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THE INFLUENCE OF INTRODUCING THE BOOROOLA MERINO GENOTYPE TO RAMBOUILLET FLOCKS ON REPRODUCTION AND FLEECE TRAITS IN COMPARISON WITH OTHER SELECTED BREED CROSSES

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Summary

Booroola Merino or crosses derived from Booroola, Finnish Landrace and Dorset rams were crossed to Rambouillet ewes to generate various genotypes for study. Ovulation rates were significantly improved by the use of Booroola or Finn rams as compared to pure Rambouillet, but not by the use of a single Dorset ram. Ewes believed to carry a single copy of the F gene from the Booroola x Rambouillet had a 59% increase in ovulation rate as compared to straight Rambouillet. This was greater than for Finn x Rambouillet. Ovulation rates greater than three were frequent for all groups containing Booroola and Finn breeding, but not for pure Rambouillet or Dorset x Rambouillet crosses. Finn x Rambouillet ewes had a higher proportion of twin ovulations and twin births, while having a lower proportion of three's and four's when contrasted with Booroola x Rambouillet. Ovulation rates for ewes carrying both Booroola and Finn breeding suggest that the high ovulation rates for these two are additive. Booroola and Finn cross ewes had significantly higher lambing rates than other types studied. Booroola crosses had larger litter sizes than Finn crosses, but the differences were not statistically significant (2.04 vs 1.91). As with ovulation, triplet or greater litter sizes occurred in all groups having Booroola or Finn genotypes. Booroola-cross ewes were smaller than Rambouillet and Dorset or Finn-crosses. Fleece weights and yields tended to favor Booroola-crosses, especially as compared to Finn or Dorset-crosses. Booroola-crosses tended to produce coarser fleeces than Rambouillet, but their fleeces still were sufficiently fine to be classified as fine wool.

(Key words: Booroola, Finnsheep, ovulation, lamb, wool)

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Introduction

Improving the lamb crop raised provides a major opportunity for increasing the income to the U.S. sheep industry. Some suggested approaches to improve lamb crops are: a) manage for maximum lamb crop from current breed resources, b) select within resources for an increased lambing rate and c) crossing to or substituting a more prolific breed. The first two are either expensive and must be repeated each season (management) or require an extended period of time to show a response (selection). Thus, a producer may wish to consider the third option in preference to or concurrent with, other practices.

It is generally recognized that the ovulation rate of a ewe sets the upper limit for the number of lambs born at any parturition. Thus, selection between or within populations for an increased ovulation rate should improve the number of lambs born. However, ovulation of an ovum does not insure that a market lamb will be produced.

Western range producers prefer white-faced breeds for crossing in order to maintain wool quantity and quality and especially to minimize black fibers in the fleece. Two breeds which have been used for this purpose have been the Dorset and Finnish Landrace (Finn) or Finn x Dorset rams to produce two or three breed cross ewes (Snowder et al., 1986). Each of these types present limitations because of lack of adaptation to range condition and reduced value (quantity or quality) of the fleece. However, crossbred ewes carrying Finn breeding do show an increased ovulation and lambing rate (Dickerson, 1977). Another breed or genotype which has become available in recent years is the Booroola Merino. This breed has the potential to bring about a marked increase in the ovulation or lambing rate. The higher ovulation rate of the Booroola has been shown to be due to a single major gene, the F gene (Davis et al., 1982; Bindon, 1984). Consequently, the use of this

resource must be treated in a somewhat different manner than that for ordinary breed crossing. The purpose of this paper is to present some preliminary information comparing various genotypes crossed to Rambouillet ewes under Texas conditions.

Materials and Methods

Beginning in the Fall of 1982, a variety of rams were mated to grade Rambouillet ewes to generate genotypes as shown in table 1. Flocks at three different locations (within the Edwards Plateau) were used to generate some of the crosses. However, all ewe performance data were collected in the flock maintained by the Texas Agricultural Experiment Station at San Angelo. All ewes involved in these comparisons were derived from Rambouillet ewes with two exceptions. One of these exceptions represented a cross of rams carrying the Booroola F gene to Finn ewes to determine if the high prolificacy factors of these two types were additive. The other exception consisted of crossing Booroola Merino rams to Booroola-cross ewes in 1984. These ewes were classified as Booroola-cross for statistical analysis since only three ewes resulted from this cross and their ovulation rates were similar to others of this type.

