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Uterine Capacity of Prolific Sheep

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It is recognized that the number of lambs born is a function of ovulation rate and embryonic survival. The latter is believed to be determined to a great extent by the physical and physiological capacity of the uterus. In non-prolific breeds of sheep, where the number of lambs born is often one or two and rarely three, the uterine capacity is seldom a determining factor for the number or size of lambs born. This situation may be different in prolific breeds with high ovulation rate. In these breeds ovulation rate (even after early embryonic loss) could be higher than the ability of the uterus to accommodate and nourish the surviving embryos. The limiting effect of the uterine space may have a greater impact when prolificacy is introduced abruptly in originally non-prolific breeds. For example, intro-

ducing a prolificacy gene, from Booroola sheep. Despite the apparent importance of the subject, only a few experiments have been conducted on the limiting effect of the uterus and particularly with prolific sheep. A study conducted recently at the La Pocatiere Experimental Farm in Quebec, Canada aimed at measuring the physical characteristics of the uterus of prolific sheep carrying different loads of embryos. The objective was to determine to what extent the uterus limits litter size and lamb development at different stages of gestation. The data collected revealed some interesting results.

The animals used in this study were 19 Finnsheep and 21 Arcott Rideau (about 40% Finnsheep blood) mature ewes. Half of the ewes in both groups were superovulated to insure sufficient

numbers of embryos to challenge the uterus, the other ewes served as controls. Seven days after mating, laparoscopy was performed and the ewes were allocated according to the number of Corpora lutea (CL, i.e., the yellow bodies indicating ovulations) observed, in such a manner that ewes with 2, 3, 4, 5, and more than 5 CL would be present in approximately equal numbers for each of the following slaughter ages: day 30 or 70 of gestation or day 3-5 after lambing.

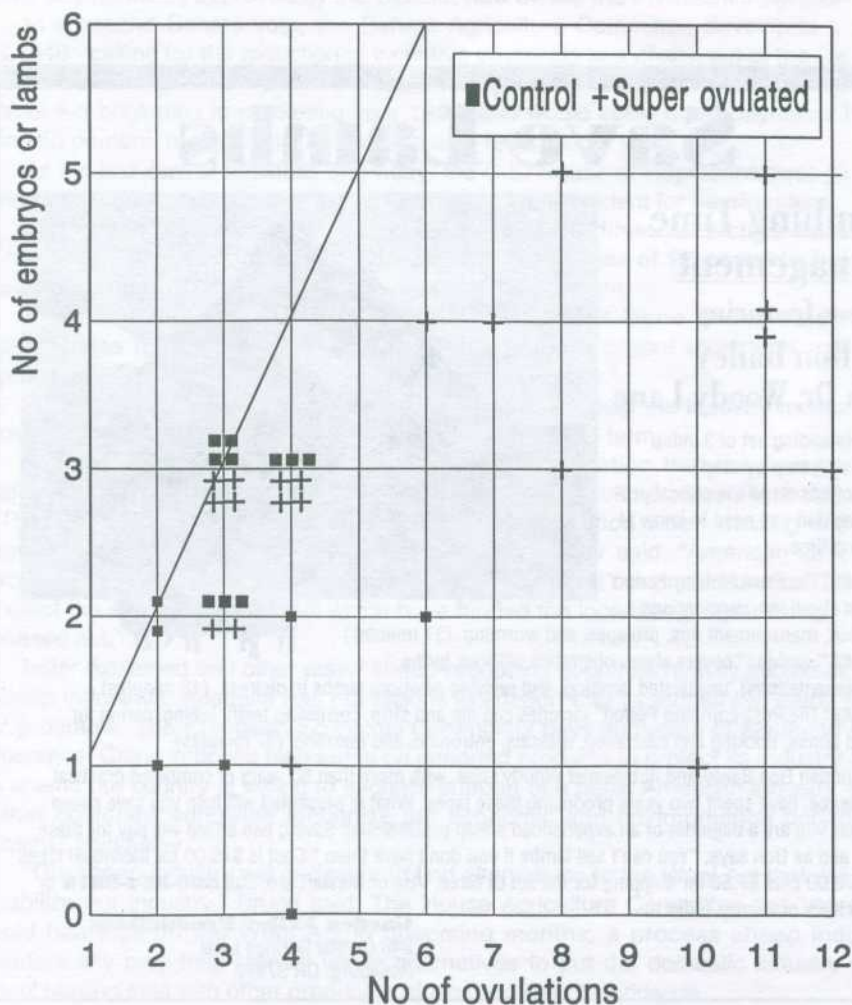
The ewes to be slaughtered on day 70 of gestation and day 4 after lambing were scanned by ultrasound on day 60 to establish the number of developing embryos and properly allocate the ewes equally.

After slaughter, the entire reproductive tract was weighed, the ovaries removed and the number of CL on each ovary counted. The uterine horns were dissected to expose the embryos. The number of embryos present in each uterine horn was recorded. On day 30, the combined weight of all the embryos was taken, while on day 70 the weight of individual embryos was recorded, then pooled. For the ewes which lambed, the individual weight of each lamb was taken. The empty uterus of each ewe was weighed, then placed on waterproof paper and measurements of length and width of the uterine horns, length of uterine body and surface of each uterus were taken.

