Ewe Productivity and Subsequent Preweaning Lamb Performance in St. Croix Sheep Bred at Different Times During the Year

M. A. Brown and W. G. Jackson

South Central Family Farm Research Center, ARS, USDA, Booneville, AR 72927

ABSTRACT: Seasonality of breeding was evaluated in 165 purebred St. Croix ewes over a period of 3 yr at a latitude of 35°6’ N. Ewes were divided into six groups for breeding starting in August of 1989 and a group was exposed to rams every 2 mo throughout the experiment. Lambing percentage was lowest for spring breeding (P < .01), which resulted in lower numbers born and weaned per ewe exposed (P < .01) and lower litter birth and weaning weights per ewe exposed (P < .01). Except as compared with late winter breeding, number born per ewe lambing was also lower for the spring breeding (P < .01), indicating potentially lower ovulation rates at that time or higher embryonic losses through summer gestation. Mean litter weaning weights were lower for spring and fall breeding seasons (P < .05), probably due to lowered forage availability and quality during the preweaning period for these lambs. These data indicate that St. Croix are sufficiently aseasonal to be of benefit in an accelerated lambing program.

Key Words: Sheep, Seasonality, Reproduction, St. Croix, Preweaning Period

Introduction

Considerable interest exists throughout the sheep industry in identifying ways to increase ewe productivity through out-of-season lamb production. However, accelerated lambing programs require breeds with relatively long breeding seasons (Dzakuma and Harris, 1989; Wang and Dickerson, 1991). St. Croix ewes have been shown to be aseasonal breeders in the Virgin Islands (Wildeus et al., 1991a) but have demonstrated more seasonality in more northern latitudes (Evans et al., 1991; Parker et al., 1991; Wildeus et al., 1991a) with some variability as to time of anestrus with respect to location. Additionally, there is a need to evaluate breeds and crosses of sheep that may be adapted to climatic conditions in the South. Parker et al. (1991), Shelton (1991), and Bunge et al. (1993a,b) reported that the hair breeds of sheep such as the St. Croix and Barbados Blackbelly were more adapted to hot, humid environments than were wool breeds of sheep. Because of the potential of the St. Croix breed to contribute to sheep production in the mid-South, the objective of this research was to evaluate the productivity of St. Croix ewes bred at different times throughout the year at the latitude of 35°6’ N in Booneville, AR.

Materials and Methods

Starting in 1989, purebred St. Croix ewes were stratified by age into six breeding groups of approximately 18 ewes per group to be bred at different times throughout the year. Three cycles were done: in the first two cycles (August 1989 through July 1991), a group of ewes was bred starting in August and a different group bred every 2 mo thereafter; in the third cycle (September 1991 through July 1992) ewe groups were bred starting in September and every 2 mo thereafter. For purposes of analyses, data were grouped into seasonal classes based on breeding seasons: late summer (August, September), fall (October, November), early winter (December, January), late winter (February, March), spring (April, May), and early summer (June, July). Breeding seasons were approximately 35 d in length and four purebred St. Croix rams were used in each cycle and breeding group. Rams were allowed to breed four or five ewes (as evidenced by marking harness) and the marked ewes and ram were separated and kept together for an additional 24 h while the replacement ram was with the remainder of the group. Marked

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ewes were then returned to the breeding flock. Rams were kept consistent within cycle, as much as was possible, but replacements based on soundness or results of breeding soundness exams were sometimes necessary so that a total of 11 rams were used in the study. Breeding soundness exams were not performed on the rams until later in the study. However, breeding was designed to allow two estrous cycles per ewe and each ewe was exposed to four rams during the breeding season. Consequently, it is unlikely that the rams used in the study. Ewes were replaced breeding was designed to allow two estrous cycles per season. Examinations of the conception data for each ram used in the study did not provide evidence of infertility in any of the rams used in the study. Ewes were replaced during the study for reasons of unsoundness, failure to produce milk, advanced age, or death; a total of 165 ewes were used. Ages of ewes represented in the data included 2-, 3-, and 4-yr-olds and older; the last group was designated as mature ewes. All ages were represented in each breeding season of each cycle.

