INTROGRESSION OF THE FEC^{B} ALLELE OF THE BOOROOLA MERINO INTO A RAMBOUILLET FLOCK - A PROGRESS REPORT

B.R. Southey, D.L. Thomas, R.G. Gottfredson, and R. Zelinsky
Department of Animal Sciences and Arlington Agricultural Research Station

Objectives: 1) Determine the effect of the Fec^{B} allele of the Booroola Merino in a U.S. sheep population unconfounded by background genotype, and 2) develop a flock of high percentage Rambouillets with the Fec^{B} allele.

Procedure: A project to introgress the Fec^{B} allele into a Rambouillet flock was initiated at the Dixon Springs Agricultural Center of the University of Illinois in 1985, and the project was moved to the Arlington Agricultural Research Station of the University of Wisconsin-Madison in 1991. This report presents results obtained at the Wisconsin site from mating in the autumn of 1991 through lambing and lamb growth in 1996.

Rambouillet (Fec^{++}) and Booroola Merino (Fec^{BB}) rams initially were mated to a flock of Rambouillet ewes during the autumns of 1985 through 1988. Booroola Merino-Rambouillet cross female progeny from this mating and subsequent matings were backcrossed to Rambouillet rams, and Rambouillet ewes continued to be mated to Rambouillet rams. The same Rambouillet rams were mated with the Rambouillet and Booroola Merino-cross ewes. Lambs were weaned at approximately 60 days of age. Rambouillet replacement ewes and rams were selected on estimated genetic merit for litter size using the "Number of Lambs Born" FEPDs from NSIP. Booroola Merino-cross replacement ewes had to be an F_1 or have a dam that had been classified as a carrier (Fec^{B+}). Selection preference was given to Booroola Merino-cross ewe lambs with higher percentages of Rambouillet breeding. Ewes were mated in order to lamb first at approximately 2 years of age and annually thereafter. Prior to breeding each year, ovulation rate of ewes was determined by counting number of corpora lutea viewed with a laparoscope. Booroola Merino-cross ewes were classed as carriers (Fec^{B+}) if they had 3 or more ovulations at their first examination at approximately 19 months of age and as non-carriers (Fec^{++}) if they had 1 or 2 ovulations. After their first or second lambing, the Fec^{++} Booroola Merino-cross ewes generally were culled to make room for Booroola Merino-cross replacements from dams classified as Fec^{B+}. Approximately 60 Rambouillet and 60 Booroola Merino-cross ewes were mated each year.

Results: To indicate the size of the experiment, the number of observations for ovulation rate (trait with the greatest number of observations) and litter size (trait with the fewest number of observations) are presented in Table 1.

Table 1. Number of Observations for Ovulation Rate and Litter Size by Proportion of Rambouillet (R) Breeding and Genotype at the Fec Locus.

Trait	1/2 R Fec^{B+}	3/4 R Fec^{++}	3/4 R Fec^{B+}	7/8 R Fec^{++}	7/8 R Fec^{B+}	Ramb. Fec^{++}
Ovulation rate	53	63	104	22	36	322
Litter size	47	37	94	17	35	289

Carriers of the Fec^{B} allele had 1.69 more ($P < .001$) ovulations than non-carriers, and this difference was relatively consistent within the two backcross groups (Table 2). Rambouillet ewes weighed 36 lb. more ($P < .05$) than F_1 Booroola Merino x Rambouillet ewes. As the proportion of Rambouillet breeding increased in the backcrosses, the breeding weights tended to increase, but at a slower rate than may be expected. Fleece weights were slightly greater for Fec^{++} ewes.

Table 2. Prebreeding Traits and Fleece Weight.

