate. All second and third order interactions among fixed effects were also fitted because they were significant. $FEC^{0.33}$ data for artificial challenge were analysed by fitting sex, breed of sire and breed of dam as fixed effects and all significant first order interactions.

PCV of lambs was also analysed using repeated measures with fixed effects of breed of sire and breed of dam since the effect of sex was not significant.

RESULTS

1. Conception rates after cervical A.I.

The average conception rate over 3 years for first insemination was 76% for D ewes and 67% for B ewes.

2. Liveweight, growth and weaning efficiency

Liveweight and growth results are summarised in Tables 2 and 3. The weaning efficiency of single-bearing and twin-bearing Deccani ewes was 0.43 and 0.62 respectively ($P<0.001$).

Table 2. Statistical significance of fixed effects and interactions fitted in the model for analysis of birth weight (BW), liveweight (LW) and growth traits (*** = P < 0.001, ** = P < 0.005, * = P < 0.05).

Fixed effects	BW	3m. LW	6m. LW	Growth to 6 m.
Sex (S)	*	***	***	**
Year (Y)	***	**	***	***
Sire breed	***	***	***	***
Dam breed	P=0.98	P=0.64	P=0.81	P=0.75
Parity (P)	***	P = 0.09	**	*
S x Y	P=0.24	not fitted	*	**
SB x DB	P=0.22	not fitted	*	*
Y x P	P=0.06	*	***	***
DB x P	P=0.13	**	*	*

The effect of sire breed was highly significant for all traits examined while the effect of dam breed was not significant for any of the traits. The interaction between sire breed and dam breed was significant for weight at 6 months and growth to 6 months.

Lambs sired by G rams had significantly lower weights and growth rates than those sired by D and B rams while there was no significant difference between the weights of lambs sired by B and D rams. The estimate of heterosis due to crossing between D and B breeds was 0.8 kg for weight at 6 months and there was a maternal effect of 0.4 kg in favour of D mothers.

3. FEC following natural challenge (1998)

The average FEC of lambs born in 1998 was 664 epg at the age of 6 to 7 months, 1354 epg at 7.5 to 8.5 months, 1580 epg at 8 to 9 months and 1064 epg at 8.5 to 9.5 months. Larval species differentiation indicated *H. contortus* to be predominant (80 to 90%) with *Trichostrongylus spp*. making up the remaining 10 to 20%. The least squares means of the last three FEC measurements are reported in Table 4. All the main effects fitted viz. sex, breed of sire, breed of dam and the age of the lamb as a covariate as well as all second, third and fourth order interactions were significant while the effect of time was not significant in the FEC analysis. The sex x sire breed interaction revealed that female Deccani lambs had lower FECs than malke Deccani lambs (704 vs 1393 epg P<0.01) There was no sex effect for either sire

Table 4. Backtransformed least squares means of $FEC^{0.33}$ of 7-9 months old lambs born in 1998 after natural challenge from pasture.

Sire breed	Dam breed	No. of lambs	L.S.M. FEC (epg)
Garole[a]	Deccani	19	829[ab]
	Bannur	15	604[a]
Bannur[b]	Deccani	36	855[b]
	Bannur	17	1031[b]
Deccani[b]	Deccani	9	1150[b]
	Bannur	17	881[b]

[ab]Means within columns not sharing a common letter in the superscript are significantly different (P<0.05).

GxB lambs had significantly lower FEC than BxD, BxB and DxD lambs (P<0.05). Exploration of the sire breed x dam breed x period interaction revealed a significant heterotic depression of FEC (-617 epg) in the BxD and DxB crosses relative to the purebreds in the first, but not subsequent, samples. Lambs of G and B sires had significantly higher overall PCV values (P<0.05) than those sired by D rams (27.1, 27.4 and 25.7% respectively).

