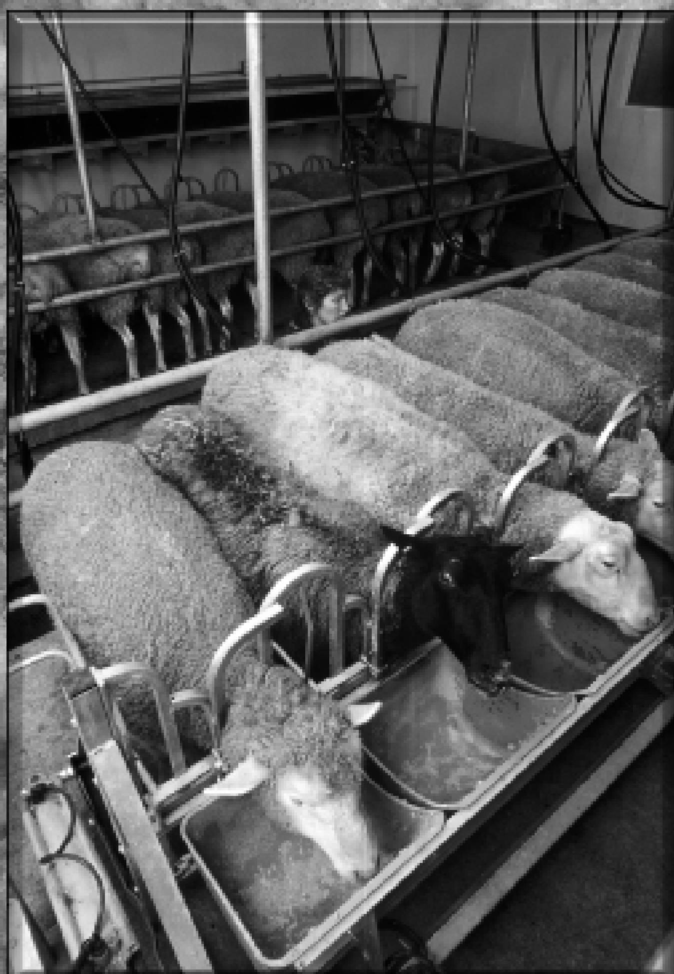
Proceedings of the 3rd Great Lakes

Dairy Sheep Symposium



April 4th, 1997

Madison, Wisconsin USA

Proceedings of the 3rd Great Lakes Dairy Sheep Symposium

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Ramada Inn Capital Conference Center
Madison, Wisconsin, USA

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Wisconsin Sheep Breeders Cooperative
Madison Area Technical College
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    Division of Cooperative Extension
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    College of Agricultural and Life Sciences
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Milking of Ewes in the Dairy Sheep Parlor at the
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Additional copies of the 1995, 1996 and 1997 Proceedings of the Great Lakes Dairy Sheep Symposium can be ordered from the Wisconsin Sheep Breeders Cooperative, 3696 Country Aire Drive, Cedarburg, WI 53012-9206, USA (phone/FAX: 414-377-1491).

PROGRAM

Great Lakes Dairy Sheep Symposium

Ramada Inn Capital Conference Center
Madison, Wisconsin

Thursday and Friday, April 3 and 4, 1997

April 3

6:30 - 8:00 pm	**Extraordinary Tastes -** The Midwest's finest chefs will spotlight American lamb and sheep dairy products in a gala promotional event for producers and the food service industry.