All Booroola type rams were of New Zealand origin, but one of those used was obtained on loan from the U.S. Meat Animal Research Center, Clay Center, Nebraska. The Booroola x Coopworth rams (2) were imported from New Zealand as carrier (heterozygous) rams in respect to the F gene. The Finn (3) and Rambouillet (4) rams used in the study were generated from a research flock maintained by the station. The Finn flock from which the rams were derived have been on the station through several generations and have not been selected for unusually high (more than three) lambing rates. Only one Dorset ram was used. The Booroola Merino rams (3) were treated as homozygous for the F gene in the present report, but there remain some question about one of these. Also, a group (P) of 1/4 Booroola ewes was generated from progeny testing of Booroola x Rambouillet rams on Rambouillet ewes.

The ewes were bred for the first time at approximately eighteen months of age. At that time laparoscopy was performed twice on all ewes to obtain ovulation rates at successive cycles. Ewes were initially exposed to vasectomized rams. Intact rams were used after the initial detection of estrus. When ewes approached thirty months of age, laparoscopy was performed once. Thus, three ovulation records were obtained on each ewe which remained in the flock for the first two seasons. The ewes were pasture mated to groups of rams which contained a mixture of Rambouillet and Suffolk rams. The one exception to this was that a few of the Booroola Merino sired ewes (M) were mated back to Booroola rams to generate grade Booroola ewes. It is recognized that this may well have affected lamb survival and growth, but these data are not included in the present analysis. Lamb survival and growth data are not included in the present analysis because much of the data were obtained on two year old ewes lambing for the first time. Also, most of the data on ewes of more advanced ages were from the 1987 lamb ing season, and a rather serious disease affected lamb survival. Thus, these lamb data have little value, and are not reported. In an earlier study (Snowder et al., 1986), lamb survival was 84.4% for single lambs, 72.3% for twins, and 44.3% for triplets. Some of the lambs contributing to the Snowder study were derived from Finncross ewes which probably contributed favorably to lamb survival. In the present study, the ewes were mated to drop lambs starting in January, and experience suggests there is a definite interaction between lambing season and litter size in respect to lamb survival.

Wool samples (side) were obtained prior to April shearing for fiber diameter measurements. Fleece (grease) weights were obtained from the Spring 1987 shearing only. All the skirted fleeces were bagged according to genetic group and cored to obtain samples on which yields were based. Three cores were obtained and scoured for each lot.

Statistical analysis procedures consisted of the use of least squares procedures. Age, breed, location (origin of ewe), year and appropriate interactions were included in the model. Location or the origin of the ewe was found not to have a significant effect for any of the variables evaluated.

Results and Discussion

Least square means for body weights and ovulation rates by breed groups are shown in table 1. Booroola Coopworth x Finn ewes had the highest ovulation rate even though only one half of these theoretically carried the F gene. This strongly suggests that the higher prolificacy of the Finn and the Booroola are additive. This is most marked if one observes the distribution of the ovulation rates as shown in table 2 in which some ewes carrying both Booroola and Finn genes had ovulation rates as high as seven with 37% having three or more, and 18% having four or more. When it is recalled that a maximum of 50% of the Booroola Coopworth x Finn ewes could carry the F gene, it is obvious that a high percentage of these have ovulation

Table 1. Expected Genetic Composition, Body Weights and Ovulation Rates by Breeding

Breed crosses	Breeding code	Maximum Expected F gene frequency	Maximum Expected proportion of ewes with F gene (%)	Breeding weight Number	(lb)[a] Mean	Number of Observations	LS Mean ovulation rate
Sire Dam							
Booroola Merino x Rambouillet	M	.50	100	55	109.3[a]	77	2.45[a]
Finnish Landrace x Rambouillet	F	.00	0	171	124.7[b]	188	2.09[b]
Booroola Coopworth x Rambouillet	C	.25	50	112	104.4[c]	144	201.1[bc]
Booroola Rambouillet x Rambouillet	P	.25	50	48	104.4[c]	96	1.86[c]
Rambouillet x Rambouillet	R	.00	0	156	125.1[b]	191	1.54[d]
Dorset x Rambouillet	D	.00	0	61	118.4[d]	82	1.36[e]
Booroola Coopworth x Finn	X	.25	50	26	97.8[e]	43	2.58[a]

[a]Column means with the same superscript are not significantly different (P >.05)

rates of three or more. In this study, the cross was made for scientific reasons and animals with ovulation rates this high would likely be of little interest to commercial producers.