Ova loss (result of fertilization failure and/or embryonic mortality) was approximately 17% for ewes with 2 and 3 ovulations. The corresponding percentages for ewes with up to 7 ovulations and those with more than 7 ovulations were 37% and 68%, respectively. Relationship between number of ovulations and number of embryos (or lambs for ewes slaughtered after lambing) is presented in Figure 1 for superovulated and control ewes. Ten ewes had 5 or more ovulations, but only 2 carried quintuplets and 4 had quadruplets, which may suggest that biological limits of these ewes were near that range. Statistically, the relation between number of ovulations and the ensuing surviving embryos was linear for up to 7 ovulations.

Since the ewes were distributed among the three slaughter periods according to number of ovulations, it was possible to calculate embryonic losses at the different stages. Table 1 showed that most of the losses occurred before day 30 of gestation. It seems that the first 30 days are the most critical in

Relationship between number of ovulations and number of embryos or lambs born



superovulated and prolific sheep, similar to what has been reported before in non-prolific breeds as well as in swine.

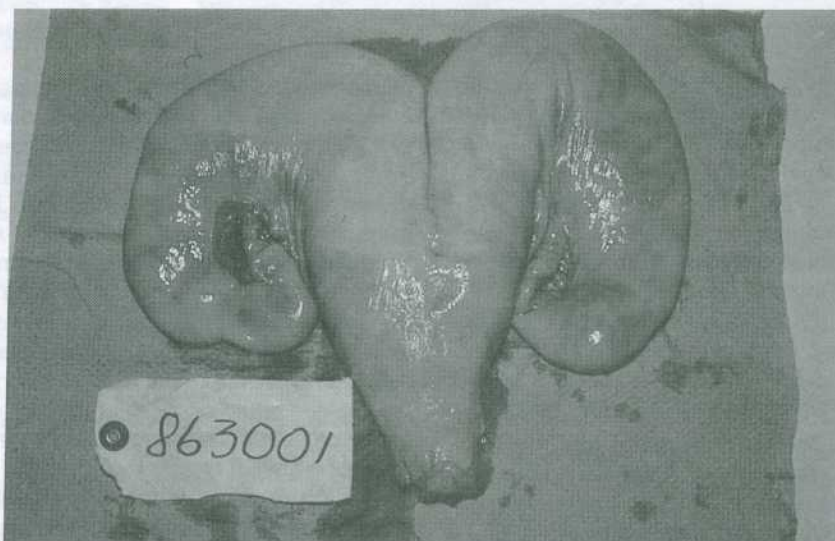
Table 2 presents the means for traits studied on days 30 and 70 of gestation and day 4 after lambing. There was no ewe carrying one embryo and only one carrying four embryos on day 30 of gestation, therefore, the comparisons are mainly between ewes carrying two and three embryos. Ewes carrying three embryos had 14% longer but 5-10% narrower uteri than ewes carrying two embryos. Surface of the uterus was similar in the two cases (262 vs. 257 cm²).

On day 70 of pregnancy, ewes carrying three or four embryos showed similar uterine measurements. Ewes with three embryos had 10.5% longer and 16% wider uteri than those carrying two embryos which in turn had 6% longer and over 50% wider horns than ewes carrying only one embryo. The surface of the uterus increased linearly with the number of embryos carried.

On day 4 after lambing empty uteri had already shown a marked regression reaching the size they had attained on day 70 of gestation when they were still carrying embryos (Table 2). Ewes giving birth to 1, 2 or 3 lambs had similar uterine dimensions, which were generally smaller than those giving birth to 4 lambs, but the differences were again non-significant. Results from the

Table 1. Ovulation losses and embryonic mortality for the three slaughter periods studied.

| | Slaughter period | | |
|--------------------------------|------------------|--------|---------------|
| | Gestation | | After Lambing |
| | Day 30 | Day 70 | Day 4 |
| Number of surviving ovulations | 49 | 60 | 62 |
| Number of surviving embryos | 34 | 37 | 35 |
| Embryonic mortality % | 30.6 | 38.3 | 43.6 |



Pregnant uterus of a prolific ewe carrying 4 embryos at day 70 of gestation.

Table 2. Means for the traits studied at days 30 and 70 of gestation, and day 4 after lambing.

