**Report:** Effect of nutritional supplementation on reproductive outcome in nulliparous female sheep

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**Background:** As replacement females make up more than 20-30% of the breeding flock, the fertility of ewe lambs has a significant impact on the overall productivity and profitability of sheep enterprises. The productivity of ewe lambs can be substantially lower than that of adult flock mates. Lower fertility of ewe lambs is reflected at several points in the reproductive process. Approximately 20-40% of mated ewe lambs fail to conceive and lamb (during the breeding season which have been associated with lighter live weights (LW) at breeding and lower weight gains between weaning and breeding. Interestingly, in several breeds, failure of ewe lambs to conceive was not correlated with age at breeding between 160-230 days. However, interactions between age and weight gain prior to breeding have not been established. Prolificacy is also significantly lower in ewe lambs compared to mature ewe which might be related to both lower ovulation rates and higher embryonic mortality. A quadratic relationship was demonstrated between ewe weight and maintenance of pregnancy, while a positive linear relationship has been demonstrated between LW at breeding and ovulation rate and between LW and litter size. These findings suggest that pre-breeding live-weight can influence the proportion ewe lambs giving birth through its effect on embryonic survival. Further, pre-breeding live-weight can influence prolificacy through its effect on both ovulation rate and embryonic survival.

**Objectives:** The objective of this study was to determine the effect of age, pre-breeding weight gain and progesterone pre-treatment on reproductive outcome in nulliparous females.

**Procedure:** Two months prior to the breeding season, ewe lambs (N = 49; 39.9 ± 1.4 kg; 5.4 ± .1 months of age (range 4-6)) and yearling females (N = 58; 44.7 ± 1.3 kg; 8.2 ± .1 months of age (range 7-10) were randomly assigned to receive a low (LP; 227 g/ day; 15% CP, 65% TDN) or high (HP; 682 g/day) plane of concentrate supplementation and free access to forage for 2 months prior to the breeding season. Prior to introduction to rams of ½ of the ewes in each nutrition plane were pre-treated with CIDR devices (0 .3 g progesterone) for 5 days (Figure 1). At CIDR removal, rams with harnesses with crayons were introduced to ewe lambs (female to ram ratio of ≤ 25:1) for a 35 day breeding period. Observation for raddle marks was used to assess the occurrence of estrus. Blood samples and ewe lamb weights were taken at the start of the experiment and at biweekly intervals. Blood samples were analyzed for progesterone as an indicator of puberty (> 1 ng/ml). Ultrasonography was conducted at days 25-30 and 45-50, 65-75, 90-100 after introduction of rams to detect pregnancy and embryonic survival. Lambing data was recorded and all data analyzed by. Analysis of variance ( JMP®, Version 11 (SAS Institute Inc., Cary, NC, 1989-2007) to evaluate the effects of age at breeding, level of concentrate supplementation (High vs Low) and progesterone pretreatment on reproductive outcome. To further analyze the effect of weight gain on reproductive outcome data across treatments were pooled and females were classified as having Low, Medium and High weight gain (*< 0.5 SD, between ± 0.5 SD and > 0.5 SD of the mean weight gain (6.8 ± 2.3 kg) respectively).*

Figure 1: Layout for Experiment

**Results and Discussion:**

The mean age and weight of the ewes at the start of the experiment was 7.2 ± .08 months and 42.7 ± 0.9 kg, respectively. Ewes assigned to the high plane of nutrition were younger at the start of the experiment (P < 0.05), tended to gain more weight (P = 0.09) and were heavier (P < 0.05) at the end of supplementation, however a significant effect of level of supplementation on average daily gain (ADG) was not detected. Yearlings were older and heavier at the start of the trial (P < 0.05) and had heavier final weights (P < 0.05), but there were no effect of age on total weight gain or ADG (Table 1).

Reproductive performance variables of ewes are presented in Table 1. The mean prolificacy to the first service, overall prolificacy, lambing rate to the first service and overall lambing rate was greater (P < 0.05) in ewes receiving the high level of supplementation. Progesterone pre-treatment prior to breeding increased the estrous response and pregnancy rate to the first service (P < 0.05), tended to increase the conception rate and pregnancy rate to the second service (P ≤ 0.1) and reduced the mean lambing day and duration from ram introduction to lambing (P < 0.05). There was no effect of age on any of the measures of reproductive performance.