April 4

7:30 am	**Registration**
8:30 - 9:30 am	**Marketing Situation for Sheep Milk in the Upper Midwest -** Jeff Foster, President, Wisconsin Sheep Dairy Cooperative and dairy sheep producer, Colfax, Wisconsin
9:30 - 10:30 am	**Management of a Dairy Sheep Flock and Production of Value-Added Cheese -** Hani Gasser, dairy sheep producer and farmstead cheesemaker, Fisher Creek Ranch, Chase, British Columbia, Canada
10:30 - 11:00 am	**Break**
11:00 a.m. - Noon	**Management for Improved Production and Quality of Milk from Dairy Sheep -** Dr. Pierre-Guy Marnet, Professor and Scientific Director, Team for Dairy Sheep Research, National Superior School of Agriculture and National Institute for Agricultural Research, Rennes, France
12:00 - 1:00 pm	**Lunch on your own**
1:00 - 2:00 pm	**Practical Feeding of Lactating Dairy Sheep - Lessons from Dairy Cattle -** Dr. David K. Combs, Department of Dairy Science, University of Wisconsin-Madison
2:00 - 3:00 pm	**Lamb and Milk Production of East Friesian Sheep - Experimental Results -** Yves M. Berger, Assistant Superintendent, Spooner Agricultural Research Station, University of Wisconsin-Madison, Spooner, WI
3:30 - 4:30 pm	**Needs and Concerns of Sheep Milk Processors - A Panel Discussion -** Moderator: Dr. Bill Wendorff, Extension Food Scientist, University of Wisconsin-Madison Participants: Scott Erickson, Specialty Cheese Processor, Bass Lake Cheese Factory, Somerset, WI James L. Path, Specialty Cheese Outreach Specialist, Center for Dairy Research, University of Wisconsin-Madison
6:30 pm	**Annual Awards Banquet and Auction Extravaganza**

TABLE OF CONTENTS

Management of a Dairy Sheep Flock and Production of Value Added Cheeses........ 1
Theres and Hani Gasser

Ewe Management for Improved Milk Yield and Quality 5
Dr. Pierre-Guy Marnet

Early Experimental Results for Growth of East Friesian Crossbred Lambs and Reproduction and Milk Production of East Friesian Crossbred Ewes.. 12
Yves M. Berger and David L. Thomas

An Example of a Dairy Sheep Budget 22
Gary G. Frank and David L. Thomas

Development of the Dairy Sheep Milking Parlor at the Spooner Agricultural Research Station 24
Yves M. Berger and David L. Thomas

MANAGEMENT OF A DAIRY SHEEP FLOCK AND PRODUCTION OF VALUE ADDED CHEESES

Theres and Hani Gasser
Fisher Creek Ranch
Mountain Meadow Sheep Dairy Inc.
Chase, British Columbia

Overview of the farm:

160 acres owned, 40 acres irrigated pasture for dairy flock
250 acres leased for beef cows, mainly bush
80 to 100 dairy ewes, 150 to 200 lambs
13 to 15 beef cows
2 horses, Border Collies and Komondor guard dogs

The farm is located in the interior of British Columbia, 40 minutes from Kamloops (pop. 100,000) and 4 1/2 hours from Vancouver (pop. 2,000,000). The climate is characterized by hot, dry summers and cold winters. There are approximately 170 days of winter feeding.

We were the first in North America to import frozen East Friesian dairy sheep semen in 1992. Our crossbreading program started with Rideau Arcott ewes. Some lambs born this spring (1997) contain 97% Friesian blood. Semen has been imported from Switzerland and Germany. The flock is OPP tested every 2 years and so far is OPP negative.

In 1996, all ewes were culled that produced below 275 litres of milk in 180 days. Our average milk production is 300 litres in 200 days and 1.8 to 2.2 lambs born per ewe. Lamb production was 1.8 lambs per ewe in 1996 with half the flock being first-time lambers.

All winter feed is bought as hay, barley and alfalfa cubes. Sheep are on irrigated white clover, grass mixed pasture all summer. Pastures are rotated, and beef cows are used to clean up behind the sheep. The cows also eat all winter feed leftovers from the sheep. Border Collies are used for herding, and Komondor guard dogs are used for predator control.

Milking is done in a parlor holding 24 ewes (12 on each side) with an in-line system with 8 milking units and a 900 litre cooling tank. There is an underground milk line to the processing plant.

The Mountain Meadow Sheep Dairy Inc. processing plant is Provincially and Federally inspected. We produce Brie, semi-hard cheese, yogurt and butter. In 1996, we processed approximately 20,000 litres of sheep milk and hope to double this figure in 1997. This year, two more producers ship sheep milk to us. We have a 600 litre cheese vat-pasteurizer on a lift to gravity feed curd or yogurt to the press-filling table. The Brie curing room has to be extremely clean and sterile, otherwise the wrong mold will be introduced.

Our sheep milk products are sold in health food and deli stores in Vancouver, throughout the Province of British Columbia, and some into Alberta. Close team work with a goat milk processor in marketing allows us to be able to attend shows financially and time wise and to reduce transport costs. This year we have two salesmen partime on the road and one person partime in the processing plant.