Before breeding, all ewes were managed as a single flock, either on endophyte-infected tall fescue or common bermudagrass/cool-season annual pastures. Ewes were supplemented with a corn and cottonseed meal (CSM) mix and/or 13% crude protein commercial pellets and bermudagrass hay (ad libitum) as dictated by forage availability, weather, and nutritional requirements. Supplemental grain and pellets averaged .3 kg ewe^{-1} d^{-1} when required in April and early May. Ewes were not supplemented when forage availability and quality were sufficient to meet their nutritional requirements (usually May-September). Breeding was done on endophyte-infected tall fescue and ewes were replaced in the main flock after breeding or on forages and supplementation consistent with the main flock. Two weeks before lambing, ewes were placed in drylot until lambing and then into lambing jugs after lambing for 2 to 3 d. Before lambing ewes were supplemented with .3 kg ewe^{-1} d^{-1} corn/CSM and/or 13% crude protein commercial pellet with bermudagrass hay available for ad libitum consumption. Lactating ewes were supplemented with approximately .7 kg ewe^{-1} d^{-1} corn/CSM and/or 13% crude protein commercial pellet, bermudagrass hay (ad libitum), and 1.0 kg ewe^{-1} d^{-1} alfalfa hay as dictated by lactational status and nutritional needs; ewes with triplets were allowed longer times in the jugs and given higher levels of supplemental feed to compensate for the extra lactational requirements. Lambs were weighed within 24 h of birth and male lambs were castrated by banding at birth. Lactating ewes were moved to pastures consistent with the main flock, supplementation was continued as was dictated by time of year and forage availability, and lambs were weaned at an average age of 90 d. Two groups of lambs were creep-fed in this study; one group was born in October 1992 and the other in December 1992. Creep feed was a 16% crude protein commercial pelleted diet formulated for lambs and fed for ad libitum intake; consumption averaged .11 kg lamb^{-1} d^{-1}. Examination of the data suggested that the October 1992 group did not benefit from creep feed, whereas it seemed that the December 1992 group gained approximately .022 kg/d more (averaged over sex of lamb) preweaning than non-creep-fed lambs from previous cycles born and reared at similar times of the year. Glimp (1971) reported no advantage in preweaning gain for creep-fed lambs weaned at 112 d. Wilson et al. (1971) reported an advantage of .028 kg/d for creep-fed lambs where ewes were under high energy supplementation and .032 kg/d where ewes were under moderate energy supplementation for a 77-d period. Data for 90-d weights in the December 1992 lambing group were adjusted by subtracting 1.99 kg (.022 kg/d × 90 d) to compensate for the potential advantage from creep feeding in this group, after adjusting for sex and age of lamb.

Because of the difficulty of adjusting for sex of lamb effects in mixed litters in the analyses of variance, birth weights and weaning weights were adjusted for sex of lamb prior to analyses. Least squares constants for sex were estimated for individual birth weights and weaning weights with males exceeding females by .2 kg and .6 kg at birth and weaning, respectively. Weights were adjusted to an average of the sexes by adding .1 kg and .3 kg to ewe lamb birth weights and weaning weights and subtracting these constants from male lambs' weights. Similarly, data for weaning weights were adjusted to an average age of 90 d prior to analyses (birth weight + 90 d × preweaning ADG).

Data were analyzed by methods of least squares and tests of hypotheses were performed using linear contrasts and associated t-statistics (SAS, 1989). Analyses were performed for lambing percentage, number born, weaning percentage, birth weight, and 90-d weight. With the exception of lambing percentage, analyses were performed per ewe exposed and per ewe lambing. Birth weight and 90-d weight were also analyzed as averages per ewe to evaluate individual lamb performance. Because of the replacement rate in the ewes and rerandomization of the sires each cycle, the design was not logically a repeated measures design. Cycle was considered a random replicate and cycle-season-age averages were used as experimental units in the analyses of reproductive traits and weights per ewe exposed or per ewe lambing. Cycle-season-age-litter size averages were used to analyze average birth weights or 90-d weights per lamb born or weaned where litter size reflected both size born and size raised in the 90-d weight analyses.

