Farmer/Grower Grant: Final report for

FNE01-396: The Effect of Growth Rate on Mammary Gland Development in Ewe Lambs: Review of the Literature and Feeding Guidelines for American Dairy Sheep Producers

2. Project goals

(a) Survey and review the current literature on the hormonal processes involved in prepubertal mammogenesis in the ewe lamb. Develop an understanding of how the prepubertal mammary gland develops, how that development changes during different prepubertal periods, how that development is influenced by hormones, and how that development subsequently affects lifetime lactation performance.

(b) Develop guidelines for target growth rates for replacement ewe lambs during identified prepubertal periods. These guidelines are to be used by producers to plan feeding programs for replacement ewe lambs, so that the growth required for reproductive efficiency can be achieved without compromising lifetime milk production.

(c) Disseminate this information and guidelines through a presentation at the 2001 Great Lakes Dairy Sheep Symposium, an article for *The Shepherd* magazine, and a summary paper mailed to all Extension Sheep or Livestock Specialists in the country for inclusion in their respective Extension bulletins.

3. Farm update

We still operate on a rented 280-acre farm in Chittenango, New York. Production is still seasonal and pasture-based. We have dropped the ewe flock numbers from 275 to 225, due to limited winter housing capacity. In 2002 we produced 48,000 pounds of sheep milk and 450 market lambs for sale.

4. Cooperators

(a) Technical advisor: Dr Brett McKusick, who received his PhD in the lactation physiology of dairy sheep from the University of Wisconsin in November, 2001. For this project, Brett translated French research on ewe lamb mammogenesis, reviewed the paper printed in the 2001 Dairy Sheep Symposium proceedings and corrected my erroneous statistical summaries, revised and edited the article printed in *The Shepherd* magazine, and revised and edited the one-page summary for Extension.

(b) Cooperator: Dr Mike Akers, Dairy Science professor, Virginia Tech. Mike helped interpret recent physiological research on the ruminant mammary gland and recent research on the hormones and growth factors that impact mammary development. (It's heavy stuff -- even the experts get fuzzy as they try to explain it!)

(c) Cooperator: Mr Bruce Clement, UNH Cooperative Extension and fellow dairy sheep producer. Bruce suggested that there wasn't enough research with ewe lambs to give specific target growth rates, and suggested instead that I establish guidelines for feeding and growth. (Which is what I did: 65-75% of ad-lib feeding levels and maximum growth rates).

(d) Cooperator: Dr Doug Hogue, Animal Science professor emeritus, Cornell University. I discussed with Doug whether a limited early growth rate would still allow ewe lambs to reach the weight required for puberty at 7 months of age and subsequent breeding for first parturition at 12 months of age. (Answer: yes, if feed levels and growth rates were substantially increased starting at about 5 months of age.)

5. What I actually did

I first went through old Lactation Physiology textbooks to reorient myself with basic mammary physiology and terminology. I then went to Cornell University and did literature searches at the general library (Mann) and the vet library. I photocopied relevant articles, brought them home, and read them repeatedly, hoping for flashes of clarity and understanding. I wrote the first draft paper for the Dairy Sheep Symposium proceedings, and sent it to Brett for review and called Mike for confirmation of my overall "picture". I presented my results at the Symposium and then, with a great deal of help from Brett, whittled the paper down for *The Shepherd* article and the Extension summary.

6. Findings (you did ask)

The negative effect of high gain occurs during a critical period: from about 1 month to 5 months of age in the ewe lamb. In this period the lamb's mammary gland is producing great masses of "ductules", the

small ducts that in pregnancy will grow into the milk-secreting alveoli and the milk-transporting ductal network. Any process that limits the development of these ductules will thus also limit the mature gland's capacity to produce and transport milk.

The effect of nutrition on prepubertal mammary growth is largely due to the inverse relationship between feeding level and growth hormone (GH) concentrations. When animals are fed at lower levels of energy, GH release is relatively higher, compared to animals on high-energy, ad-lib diets. GH acts via other hormones to stimulate cell division, provoking growth and proliferation of the ductules, and it makes energy available for the rapidly-dividing cells in the ductules. If nutrition is too restricted, however, there will be inadequate growth of the mammary fat pad, which is essential for mammogenesis. The fat pad provides the framework for mammary gland development and is also a source of local hormones critical to the growing gland. If energy intake is too low, and the fat pad too small, mammary growth can be inhibited because the proliferating system of ducts will literally run out of fat pad area in which to expand.