4. FEC following artificial challenge (1997, 1998)

In 1997, the effects of sire breed (P<0.05), dam breed (P<0.05) and sampling date were significant while in 1998, the effects of sex (P<0.001), sire breed (P<0.05) and sampling date (P<0.001) were significant. In 1998, ewe lambs had significantly lower FEC than wethers (LS means of 367 and 1239 epg respectively). Effects of sire breed on FEC and PCV are shown in Table 5. Lambs sired by G rams had lower FEC than those sired by D and B rams in 1997 (P<0.05). Lambs sired by B rams had lower FEC and higher PCV than those sired by D rams in 1998 (P<0.05).

Table 3. Mean liveweights and growth rates of lambs sired by Garole, Bannur and Deccani rams

Sire breeed	Birth weight (kg)			Weight 3 m. (kg)			Weight 6 m. (kg)			Gr. to 6 m. (gm/d)		
	n	Mean	S.E.	n	Mean	S.E.	n	Mean	S.E	n	Mean	S.E.
Garole	98	2.3[a]	.05	85	11.5[a]	0.3	53	14.1[a]	0.4	53	68[a]	3
Bannur	114	2.5[b]	.05	94	12.2[b]	0.3	70	16.9[b]	0.4	70	81[b]	3
Deccani	104	2.6[b]	.05	75	12.5[b]	0.3	61	17.1[b]	.05	61	82[b]	3

[ab] Means within columns with different superscripts differ significantly (P<0.05).

Table 5. Backtransformed least squares means of $FEC^{0.33}$ and PCV after artificial challenge (with *H. contortus*) of lambs born in 1997 and 1998.

Sire breed	n	FEC (epg) 1997	n	FEC (epg) 1998	PCV (%) 1998
Garole	11	783^{a}	34	625^{ab}	27.2^{ab}
Bannur	16	2535^{b}	53	467^{a}	27.6^{a}
Deccani	18	2600^{b}	26	1171^{b}	26.4^{b}

[ab]Means within columns not sharing a common letter in the superscript are significantly different ($P<0.05$).

DISCUSSION

Lambs sired by B and D rams had significantly higher liveweights and growth rates than those sired by G rams, as would be expected given the relatively small size of the G breed. Liveweights and growth rates of lambs sired by D and B rams did not differ and ewe breed also had no effect. The increase of 42% in weaning efficiency of twin-bearing as compared to single-bearing Deccani ewes is strong evidence for the economic advantages of prolificacy.

Lambs sired by D rams were found to be less resistant to gastrointestinal nematode infections than those sired by G rams in 1997 and by B and G rams in 1998. The ranking of lambs sired by B and G rams was, however, different for FECs after artificial infection in 1997 and 1998. G-sired lambs had significantly lower FECs than B-sired lambs in 1997 and the difference between the two groups was not significant in 1998. These findings are important given the lack of other properly designed studies comparing resistance to gastrointestinal nematodes among Indian sheep breeds.

The greater susceptibility of wethers to *H. contortus* infections than ewes of similar age, found in this study, is consistent with reports in the literature (Barger, 1993).

There are advantages to be gained from crossbreeding D and B breeds and by introducing prolificacy from the G into the cross. Studies on the genetic basis of the G prolificacy are being carried out simultaneously as a part of this project. If prolificacy is controlled by a major gene this may enable the prolificacy trait to be introgressed into other breeds without the undesirable effects on growth. It is envisaged that rather than a continuous crossbreeding system, it would be more practical to aim for the development of a composite breed which would have higher prolificacy, worm resistance and better carcass conformation than the local Deccani breed and would require less frequent shearing. A breeding programme has been planned for the crossbred ewes generated in the diallel.

CONCLUSION

The 3-breed crossbreeding experiment reported here has revealed that the Deccani and Bannur breeds, although of low prolificacy, produce lambs of similar size and growth potential. The Bannur has the added attractions of a degree of resistance to worms, lack of a wool coat and a specialist meat conformation. The Garole breed is prolific and exhibits resistance to worms but has the disadvantage of very small size and consequent low lamb birthweights and growth rates. These breeds will be used to develop a composite breed exhibiting the best traits of the contributing breeds, to assist with improving the efficiency of sheep meat production in Maharashtra.

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