| Traits studied | Number of embryos | | | | | | | | | | | |
|-----------------------------|----------------------|--------------------|------------------|----------------------|------------------|--------------------|-------------------|----------------------|-------------------|-------------------|--------------------|--|
| | 30 days of gestation | | | 70 days of gestation | | | | 4 days after lambing | | | | |
| | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| No. of ewes | 4 | 7 | 1 | 2 | 5 | 4 | 3 | 2 | 3 | 7 | 2 | |
| <i>Uterine measurements</i> | | | | | | | | | | | | |
| Length of horns, cm | 52.4 | 60.0 | 72.1 | 68.4 | 75.9 | 81.7 | 80.2 | 75.3 | 76.1 | 83.6 | 84.8 | |
| Length of body, cm | 3.5 | 4.2 | 4.4 | 8.5 | 6.5 | 9.0 | 7.7 | 4.9 | 5.8 | 5.5 | 6.9 | |
| Width 1, cm | 4.3 | 3.9 | 3.1 | 6.8 | 12.9 | 15.1 | 15.2 | 11.8 | 11.4 | 13.4 | 18.0 | |
| Width 2, cm | 5.0 | 4.8 | 3.0 | 13.0 | 16.1 | 18.7 | 18.8 | 15.8 | 14.3 | 16.8 | 23.3 | |
| Surface, cm ² | 257 ^a | 262 ^a | 168 ^b | 796 ^a | 895 ^a | 1205 ^{ab} | 1410 ^b | 689 | 708 | 876 | 1147 | |
| Litter weight, g | 32.0 | 35.6 | 26.4 | 166 | 408 | 544 | 756 | 3200 ^a | 6800 ^b | 9200 ^c | 13900 ^d | |
| Avg. wt. of embryos, g | 16.6 ^a | 12.2 ^{ab} | 6.6 ^b | 159 | 190 | 192 | 173 | 3200 | 3300 | 3200 | 3000 | |

Width 1 and 2 are taken at the upper and lower 1/3 of the uterine horns, respectively. a-b means followed by different letters are significantly different.



Opening and measuring uterus.



Embryos at 70 days of gestation.

present experiment indicated that uterine involution (the return of uterus to its non-pregnant state) in sheep is a fairly rapid process, and measurements taken as early as 3 days after lambing are probably not indicative of the real physical state of the uterus at the end of pregnancy. Weight of individual embryos (or lambs) was similar in litters of different sizes at the three stages studied.

There is a biological limit beyond which the uterine space can not expand. This limit can differ in different breeds, and at different stages of the reproductive life. Knowledge of the time when the uterine space starts to control the number of embryos is important for superovulation and embryo transfer studies and applications. When the number of embryos and the space they require to develop are within the biological limit, these embryos are less likely to be lost. In contrast, when the physical capacity is reached the embryos have to compete for the existing limited space. The expected relationship therefore is curvilinear, with the uterus expanding proportionally to the increase in number of embryos until it reaches its biological capacity and stays constant thereafter. The embryos surviving at that stage have to compete for the available space and nutrients.

In pigs, most of the embryonic loss occurs normally before 30 days of gestation, long before the available uterine space can be a determining factor. Nevertheless, in super-ovulated animals uterine capacity becomes an important limiting factor. It seems from the present study, that up to day 30 of gestation is also a critical time in sheep. Most of the embryos destined to be lost would be lost by then. It is difficult to determine if loss is due to embryonic mortality or failure to fertilize. The latter

cause is especially important in super-ovulated ewes with high concentrations of the hormone progesterone. However, embryonic mortality is a more likely explanation since fertilization rate in farm animals is usually fairly high. At that stage of pregnancy the uterine carrying capacity does not seem to be a cause for embryonic mortality. However, the present data on prolific sheep indicates that more than 10% of embryonic losses could occur after day 30 of gestation, and that uterine capacity may then be a limiting factor.

It is concluded that the space available seems to be adequate for development of most of the embryos surviving the critical first 30 days of pregnancy since embryonic weight and average weight of the lambs did not vary between groups of different ovulation sizes. Because most of the embryonic mortality in prolific sheep had already occurred by day 30 of gestation, it is probable that in sheep as in pigs, the limiting capacity is not likely a physical space but rather is an embryo-maternal relationship which develops in the first days of gestation.

Virginia-North Carolina Shepherds' Symposium

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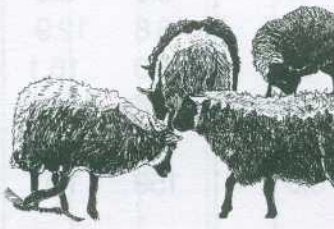
The Virginia-North Carolina Shepherds' Symposium will be held at Virginia Tech in Blacksburg, Virginia, from December 2-4. The primary activity of the Symposium is the three-day educational program which will feature topics for beginners and experienced shepherds alike. The symposium is open to all sheep producers from Virginia-North Carolina and surrounding states. It provides in-service opportunities for extension personnel, educators and other professionals in sheep and related agribusiness industries. Youth are an important segment of the sheep industry and are invited to attend. The program is arranged so that participants can attend any part of the three-day meeting.

The theme for the 1993 Symposium is "Improving Your Quality of Life Through Sheep." In addition to the numerous topics being presented on the management and economics of sheep production, the symposium will feature a special workshop on Thursday, December 2, intended to enhance the quality of life of producers raising sheep. The presentation will be made by Mr. Ron Butler, North Carolina State University Associate Vice Chancellor for Student Affairs, and is entitled "Leadership Vitality—How's Your Spizzintum?" Mr. Butler's presentation will be both informative and inspirational, and is intended to help producers as they deal with the challenges of everyday life.

Approximately 20 exhibitors will participate in the one-day commercial

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