The initial linear model for reproductive traits and weights per ewe exposed or lambing included the random effect of cycle and the fixed effects of season, age of ewe, and season × age of ewe. Initial models for individual lamb birth weight and weaning weight
included the random effect of cycle, and the fixed effects of season, age of ewe, litter size born, litter size raised (weaning weight), and all interactions among fixed effects. All models were reduced appropriately to include only those effects with an observed significance level less than .15.

Results and Discussion

Analyses of reproductive traits indicated significant breeding season effects as well as age of ewe effects but there was little evidence of breeding season × age interactions (P > .15). Least squares means and standard errors for reproductive traits for each breeding season are given in Table 1. Ewes bred in spring were lower (P < .01) than ewes bred in other seasons for lambing percentage, number born per ewe exposed and per ewe lambing, and number weaned per ewe exposed with the exception of the mean litter size per ewe lambing for ewes bred in late winter. There was some evidence that ewes bred in the fall had higher lambing percentages than ewes bred in early or late summer and higher litter size per ewe exposed than ewes bred in early summer (P < .11). There was also some evidence that ewes bred in late winter had smaller litter sizes per ewe lambing than ewes bred in late summer (P < .10). There was little evidence of breeding season differences in number weaned per ewe lambing, although the spring season was numerically the smallest. Lamb losses to weaning were fairly substantial, particularly for winter- and spring-born lambs. However, it is difficult to separate predation losses from other causes in these data. Pope et al. (1989) reported lambing percentages of 55% and 74% for St. Croix ewes bred in the spring and fall, respectively. Parker et al. (1991) reported lower lambing percentages, litter size per ewe exposed, and litter size per ewe lambing for St. Croix ewes bred in winter in Ohio than for ewes bred in summer. Pond et al. (1991) reported a lambing percentage of 14% for St. Croix ewes bred in May and early June in North Carolina with litter size born per ewe lambing of 1.78 lambs and litter size weaned per ewe lambing of 1.27 lambs. Evans et al. (1991) reported a transition into anestrus during April and May and distinct anestrus during June and July for St. Croix ewes in Utah.

Least squares means and standard errors for reproductive traits for each age are given in Table 2. There is no evidence of age differences in percentage lambing, but mature ewes had higher litter size per ewe exposed compared to 2-yr-old ewes (P < .05), due primarily to a higher litter size per ewe lambing (P < .01). There was also evidence that 2-yr-old ewes had

Table 1. Least squares means and standard errors for reproductive traits by breeding season

<table>
<thead>
<tr>
<th>Breeding season</th>
<th>n(^a)</th>
<th>Lambing(^b)</th>
<th>Born/ewe(^c) exposed</th>
<th>Weaned/ewe(^d) exposed</th>
<th>n(^e)</th>
<th>Born/ewe(^e) lambing</th>
<th>Weaned/ewe(^f) lambing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late summer</td>
<td>58</td>
<td>71.2 ± 7.3</td>
<td>1.26 ± .14</td>
<td>.84 ± .12</td>
<td>42</td>
<td>1.76 ± .10</td>
<td>1.18 ± .11</td>
</tr>
<tr>
<td>Fall</td>
<td>57</td>
<td>88.6 ± 7.4</td>
<td>1.53 ± .14</td>
<td>.99 ± .12</td>
<td>51</td>
<td>1.72 ± .09</td>
<td>1.11 ± .10</td>
</tr>
<tr>
<td>Early winter</td>
<td>46</td>
<td>86.7 ± 8.3</td>
<td>1.49 ± .16</td>
<td>.90 ± .14</td>
<td>39</td>
<td>1.69 ± .10</td>
<td>1.01 ± .12</td>
</tr>
<tr>
<td>Late winter</td>
<td>52</td>
<td>83.6 ± 7.7</td>
<td>1.28 ± .15</td>
<td>.92 ± .13</td>
<td>46</td>
<td>1.53 ± .10</td>
<td>1.10 ± .11</td>
</tr>
<tr>
<td>Spring</td>
<td>54</td>
<td>77.7 ± 7.6</td>
<td>.47 ± .15</td>
<td>.34 ± .12</td>
<td>21</td>
<td>1.29 ± .14</td>
<td>.95 ± .16</td>
</tr>
<tr>
<td>Early summer</td>
<td>72</td>
<td>72.3 ± 6.5</td>
<td>1.21 ± .13</td>
<td>.87 ± .11</td>
<td>53</td>
<td>1.67 ± .09</td>
<td>1.23 ± .10</td>
</tr>
</tbody>
</table>