The negative impact of high-energy diets on ewe lambs is greatest starting at about 4 to 6 weeks of age and declines over the next few months of age, due to both the reduced concentration of circulating growth hormone and the lessening influence of growth hormone on mammary tissue. At the end of this phase of rapid duct extension, the absolute amount of ductal tissue, the degree of ductal penetration into the mammary fat pad, and the final size of the fat pad, will be primary determinants of the ultimate size of the adult lactating mammary gland.

Recent trials in dairy heifers suggest that optimal gain -- that which results in the greatest milk yield -- is about 65 to 75% of maximum daily gain. Although there have been no equivalent trials with sheep, research has shown that growth rates in the young ewe lamb must not be too low, limiting fat pad area and seriously delaying puberty (thus lowering reproductive efficiency), nor too high, resulting in lower milk production.

Early puberty, especially before 20 weeks of age, may substantially reduce mammary gland development in rapidly-reared ewe lambs by curtailing both the rate and the duration of the allometric growth phase. It is therefore recommended that dairy sheep producers should restrict the energy intake of replacement ewe lambs to about 65 to 75% of their ad-libitum intake. This will increase the rate of mammary growth and increase the total amount of epithelial tissue that will later develop into milk-secreting alveolar cells. Increased feed levels after 20 weeks have less influence on mammary development and can improve liveweight at breeding.

7. Site conditions

Not applicable

8. Economic findings

Not applicable

9. New ideas

Based on the results of this project, the University of Wisconsin is planning a major research trial at the Spooner Agricultural Research Station. The University of Wisconsin is the only U.S. institution to be actively engaged in applied sheep dairy research. Dr David Thomas has told me that the study will be dedicated to identifying specific growth-rate targets for dairy ewe lambs. And because of Spooner's sheep dairy facility and genetic records, the trial will be able to correlate daily gain in ewe lambs with milk production in adult dairy ewes. This is exactly what is needed by the dairy sheep industry, and will hopefully supply a missing piece of information in the total picture of ewe lamb management.

10. Using these results

These results have given me the confidence to allow young ewe lambs to graze through summer with only minimum supplementation (and therefore minimum gain). This year, my ewe lambs were fed less than 0.5 lb grain/hd/d, and gained only 0.25 lb liveweight/hd/d from June through August. In September, feed supplementation was increased to 0.75 lb grain/hd/d, and weight gain increased to 0.35 lb/hd/d. In October and November, grain went up to 1.00 lb/hd/d and weight gain to 0.67 lb/hd/d. Recent weighings have indicated that target breeding weights of 90 lb liveweight will easily be achieved by December 5th, the first day of the breeding season.

As a comparison, the University of Wisconsin has in the past fed their dairy ewe lambs 2 pounds of supplement/hd/d from 30 days of age until breeding at 7 months of age. That's 360 lb grain per ewe lamb, which at $100/ton = $18 grain/ewe lamb. This year my 7-month-old ewe lambs had received a total of 127 lb grain each (@ $100/ton = $6.35 grain/ewe lamb).

11. Outreach (please also see attached sheets)

(a) Presentation at the 7th Annual Great Lakes Dairy Sheep Symposium, attended by over 100 dairy sheep producers from around the U.S. and Canada.
(b) Paper printed in the Dairy Sheep Symposium proceedings
(c) Presentation of results to group of Vermont dairy sheep producers. Organized by the Small Ruminant Dairy Project (UVM Center for Sustainable Agriculture). Randolph, Vermont, January 26, 2002.
(d) Article of results published in The Shepherd magazine, April 2002
(e) Summary article printed and mailed to Extension Livestock Program Leader in each of the 50 U.S. states
(f) Presentation of results to be given to New Hampshire Dairy Goat Seminar at the NH Farm and Forest Exposition, February 8, 2003.

Thank you,

Bee Tolman 11/18/02

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November 18, 2002