EFFECTS OF EWE MATING CONDITION AND POST-MATING NUTRITION ON EMBRYO SURVIVAL

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Abstract

Polypay (P) and Coopworth x Polypay (CxP) 3-year-old ewes were placed on differential pre-mating nutrition to produce high (H) and low (L) body condition groups (mean pre-flushing body condition scores of 3.9 *vs.* 1.7). Low ewes were flushed for three weeks pre-mating and all ewes were estrus synchronized. Ewes were randomized within pre-mating treatments to either H or L post-mating treatments of 6 week's duration. Ovulation rate was higher for the H pre-mating group (2.87 *vs.* 2.39) but conception rate was reduced 79% *vs.* 93% for L ewes). Litter size (LS) was lower for L ewes both when conceiving to twin ovulations (1.59 lambs for L ewes *vs.* 1.73 for H ewes) and whev conceiving to triple ovulations (L = 2.17 *vs.* H = 2.40). Post-mating nutrition did not affect litter size of twin ovulators but low post-mating nutrition reduced litter size of triple ovulators by 0.43 lambs (H = 2.50 *vs.* 2.07). The effect of low post-mating nutrition was more severe among ewes already in low body condition at the time of mating. Polypay ewes had slightly higher mean ovulation rates (2.7 *vs.* 2.6) and produced an average of 0.2 more lambs (2.1 *vs.* 1.9) than the crossbred ewes. Polypay ewes produced more lambs following conception to either twin ovulations (P = 1.78 *vs.* CxP = 1.54) or triple ovulations (P = 2.42 *vs.* CxP = 2.15).

(**Key Words**: Embryo survival, Uterine efficiency, Ewe nutrition, Body condition)

Introduction

Among meat breeds of sheep, net reproductive rate is the major single factor determining profitability. Number of lambs weaned is dependent upon litter size which, in turn, is limited by ovulation rate. Short-term high pre-mating nutrition, or "flushing" has long been known to improve litter size through increasing ovulation rates and is a common management practice of many commercial flocks. However, little is known regarding the importance of mating nutrition and body condition on the subsequent survival of ova produced.

This study was designed to examine the effects of differential pre-mating and early post-mating nutrition on ewe reproduction performance, particularly production of multiple births following conception to multiple ovulations.

Materials and Methods

Three-year-old Polypay (P; n=48) and Coopworth x Polypay (CxP; n=58) ewes were allocated within genotype to a 2 x 2 array of pre-mating and post-mating nutrition levels. Ewes were managed on similar pasture for the 4 months preceding the initiation of the trial in late June. Ali ewes were weighed and scored prior to trial initiation on a 5-point condition score (CS) scale (1 = emaciated; 5 = grossly fat). Above and below average condition ewes were assigned within genotype to the high (H) treatment (good pasture + alfalfa pellets) or low flushed (L) treatment (sparse pasture), respectively, 16 weeks prior to mating. The allocation by body condition was done in an attempt to utilize variation in existing body condition to accentuate pre-mating treatment effects on body condition difference between groups. Ewe body condition at allocation was not related to reproductive performance at the group's only previous lambing as 2-year-olds. Six weeks prior to mating the L group was placed on a maintenance diet to stabilize body condition and 3 weeks prior to mating the group was placed on an alfalfa pellet flushing diet of 150% of NRC maintenance energy requirements based on average body weight. High ewes remained on their high nutrition plane through mating.

Ovulation rate, litter size, body weights and condition scores were analyzed by the analysis of variance procedure of the Statistical Analysis System of the SAS Institute Inc. (1986) using the general linear model with all main effects regarded as fixed. The model included genotype, pre-mating treatment and genotype x pre-mating treatment interaction for analysis of ovulation rates, pre-mating weights and pre-mating CS, and included genotype, pre-mating treatment, post-mating treatment and all 2-way interactions for analyses of litter size and post-mating weight and CS. Differences observed between ovulation rate and litter size in ewes lambing to the synchronized mating were designed as embryo loss.

Estrus was synchronized by placing vaginal progesterone-impregnated pessaries in all ewes 14 days prior to mating. Ewes were checked daily for device loss and lost devices were immediately replaced. Pessaries were removed 48 hours prior to introduction oF semen-tested, harnessed rams placed with the separate treatment groups at a ratio of 1 ram per 10 ewes for a 3-day mating period. Crayon marks were recorded daily. Following ram removal, ewes were fasted for 24 hours then examined by laparoscopy to count corpora lutea as an estimate of ovulation rate.

After laparoscopy, ewes were placed on their pre-assigned high or low post-mating treatment levels. High nutrition was defined as 150% of NRC maintenance energy requirements of L ewes and 100% of NRC maintenance energy requirements for H ewes. Low post-mating nutrition was defined as 80% of NRC maintenance energy requirements for H ewes and 100% NRC maintenance energy requirements for L ewes.

Harnessed rams were re-introduced to all treatment groups 2 weeks after the synchronized mating to identify returns to service; returning ewes were dropped from the study.

Ewes remained on assigned nutrition levels for 45 days post-mating, then were combined and managed as a single group through parturition when litter size was recorded for each ewe. Ewes which failed to lamb to the synchronized mating were dropped from the study.