Ramb. breeding Fec genotype	Ovulation rate, no.	Breeding wt., lb.	Condition score	Fleece wt., lb.
1/2 Rambouillet				
Fec^{B+}	3.77±.15[a]	124.1±4.8[a]	3.19±.11[a]	10.76±..48[a]
3/4 Rambouillet				
Fec^{++}	1.93±.12[c]	137.7±3.5[b]	3.18±.09[a]	11.33±.51[a]
Fec^{B+}	3.40±.11[b]	137.7±3.5[b]	3.23±.07[a]	10.78±.40[a]
7/8 Rambouillet				
Fec^{++}	1.94±.19[c]	141.9±4.4[b]	3.25±.12[a]	10.19±.46[a]
Fec^{B+}	3.55±.16[ab]	140.8±4.2[b]	3.53±.10[b]	10.30±.33[a]
Rambouillet				
Fec^{++}	2.02±.08[c]	160.2±2.4[c]	3.47±.05[b]	10.89±.24[a]
Contrast				
Fec^{B+} - Fec^{++}	1.69***	-7.7*	.10	-.64[†]

[a,b,c]Within a column, means lacking a common superscript differ ($P < .05$).
***$P < .001$, *$P < .05$, [†]$P < .10$.

Even with the high ovulation rates of Fec^{B+} ewes presented in Table 2, the lamb production of these ewes continues to be disappointing (Table 3). Weight of lamb weaned at 60 days per ewe exposed (ewe productivity) was not significantly different between Fec^{B+} and Fec^{++} ewes. The Fec^{B+} ewes gave birth to .70 more ($P < .001$) lambs per ewe than did Fec^{++} ewes, but the lambs from Fec^{B+} ewes had greater mortality and were lighter at 60 days of age than lambs from Fec^{++} ewes. The lamb production advantage of the Fec^{B+} ewes at birth was lost by weaning.

Since most sheep producers do not sell lambs at 60 days of age, but instead as older feeder lambs or as market-ready lambs, ewe productivity 120 days post-lambing may be a more valuable endpoint at which to evaluate the ewe groups. This is presented in Table 4. The same advantages of Fec^{++} ewes over Fec^{B+} ewes for lamb survival and lamb weight that existed at 60 days were still present at 120 days, so there were no differences between Fec^{++} and Fec^{B+} ewes for ewe productivity at 120 days.

However, .27 more lambs were raised to 120 days post-weaning per ewe exposed for Fec^{B+} ewes than for Fec^{++} ewes (Table 4). If lambs are marketed at a constant live weight of 120 lb. and assuming no lamb losses from 120 days to marketing, weight of lamb marketed per ewe exposed would be 32.4 lb. more for Fec^{B+} ewes than for Fec^{++} ewes. With lambs valued at $.85 per lb. live weight, gross lamb income per ewe would be $27.54 higher for Fec^{B+} ewes compared to Fec^{++} ewes. An economic analysis needs to be conducted to determine if this increase in gross income from Fec^{B+} ewes will offset their greater costs of production, e.g.. increased ewe feed costs during late pregnancy and lactation, increased lamb feed costs for more and lighter lambs which take longer to reach market weight, increased labor in caring for ewes of higher prolificacy, increased costs from more artificially reared lambs, etc.

Table 3. Lamb Production to Weaning.

Ramb. breeding Fec genotype	Fertility, %	Prolificacy, no.	Lamb survival, %	Lamb wean. wt., lb.	Ewe productivity, lb.
1/2 Rambouillet					
Fec^{B+}	95.4±3.3^{a}	2.57±.15^{a}	81.5±4.8^{ab}	37.0±1.3^{a}	76.8±5.5^{a}
3/4 Rambouillet					
Fec^{++}	96.0±3.5^{a}	1.61±.14^{d}	94.9±5.7^{c}	50.2±1.5^{de}	75.7±5.9^{a}
Fec^{B+}	92.6±2.2^{a}	2.66±.11^{a}	75.8±3.8^{a}	38.9±1.1^{b}	74.4±3.7^{a}
7/8 Rambouillet					
Fec^{++}	94.8±5.0^{a}	1.89±.19^{bc}	94.9±7.4^{bc}	50.8±2.0^{e}	88.7±8.6^{a}
Fec^{B+}	98.5±3.6^{a}	2.15±.16^{b}	82.1±5.5^{ab}	43.8±1.5^{c}	78.1±6.2^{a}
Rambouillet					
Fec^{++}	94.3±1.4^{a}	1.83±.08^{c}	92.2±3.6^{c}	47.7±.9^{d}	78.1±2.4^{a}
Contrast					
Fec^{B+} - Fec^{++}	.1	.70***	-15.1***	-10.6***	-5.9