Mean body weights for all age groups are pooled and shown in table 1, for the various genptypes. The body weights for the various groups with the Booroola gene are significantly lighter than all other genotypes. The groups with Coopworth as well as Booroola do not differ significantly from those having only the Booroola genotype. This suggests that both the Booroola and Coopworth types are relatively small as compared to the Rambouillet. The Booroola-Coopworth x Finn ewes were significantly smaller than all other groups, whereas Finn x Rambouillet did not differ from straight Rambouillet. This suggests that the Finn genotype is reacting differently depending upon the breed to which they are crossed. The Dorset-crosses were significantly smaller than straight Rambouillet, but this difference was only between six and seven pounds.

Table 2. Ovulation Rate Distributions by Breed Group. Percent of Total Observations with Indicated Number of Corpora Lutea

Breed group	No. of observations	1	2	3	4	5	6	7
M	77	7.8	46.7	37.7	6.5	1.3	.0	.0
F	188	16.5	65.9	15.9	1.6	.0	.0	.0
C	144	35.4	36.1	21.5	6.3	.7	.0	.0
P	96	25.0	57.3	13.5	3.1	1.1	.0	.0
R	191	52.4	45.5	2.1	.0	.0	.0	.0
D	82	67.1	29.3	1.2	2.4	.0	.0	.0
X	43	9.3	33.5	18.6	9.3	2.3	2.3	4.6

Ovulation data presented in table 1 represent a least squares estimate combining three measurements (two at nineteen months and one at thirty months). Distribution of corpora lutea (CL) for each breed group are shown in table 2. As noted earlier, those animals having both Finn and Booroola genes have a number of ewes with extremely high numbers of CL. Also, both the Finn and Booroola genotypes contain a number of ewes having three or more ovulations. In this comparison, the F gene from the Booroola appears to contribute to more ewes with three or more CL than was the case with the Finn ewes, but this may be somewhat a reflection of the Finn rams used. Ewes with three or more ovulations would likely be undesirable to most producers. It should not be assumed that lambing rates would be this high, but only that there is a potential for this to be the case. Ovulation rates for each age group are shown in table 3. These data show that two year olds had a higher ovulation rate than yearlings for all breed groups except one (D). However, on an overall basis, this difference was only on the order of 11%.

The number of lambs born at any given parturation is a function of ovulation rate minus various forms of re-

Table 3. Least Square Means for Ovulation Rate by Age

Breed group	No. of obs.	Yearling ovulation rate[ab]	No. of obs.	2-Yr. old ovulation rate[a]
M	66	2.44[a]	11	2.64[ab]
F	127	1.98[b]	61	2.11[c]
C	98	1.93[b]	46	2.17[bc]
P	96	1.98[b]	-	-
R	132	1.44[c]	59	1.63[d]
D	58	1.45[c]	24	1.25[e]
X	34	2.59[a]	9	3.00[a]

[a] Column means with the same superscript are not significantly different (P>.05)

[b] Yearling ovulation rate is the mean of two consecutive measurements

productive wastage such as degenerate ova, fertilization or implantation failure and abortion. In one study with Rambouillet ewes, reproductive wastage between ovulation and lambing resulted in the loss of 34.8 potential lambs per 100 ewes (Willingham et al., 1986). The percentage loss was greater as the ovulation rate increased.

The number of lambs born per ewe is shown in table 4, and the distribution of these births is shown in table 5. The numbers contributing to the lambing data are reduced compared to those reported for the ovulation rate. This is explained by the use of multiple observations on the same animal for ovulation rate data, and to some ewe death losses that occurred between mating and lambing. The Booroola-cross ewes (M) had a higher lambing rate than Finn-crosses (F), but this was not statistically significant. The response to the Booroola, or F, gene is much reduced when lambing rate is the measure as contrasted to ovulation rate. Still, multiple births are common with both the Finn and Booroola groups. For instance, approximately one half (47%) of the ewes with a single copy of the F gene dropped twins, with one fourth singles and one fourth having three or more lambs.

One of the more noticeable features of these data is the vastly reduced lambing results for those animals carrying both Finn and Booroola breeding (group X). A large portion of these were dry, suggesting that they failed to carry the embryos from the multiple ovulations. As indicated earlier, this may be of theoretical interest only, but this observation warrants further study.