The weaning strategy used in 1996 and 1997 is for the lambs to stay with the ewes for the first 14 days. Ewes get milked twice daily from the second day after lambing to increase milk flow. When lambs are two weeks old, we remove them over night for 10 to 12 hours. When lambs triple their birth weight, are at least 30 days old and weigh 30 pounds, we wean them completely and now all the milk is ours.

Weaning Strategies for Dairy Sheep Management : a study conducted by the Ministry of Agriculture, Kamloops, British Columbia and Fisher Creek Ranch

Supervisor: E.L. (Ted) Moore, P.Ag.

Objectives:

1. To reduce the volume and cost of purchased lamb milk replacer
2. To reduce labor required at lambing time
3. To maintain or increase total milk produced during the lactation period

Results:

Description of Ewe Group Management:

1. Group 1 — Lambs nurse 24 hr./day for 4 weeks, then weaned

   Ewes milked 2x/day when lambs weaned

2. Group 2 — Lambs nurse 24 hr/day for 2 weeks;

   After 2 weeks, lambs removed from ewes twice each day for 14 hours

   (i.e. - allowed to nurse for 2 - 5 hr periods each day)

   Ewes milked twice each day

   After 2 weeks of nursing/milking, lambs weaned, ewes continue to be milked 2x/day

3. Group 3 — Lambs nurse 24 hr/day for 2 weeks

   After 2 weeks, lambs removed for 14 hr/day

   and ewes milked 1 time per day

   When lambs 4 weeks old, they are weaned and ewes are milked 2 times/day

Table l - Summary of Results

Ewe Group	# Days Milked	Average Milk Yield, L	# Lambs Weaned/Ewe	Lamb Weaning Wt (lb)	Lamb 100 day wt
Group 1	85	57.3	1.73	31.3	74.1
Group 2	158	131.0	2.12	32.8	72.5
Group 3	186	163.0	2.05	33.2	66.0

Discussion

1. Genetics of groups variable; Group 1 ewes lower genetic potential for milk than Groups 2 and 3.
2. Weaning weights not significantly different between groups, e.g.

   Group 1 31.3 lb
   Group 2 32.8 lb
   Group 3 33.2 lb

   The trend was to heavier weaning weights for Groups 3 (12 hour lamb removal after 2 weeks of nursing).
3. Milk production was highest for Group 3 ewes, as was number of days milked. However, this result is also due to differences in genetics as well as management, as Group 3 ewes had a higher percentage of East Friesen genetics than Group 1 and were the better producing ewes the previous year, relative to Group 2.
4. From a management perspective, Group 3 (14 hours removal of lambs with 1 time per day milking) is the easiest and most practical system. It requires separation of ewes and lambs only once per day (as compared to twice per day with Group 2) but still produced comparable weaning weights with the other management systems. It also eliminated the need to raise lambs on milk replacer.
5. Economic impact of Group 3 management also appears positive as compared to other options (i.e. weaning at 6 hours and training on milk replacer or allowing lambs to nurse for 4 weeks, then weaning and starting to milk at that point).

   Estimated economic impact:
   Assumptions:
   Sheep Milk value $1.75 /litre
   Cost of raising lambs on milk replacer:
   $1/day for 30 days = $30/lamb

   For ewes raising an average of 2 lambs per ewe, the value of ewes milk replaces $60 of milk replacer when weaning at 30 days of age.

   Based on milk yield records before and after weaning of Group 3, it is estimated that 2 lambs per ewe consume just under 1 liter per day.

   Therefore over 30 days, twin lambs consume a total of 30 litres, at a value of $1.75 per litre.

   The total cost is 1.75 x 30 $52.50

Therefore using the Group 3 weaning management results in a net benefit of $60 - $52.50 = $7.50 per ewe.

This does not take into account the labour savings of not having to raise lambs on milk replacer. This labour requirement for 200 lambs is quite significant.

6. Lamb Management After Weaning

   Lamb management after weaning has been identified as an area requiring more attention. From the results of the 100 day weights, it can be seen that the Group 3 lambs did not do as well after weaning as Group 1 and 2 lambs, despite the fact that Group 3 lambs were slightly heavier at weaning.