^{a,b,c,d,e}Within a column, means lacking a common superscript differ ($P < .05$).
***$P < .001$.

Table 4. Lamb Production to 120 Days Post-Lambing.

Ramb. breeding Fec genotype	Lamb survival, %	Lamb 120 day wt., lb.	Ewe productivity, lb.	Lambs raised to 120 days per ewe exposed, no.[e]
1/2 Rambouillet				
Fec^{B+}	79.6±5.7[ab]	67.1±2.2[a]	136.6±10.6[a]	1.93
3/4 Rambouillet				
Fec^{++}	95.1±6.4[c]	82.9±2.2[d]	125.4±11.2[a]	1.47
Fec^{B+}	75.4±4.7[a]	70.8±1.8[b]	134.0±7.0[a]	1.86
7/8 Rambouillet				
Fec^{++}	91.4±8.2[bc]	85.6±2.9[d]	146.5±16.1[a]	1.64
Fec^{B+}	80.5±6.3[ab]	78.1±2.4[c]	137.3±11.7[a]	1.70
Rambouillet				
Fec^{++}	90.5±4.6[c]	82.9±1.5[d]	134.4±4.6[a]	1.56
Contrast				
Fec^{B+} - Fec^{++}	-14.8***	-10.1***	.0	+.27

[a,b,c,d]Within a column, means lacking a common superscript differ ($P < .05$).

[e]No statistical analyses have been conducted on the means and the contrast in the last column.

***$P < .001$.

Further analyses were conducted to determine if the Fec^{B} allele was directly responsible for the increased lamb mortality and decreased lamb weights. The results indicated that the decreased performance of lambs from Fec^{B+} ewes was due to increased litter size and not to the direct effect of the Fec^{B} allele. Therefore, lamb-rearing strategies employed for other prolific breeds also should be used for Fec^{B+} ewes.

Increasing the proportion of Rambouillet breeding (decreasing the proportion of Booroola Merino breeding) in Fec^{B+} ewes will solve part of the light-lamb problem because there was a linear increase in lamb weights as the proportion of Rambouillet breeding in the lambs increased (Table 5). However, proportion of Rambouillet breeding had no effect on lamb survival (Table 5).

Table 5. Lamb Growth and Survival (Adjusted for Lamb Type of Birth).

Trait	Proportion of Rambouillet (Booroola Merino) breeding of the lamb			
	.75 (.25)	.875 (.125)	.9375 (.0625)	1.00 (0.0)
Weight (lb.) at:				
Birth	8.69±.31[a]	9.39±..24[b]	9.31±..31[b]	10.54±.24[c]
30 d	23.3±.7[a]	25.3±.4[b]	26.6±.7[c]	27.7±.4[d]
60 d	38.3±1.3[a]	41.8±.9[b]	44.2±.1.3[c]	45.5±.9[c]
120 d	68.0±2.0[a]	73.5±2.0[d]	78.5±2.0[c]	80.3±1.5[c]
Survival (%) to:				
30 d	89.2±3.8	86.1±2.7	87.7±4.0	90.6±2.6
60 d	87.8±4.8	82.9±3.7	85.1±5.0	87.7±3.6
120 d	84.7±5.7	81.6±4.6	82.4±5.9	85.6±4.6

[a,b,c,d]Within a column, means lacking a common superscript differ ($P < .05$).