Fleece data are shown in table 6. Groups which had Finn or Dorset breeding had lower grease fleece weights. The Booroola x Rambouillet ewes tended to shear heavier fleeces of slightly courser and higher yielding wool than straight Rambouillet. The end result should be higher clean fleece weights. The 1/4 Booroola sheared lighter fleeces having higher yields and coarser fibers than straight Rambouillet. However, this comparison was not completely orthogonal in respect to year or age. These animals were generated later in the breeding program, and even though the data presented are least square values, this may not have been completely corrected for year differences.

The ovulation and lambing rates of ewes thought to carry the F gene are lower than those reported by other workers in Australia (Bindon and Piper, 1984). The explanation for this is not known, but may be a result of nutrition under Texas conditions. Nutrition has been shown to alter the distribution of ovulation rates in ewes carrying the F gene (Montgomery et al., 1983). Other explanations could be that the F gene is reacting

Table 4. Least Square Means of Lambs Born per Ewe Exposed by Breed

Breed	No. Ewes exposed	Lambs born per ewe exposed[a]	Lambs born per ewe lambing[a]
M	55	1.93[a]	2.04[a]
F	171	1.77[a]	1.91[a]
C	112	1.49[b]	1.64[b]
P	48	1.52[bc]	1.66[b]
R	153	1.31[bc]	1.39[c]
D	60	1.25[c]	1.34[c]
X	26	1.19[bc]	1.55[bc]

[a] Column means with the same superscript are not significantly different (P>.05)

Table 5. Distribution (Percent) of Ewes Having Various Number of Lambs by Breed

Breed	Open	Single	Twin	Triplet	Quadruplet
M	5.5	23.6	47.3	20.0	3.6
F	7.0	25.7	52.6	12.3	2.3
C	8.9	49.1	27.7	12.5	1.8
P	8.3	41.7	39.6	10.4	.0
R	5.9	58.8	34.0	.3	.0
D	6.7	65.0	25.0	3.3	.0
X	23.1	38.5	34.6	3.8	.0

Table 6. Fleece Production and Fiber Characteristics of Various Breed Crosses

Breed	Breed code	No. of animals	Grease fleece weight (lb)[ab]	No. of animals	Fiber diameter (um)[ab]	Spinnig count	Clean wool fiber present (%)[ab]
Booroola Merino x Rambouillet	M	81	10.41[a]	38	21.87[b]	64's	59.7
Finn x Rambouillet	F	223	7.39[d]	65	22.12[bc]	62's	54.6[de]
Booroola-Coopworth x Rambouillet	C	156	9.43[c]	58	23.48[d]	62's	56.3[cd]
¼ Booroola Merino - ¾ Rambouillet	P	92	9.49[bc]	54	22.98[cd]	62's	61.1[a]
Rambouillet x Rambouillet	R	205	9.99[ab]	57	20.90[a]	64's	50.0[f]
Dorset x Rambouillet	D	83	7.49[d]	31	27.65[e]	56's	53.4[e]
Booroola-Coopworth x Finn	X	41	7.79[d]	22	27.77[e]	56's	66.5[a]

[a] Values for fleece weight and fiber diameter are least square means. Yeilds are actual means of core samples from skirted fleeces for the 1987 shearing season

[b] Column means sharing common superscripts are not significantly different (P >.05)

differently with the Rambouillet genotype compared to that of other breed crosses (Binden and Piper, 1984) or that the F gene frequency is lower than hypothesized in this study.

The overriding conclusion concerning these data is that the Booroola genotype is markedly smaller than the Rambouillet. Thus, the immediate effect of using Booroola rams to generate F1 ewes is the loss of sale weight in the male offspring even though they are out of Rambouillet dams. Backcrossing to the Booroola would be expected to result in a further reduction in weights. Thus, pure Booroola genotypes would likely be unacceptable to the U.S. sheep industry due to low growth rate and possibly unacceptable conformation. The F1 females resulting from crossing Booroola or percentage Booroola rams on other breeds will almost certainly be smaller than the Rambouillet, but this may prove not to be a big disadvantage. The market lamb resulting from the cross of this F1 ewe to a third breed or sire breed would likely be indistinguishable at slaughter. These data suggest that crossing Booroola to Rambouillet will not improve quality (fineness), but may result in some increase in clean fleece weights. This conclusion is even more significant when wool production is expressed as a function of body size and feed intake.

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