   This slower growth is attributed to how these lambs were managed at weaning. Group 3 lambs were moved from their familiar surroundings (i.e. the pen where they were separated from the ewes for 14 hours per day for 2 weeks prior to weaning) and placed with the older, already weaned, Group 1 and 2 lambs. The change of surroundings, plus the need to compete for feed with older lambs, placed added stress on these lambs.

   The following recommendations are made:

   1. Minimum target weight for weaning is 30 pounds or 3 times birth weight, which ever is greater.
   2. Lambs should not be removed from familiar surroundings when being weaned.
   3. Lamb groups should not be mixed at weaning, as this adds to stress, especially if younger lambs are added to a group of older, already weaned lambs.
   4. Careful monitoring of creep feed intake prior weaning helps to identify whether lambs are used to dry feed. Lambs that do not consume creep feed while still nursing will suffer more stress at weaning.
   5. Be flexible - it may be necessary to leave some lambs on the ewes longer than 4 weeks, while other lambs (e.g. big singles, may be weaned earlier). Attention to detail and individual animal differences are important for success.

EWE MANAGEMENT FOR IMPROVED MILK YIELD AND QUALITY

Dr. Pierre-Guy Marnet
Professor and Scientific Director
Team for Dairy Sheep Research
National Superior School of Agriculture and
National Institute for Agricultural Research, Rennes, France

Introduction

There are a number of methods to improve the quality and quantity of milk, some of which have been neglected in the past 20 years. Indeed, much work has been dedicated to feeding and genetic improvement of milk yield and composition, but milk retrieval at milking has been considered as secondary because milking equipment technology has not considerably evolved. But now the gains to be expected from feeding are reduced, investment returns are increasingly uncertain, and work is more complex. In Europe, the extension of milk quotas (restriction of the right to produce) to small ruminants have encouraged farmers to seek technical solutions to improve the quality of the milk and at the same time simplify working procedures. Some of the answers to their plea lie in a better understanding and exploitation of the milk ejection mechanisms.

Review of Milk Synthesis and Ejection

After a phase of mammary growth (secretory alveoli and ducts) mainly controlled by ovarian steroids, the milk surge, or lactogenesis, will necessitate stimulation of secretory cells by a number of pituitary hormones; prolactin and ACTH in particular. Note that inducing lactation artificially only requires steroid administration to prepare the udder for these pituitary hormones before turning the animals to milking. Milking, through udder stimulation, induces the release of a hormone compound necessary for the ultimate phase of mammogenesis and the induction of lactation. Once lactation has been induced, its maintenance will require, in addition to the above hormones, other hormones that preferentially act on mammary metabolism, such as growth hormone (GH). There again, it is worth noting that udder clearance is always followed by GH release. This also explains the so-called lactation maintenance reflex linked to mammary gland stimulation. Once the milk has been produced, it still has to be drawn from the udder, otherwise drying-out will occur very quickly. This means that the accumulation of milk, adding to the lack of the hormones required for milk synthesis, will stop the cellular mechanism. Two reasons have been put forward. First, pressure in the secretory alveoli crushes alveolar cells and impedes secretion vesicle transfer and also slows down the passive passage of elements from blood to milk. The second cause is thought to involve one or several lactoserum peptides (Feed Back Inhibitor of Lactation : FIL) which, by accumulating in the alveoli, would have an inhibitory effect on lactose synthesis. This clearly demonstrates the importance of thoroughly draining all the milk contained in the alveoli at each milking. But thorough draining requires the active participation of the animal. Indeed, if between milkings the milk is partially discharged into the cisterns in the lower part of the udder, some of it remains in the alveoli and in the small galactophores at the top of the udder. That milk contains much more fat because fat cells are larger than the diameter of these small ducts. To be extracted, that milk must be expelled from the alveoli by the pressure applied on the alveolar wall by myoepithelial muscle cells. These cells spontaneously contract (smooth muscle cells), but the ejection of milk will only be effective if their contractions are synchronized, which can only be achieved if they are stimulated by a neuro-pituitary hormone, oxytocin. There again, the release of that hormone in blood results from a neuro-humoral reflex initiated in the udder. So optimizing milk ejection comes down to retrieving the milk and usable matter that was produced through genetic selection and feeding and thus optimizing the animals' potential. The milk, by going down into the cisterns, increases the intramammary pressure and the pressure ratio between the cisterns and the mouth of the sucking lamb or the machine vacuum nozzle. This also accelerates draining and makes milking quicker.