More ewes with high pre-breeding rates of gain tended (P = 0.08) to lamb to the first service. Prolificacy and lambing rates were higher (P < 0.05) in ewes with high pre-breeding rates of gain than ewes with low rates of gain. In conclusion nutritional supplementation that achieved high rates of gain increased lambing rates of nulliparous females. Further, breeding replacement females for the first time at 6-8 months had no detrimental effect on reproductive performance and progesterone pre-treatment synchronized and advanced lambing of replacement females.

**Impact:**

The combined use of pre-breeding nutritional supplementation and progesterone pre-treatment can enhance productivity of replacement females and provides an opportunity to increase productivity of replacement females. Additionally, the cost of raising replacements can be reduced and the lifetime productivity of ewes can be increased by breeding females to lamb at 1 year of age.

Table 1: The Effect of Pre-breeding Plane of Nutrition, Age and Progesterone Pre-treatment on Reproductive Variables of Nulliparous Ewes (Values are least square means ± SEM)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Supplement a** | | **Age** | | **Progesterone** | |
|  | **Low** | **High** | **lambs** | **Yearlings** | **CIDR -** | **CIDR +** |
| N | 56 | 51 | 49 | 58 | 55 | 52 |
| Initial Age (months) | 7.4 ± .1a | 6.3 ± .1b | 5.4 ± .1a | 8.2 ± .1b | 6.8 ± .1 | 6.8 ± .1 |
| Initial weight (kg) | 40.7 ± 1.4 | 43.9 ± 1.4 | 39.9 ± 1.4a | 44.7 ± 1.3b | 42.9 ± 1.4 | 41.8 ± 1.3 |
| Final weight (kg) | 46.9 ± 1.4a | 51.1 ± 1.4b | 46.4 ± 1.4a | 51.6 ± 1.4b | 49.7 ± 1.4 | 48.2 ± 1.3 |
| Weight gain (kg) | 6.3 ± .3e | 7.3 ± 0.8f | 6.7 ± .4 | 6.9 ± 0.4 | 6.9 ± .3 | 6.7 ± 0.9 |
| Average daily gain (g) | 111 ± 8 | 126 ± 8 | 118 ± 8 | 119 ± 8 | 119 ± 8 | 118 ± 7 |
| Estrous Response (%)b | 85 ± 4 | 83 ± 5 | 81 ± 5 | 86 ± 5 | 74 ± 5a | 93 ± 5b |
| Conception Rate (%)c | 83 ± 7 | 75 ± 7 | 76 ± 7 | 82 ± 7 | 72 ± 7e | 86 ± 6f |
| Pregnancy to 1st service (%)d | 71 ± 7 | 61 ± 7 | 62 ± 7 | 71 ± 7 | 53 ± 7a | 80 ± 7b |
| Pregnancy to 2nd service (%)e | 82 ± 5 | 92 ± 5 | 82 ± 5 | 93 ± 5 | 81 ± 5e | 93 ± 5f |
| Percent Lambed to 1st service (%)f | 49 ± 8 | 49 ± 8 | 46 ± 8 | 52 ± 8 | 41 ± 8e | 57 ± 7f |
| Percent Lambed (%) | 70 ± 7 | 74 ± 7 | 74 ± 7 | 70 ± 7 | 74 ± 7 | 70 ± 7 |
| Prolificacy to 1st service g | 1.1 ± .09a | 1.7 ± .26b | 1.3 ± .11 | 1.5 ± .10 | 1.4 ± .11 | 1.4 ± .09 |
| Prolificacy-overall | 1.1 ± .08a | 1.5 ± .09b | 1.2 ± .09 | 1.4 ± .09 | 1.3 ± .08 | 1.3 ± .08 |
| Lambing day h | 10 ± 1 | 11 ± 1 | 12 ± 1 | 10 ± 1 | 13 ± 1a | 8 ± 1b |
| Ram introduction to lambing (days)i | 152 ± 1 | 154 ± 1 | 155 ± 1 | 153 ± 1 | 156 ± 1a | 151 ± 1b |
| Lambing rate 1st service (%)j | 51 ± 12a | 84 ± 28b | 62 ± 12 | 73 ± 12 | 57 ± 12 | 79 ± 11 |
| Lambing rate (%)k | 74 ± 11a | 115 ± 11b | 91 ± 11 | 97 ± 11 | 97 ± 11 | 92 ± 10 |
| Pregnancy Retention to 1st service (%)m | 71 ± 9 | 80 ± 10 | 77 ± 9 | 74 ± 18 | 78 ± 9 | 72 ± 11 |