Results and Discussion

High ewes began the trial at a mean CS of 2.9 and an average weight of 58 kg compared to mean CS 2.1 and 48 kg for L ewes (Table 1). Following 16 weeks on differential nutrition, H ewes had gained 9 kg while L ewes had increased by 1 kg, and pre-mating condition scores averaged 3.9 for H ewes compared to 1.7 for L ewes. During the subsequent 3 weeks of flushing, both groups gained weight, resulting in a net difference of 15 kg (74 *vs.* 59 kg) between H and L ewes at mating ($P<0.01$) and a mean CS difference of 1.3 units ($P<0.01$).

During the first 4 weeks of post-mating treatment, H ewes continuing on high nutrition maintained body weight while those going to low nutrition lost 2 kg. Low ewes gained weight on both post-mating nutritional regimens, but those going to high nutrition gained 2 kg more than those remaining on low. Changes in CS were small during the first 4 weeks post-mating. Neither body weight nor CS were significantly influenced by genotype at any point during the trial.

Treatment means for reproductive traits are presented in Table 2. Overall mean ovulation rate was 2.6 and did not differ significantly between genotypes. However, H ewes had a higher mean ovulation rate than L ewes (2.87 *vs.* 2.39; $P<0.01$). Conception to the synchronized estrus averaged 86% with L ewes exhibiting higher conception than H ewes ($P<0.05$). Twin and triple ovulators comprised over 90% of ewes with twin ovulators showing slightly higher conception than triple ovulators. Coopworth cross ewes had higher conception rates among both twin and triple ovulators.

Mean litter size averaged 2.1 for H pre-mating treatment ewes *versus* 1.8 for L ewes ($P<0.05$). Body weight and CS variation within treatment groups did not affect reproductive traits. Genotype and post-mating treatment had no effect on overall litter size. However, among triple ovulators, both post-mating treatment effects ($P\sim0.06$) and pre-mating by post-mating interactions ($P<0.01$) were observed; high post-mating nutrition produced a mean litter size of 2.5 lambs/ewe *versus* 2.1 lambs per ewe in the low treatment group. Groups which had been on high nutrition during the pre- and/or post-mating periods averaged 2.3 to 2.7 lambs per litter compared to only 1.65 for ewes restricted to low nutrition throughout the trial ($P<0.01$). The litter size of L-L ewes conceiving to triple ovulations was actually lower than for L-L ewes conceiving to twin ovulations.

While little previous research effort appears to have been devoted to embryonic losses among highly fecund ewes on poor nutrition, the conditions of this trial are not uncommon in commercial environments. The results indicate that prolonged low body condition is more detrimental than weight losses or poor body condition during either pre- or post-mating alone.

The adverse effects of low nutrition on embryo success following multiple ovulation appeared more pronounced in CxP ewes than in the straightbred Polypays and extended to CxP twin ovulators. The uterine efficiency (UE), or marginal litter size increase resulting from an extra egg ovulated, was only 0.38 for CxP twin-ovulating ewes on the pre-mating treatment *versus* 0.71 for H ewes. Comparable values for Polypay ewes were 0.80 and 0.75 respectively. The CxP UE value for H ewes is almost identical to a value of 0.70 for good condition Border Leicester x Romney ewes (the genetic origin of Coopworths) previously reported from New Zealand for ewes in good body condition. Similar effects were observed among triple ovulators where low pre-mating nutrition reduced litter size by 0.4 lambs among CxP ewes but had no effect on Polypays. Low post-mating nutrition of CxP triple ovulators reduced litter size by 0.6 lambs compared to a reduction of 0.3 for Polypay ewes.

Table 1. Mean body weights (BW; kg) and condition scores (CS) of ewes at trial initiation (Week 0), pre-flushing (Week 16), mating (Week 19) and post-mating (Week 23)

	Start		Week 16		Mating		Post-mating	
	BW	CS	BW	CS	BW	CS	BS	CS
PRE-/POST-MATING TREATMENT								
H-H	58	2.9	67	3.9	74	3.9	75	4.2
H-L	--	---	--	---	--	---	72	4.1
L-H	48	2.1	49	1.7	59	2.6	63	3.0
L-L	--	---	--	---	--	---	61	2.6
GENOTYPE								
CxP	52	2.6	55	2.6	66	3.2	---	---
P	53	2.4	57	2.7	67	3.2	---	---

Table 2. Mean reproductive performance

	No.	Conc. rate	Ovulation rate (OR)	OR=2	OR=3	Litter size Mean (NO.)
PRE-MATING						
H	50	0.79^b	2.87^a	1.73	2.40	$2.15(40)^a$
L	56	0.93^a	2.39^b	1.59	2.17	$1.82(52)^b$
GENOTYPE						
CxP	58	0.88	2.58	1.54^a	2.15	1.88(51)
P	48	0.84	2.68	1.78^b	2.42	2.08(41)
POST-MATING						
H				1.63	2.50	2.04(46)
L				1.69	2.07	1.92(46)

a,b Means in the same column within categories without common superscripts differ ($P < 0.05$).