\(^{a}\) Number of ewes exposed.  
\(^{b}\) Spring vs others, P < .01; late summer vs fall, P < .10; fall vs early summer, P < .11.  
\(^{c}\) Spring vs others, P < .01.  
\(^{d}\) Spring vs others, P < .01.  
\(^{e}\) Number of ewes lambing.  
\(^{f}\) Spring vs others (except late winter), P < .01; late summer vs late winter, P < .10.  
\(^{g}\) No contrasts were significant.

Table 2. Least squares means and standard errors for reproductive traits by age of ewe

<table>
<thead>
<tr>
<th>Age of ewe, yr</th>
<th>n(^a)</th>
<th>Lambing(^b)</th>
<th>Born/ewe(^c) exposed</th>
<th>Weaned/ewe(^d) exposed</th>
<th>n(^e)</th>
<th>Born/ewe(^e) lambing</th>
<th>Weaned/ewe(^f) lambing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>95</td>
<td>70.3 ± 5.7</td>
<td>1.03 ± .11</td>
<td>.73 ± .09</td>
<td>68</td>
<td>1.42 ± .08</td>
<td>1.02 ± .09</td>
</tr>
<tr>
<td>3</td>
<td>87</td>
<td>75.1 ± 6.0</td>
<td>1.26 ± .12</td>
<td>.83 ± .10</td>
<td>65</td>
<td>1.61 ± .08</td>
<td>1.09 ± .09</td>
</tr>
<tr>
<td>4+</td>
<td>157</td>
<td>74.6 ± 4.5</td>
<td>1.36 ± .09</td>
<td>.88 ± .07</td>
<td>119</td>
<td>1.79 ± .06</td>
<td>1.18 ± .07</td>
</tr>
</tbody>
</table>

\(^{a}\) Number of ewes exposed.  
\(^{b}\) No contrasts were significant.  
\(^{c}\) 2 vs 4+, P < .05.  
\(^{d}\) Number of ewes lambing.  
\(^{e}\) 3 vs 2 and 4+, P < .10; 2 vs 4+, P < .01.
fewer lambs per ewe lambing than 3-yr-old ewes \((P < .10)\). However, age differences in weaning rates were not significant even though the trend in the means suggested higher weaning rates per ewe exposed or per ewe lambing in the older ewes. Foote \((1983)\) reported lower lambing percentages, number of lambs per ewe exposed, and number of lambs per ewe lambing in younger St. Croix ewes bred in summer than in mature ewes.  

Analyses of birth and 90-d weights evidenced breeding season, age, and litter size effects for both traits but did not suggest any two- or three-factor interactions. Least squares means and standard errors for weights per ewe exposed, per ewe lambing, or per lamb born or weaned are given in Table 3 for the different breeding seasons. Birth and 90-d litter weights per ewe exposed were lower for ewes bred in spring than for those bred in the other months \((P < .05)\), for which litter birth weights were similar. Litter weights for 90-d weights per ewe lambing were more complex with respect to differences, but fall and spring were lower than early and late summer and late winter \((P < .10)\). There was evidence of breeding season differences in birth weights per lamb born \((P < .11)\), but differences were relatively small and unimportant. There were also differences in 90-d weight per lamb weaned \((P < .05)\); lambs from ewes bred in fall or spring were lighter than lambs from ewes bred in the other months.