*abc ef means within main effects with different superscript differ abcP < 0.05, efP ≤ 0.1*

*aEwes were supplemented with either 227 (low) or 682 grams (high) of concentrate per day*

*bNumber of ewes marked by rams of all ewes in a treatment group*

*cNumber of ewes diagnosed pregnant as a percentage of ewes marked by rams*

*dNumber of ewes diagnosed pregnant on day 30-35 as a percentage of all ewes exposed to rams*

*eNumber of ewes diagnosed pregnant on day 50-55 expressed of all ewes exposed to rams*

*fEwes lambing by day 13 of the lambing period*

*gLambs born per ewe lambing to the first service period*

*hDay of the lambing period*

*iNumber of days from ram introduction to lambing*

*jLambs born to the first service period per 100 ewes exposed*

*kLambs born to the first service period per 100 ewes exposed*

Table 2: The Effect of Pre-breeding Weight Gain on Reproductive Performance Variables of Nulliparous Ewes (Values are least square means ± SEM)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Weight Gain Levela | | |
|  | Low | Medium | High |
| N | 29 | 46 | 32 |
| Initial Age (months) | 7.4 ± .3a | 7.8 ± .4a | 6.4 ± .3b |
| Initial weight (kg) | 43.2 ± 1.4 | 43.1 ± 1.4 | 41.7 ± 1.6 |
| Final weight (kg) | 46.9 ± 1.7a | 49.8 ± 1.4ab | 51.3 ± 1.7b |
| Weight gain (kg) | 4.0 ± .2a | 6.6 ± 0.2b | 9.6 ± 0.2c |
| Average daily gain (g/day) | 83 ± 8a | 100 ± 5b | 184 ± 6c |
| Estrous Response (%)b | 79 ± 7e | 93 ± 5f | 78 ± 7e |
| Conception Rate (%)c | 74 ± 9 | 81 ± 6 | 80 ± 8 |
| Pregnancy to 1st service (%)d | 57 ± 9 | 76 ± 7 | 63 ± 8 |
| Pregnancy to 2nd service (%)e | 90 ± 7 | 83 ± 5 | 88 ± 6 |
| Percent Lambed to 1st service (%)f | 38 ± 9e | 57 ± 7f | 53 ± 8ef |
| Percent Lambed (%) | 62 ± 8 | 74 ± 7 | 78 ± 7.3 |
| Prolificacy to 1st service g | 1.1 ± .16a | 1.2 ± .1a | 1.8 ± .12b |
| Prolificacy-overall | 1.1 ± .11a | 1.2 ± .09a | 1.6 ± .1b |
| Lambing day h | 12 ± 2 | 9 ± 1 | 12 ± 2 |
| Ram introduction to lambing (days)i | 155 ± 2 | 152 ± 1 | 155 ± 1 |
| Lambing rate 1st service (%)j | 39 ± 15ae | 69 ± 12bf | 94 ± 14b |
| Lambing rate (%)k | 64 ± 13ae | 91 ± 11af | 122 ± 13b |
| Pregnancy Retention to 1st service (%)m | 65 ± 11e | 74 ± 7.3ef | 85 ± 10f |

*abc ef means within main effects with different superscript differ abcP < 0.05, efP ≤ 0.1*

*aLow, medium and high weight gain represents gains < 0.5 SD, between ± 0.5 SD and > 0.5 SD of the mean respectively.*

*bNumber of ewes marked by rams of all ewes in a treatment group*

*cNumber of ewes diagnosed pregnant as a percentage of ewes marked by rams*

*dNumber of ewes diagnosed pregnant on day 30-35 as a percentage of all ewes exposed to rams*

*eNumber of ewes diagnosed pregnant on day 50-55 expressed of all ewes exposed to rams*

*fEwes lambing by day 13 of the lambing period*

*gLambs born per ewe lambing to the first service period*

*hDay of the lambing period*

*iNumber of days from ram introduction to lambing*

*jLambs born to the first service period per 100 ewes exposed*

*kLambs born to the first service period per 100 ewes exposed*