In other months \((P < .05)\), for which litter birth weights were similar. Litter weights for 90-d weights per ewe lambing were more complex with respect to differences, but fall and spring were lower than early and late summer and late winter \((P < .10)\). There was evidence of breeding season differences in birth weights per lamb born \((P < .11)\), but differences were relatively small and unimportant. There were also differences in 90-d weight per lamb weaned \((P < .05)\); lambs from ewes bred in fall or spring were lighter than lambs from ewes bred in the other months. Differences in 90-d litter weight per ewe lambing and 90-d weight per lamb weaned were probably associated with lower forage availability and quality when fall-bred ewes lambed in March and spring-bred ewes lambed in September.

Wildeus et al. \((1991b)\) reported similar litter weights born per ewe lambing in St. Croix in the Virgin Islands, independent of time of year bred, but reported larger 63-d litter weights weaned per ewe lambing for the late winter breeding season compared to summer and fall breeding seasons. Pond et al.
(1991) reported litter weights born per ewe lambing of 5.89 kg for St. Croix ewes bred in May and early June in North Carolina. Rastogi et al. (1991) reported lower 56-d litter weights per ewe lambing for hair ewes of four breeds bred in the spring compared to similar groups bred in the summer and fall and reported 56-d litter weights per ewe lambing for St. Croix, averaged over breeding season, of 9.6 kg.

Least squares means and standard errors for lamb weights for ages of ewe are given in Table 4. Litter birth weights per ewe exposed were smaller in 2-yr-old ewes than in older ewes (P < .10) but there were no significant age differences in 90-d weight per ewe exposed. Birth weights per ewe lambing were different among all ages (P < .01) and increased with age. Similarly, 90-d weight per ewe lambing was higher for mature ewes than for 2-yr-old ewes (P < .10). Birth weight per lamb born was similar to litter birth weight per ewe lambing with birth weights increasing with age. However, there was no evidence of differences in 90-d weight per lamb weaned among the ages of dam.

Least squares means and standard errors for different litter sizes are given in Table 5. Predictably, birth weight decreased as litter size increased (P < .05). Similarly, single lambs were heavier at 90 d than twins or triplets (P < .05) and twins were numerically but not statistically heavier than triplets. There was not strong evidence that litter size reared affected 90-d weights of lambs. Wildeus et al. (1991b) reported litter weight born per ewe lambing for St. Croix of 3.3 kg, 5.7 kg, and 7.6 kg and 63-d litter weight per ewe lambing of 14.9 kg, 20.2 kg, and 21.5 kg for single, twins and triplets, respectively. Litter averages for 63-d weight reported by Wildeus et al. (1991b) were 14.7 kg, 11.3 kg, and 9.9 kg for singles, twins, and triplets, respectively.

These data indicate that the St. Croix breed has potential for accelerated lambing systems. Reproduction was acceptable for all breeding seasons with the exception of late spring, as was productivity measured by 90-d litter weight per ewe exposed. It is empirically evident that the growth performance and productivity to weaning of the St. Croix breed is not comparable to those of larger wool breeds of sheep in the United States. Further research is needed to evaluate the productivity of purebred St. Croix and crosses with St. Croix under accelerated lambing systems. Evaluation of management variables in the spring may also be helpful in improving out-of-season breeding.

**Implications**

This research has demonstrated that St. Croix hair sheep are sufficiently aseasonal in breeding to be useful in an accelerated lambing program. However, individual and litter performance to weaning of lambs from ewes bred in the spring or in the fall seems to be lower than that of lambs from ewes bred in other seasons. Nonetheless, coupled with their reported adaptability to hot, humid conditions, the St. Croix breed has potential to serve as a useful resource in increasing efficiency of sheep production in the South and may have particular utility in low-input farming systems.

**Literature Cited**


Parker, C. F., K. E. McClure, and R. P. Herd. 1991. Hair sheep potential for specific environmental conditions and production