Lastly, if all information transits through the central nervous system, it is likely that the CNS may act as a modulator of response to udder stimulation. For instance, the connections of the oxytocin-producing hypothalamic nuclei (supra-aortic and paraventricular nuclei) to the limbic system, which is the emotion site, and the cortical areas which are the memory sites, explain why recognition of an anxiety factor (biting dog, stranger in the farm, sudden replacement shepherd, bleating of lambs, undergoing such treatments as injection or foot trimming, shearing noise) may inhibit oxytocin release and hence milk ejection. Other factors, on the contrary, may facilitate milk ejection. In suckling farms, it is the sight and cry of the young and in dairy farming, when all is well, the sight of the usual milker, the starting of the vacuum pump and/or pulsation, entering the milking pen and above all concentrate feeding in the milking pen. It has to be noted that there is a close relationship between oxytocin and another peptide: CCK (cholecystokinine). Although this has not been proven in ruminants, the CCK released at the peripheral level when the feed bolus reaches the stomach is thought to induce oxytocin release and might therefore promote milk ejection. However, CCK may also be released at the central level, which controls rumination. But oxytocin may in turn induce CCK release. This implies therefore that rumination nearly always follows oxytocin release and milk ejection. An animal that does not ruminate in the milking pen is therefore under unfavorable conditions and surely does not express its full potential.

So respecting the animal, stimulating it as much as possible may appear coarse (but not that easy) but is necessary to extract all the secreted milk as quickly as possible and to maintain lactation.

Milk Ejection

Milk ejection, which in dairy cows usually occurs during massage and in the first minutes of milking, has to take place within only two milking minutes in ewes. It therefore requires careful animal selection and optimal setting of the milking machine. Milk ejection can be monitored during milking without using any invasive technique and without bothering the animals. Measuring the milk emission output at milking is sufficient. The technique has produced very interesting results in terms of the distribution of milk in the udder and is still a reference method for selecting animals according to their milking easiness. In ewes, milk generally flows in several stages. The first outflow peak corresponds to cisternal milk discharge. Then a second outflow peak occurs only if the nervous connection between the udder and the CNS is unimpaired. That outflow therefore depends on oxytocin and represents the volume of milk trapped in the small galactophores and the alveoli. That milk is called the alveolar milk. Lastly, a third increase in outflow is noted at the time of stripping. That milk fraction represents the milk kept below the teat in the mammary gland pockets. But if the ejection of alveolar milk is incomplete, the massage performed during stripping and the tap stimuli applied by the milker under the udder will help in retrieving all or part of the alveolar milk with that fraction. Note that in the early days of mechanization, the poor performance of the machines, and the large number of ewes that did not respond to mechanical milking stimulation forced the milkers to perform hand milking to retrieve residual milk after removing the milking bundle. That operation is now rarely performed.

In 1982, almost half of French Lacaune ewes were unresponsive and necessitated time-wasting and tedious stripping and manual re-milking operations for all the milk produced to be retrieved and collected. In 1995, only 7 to 8 % of these remained and essentially among ewe-lambs. Those ewes which only emit their cisternal milk have lower milk yield, less rich milk (up to 70% of the fat can be trapped in the alveolar fraction between milkings) and poor lactation persistence. These ewes therefore are removed from the flocks. It should be noted also that ewes with poor reflex have a lower milk outflow, inducing protracted milking times. It is therefore important to carry on selecting ewes according to their milk emission kinetics. Nowadays, because of the sharp increase in the volume of milk produced, it is frequent that the cisternal milk has not finished flowing when the alveolar milk ejected by the action of oxytocin reaches the teat. As in cows and goats, it becomes difficult or impossible to distinguish between the two emissions and to measure their respective outflow. At the most, the reflex is known to have occurred if the milk emission kinetics lasts for more than 40 sec. with a high outflow, which is the maximum time for effective oxytocin release. There is a good correlation between the cisternal milk volume and milk yield. That volume currently represents as much as 38% of total milk yield on average. The alveolar milk volume is similar (34%) and so up to 28% of total milk is represented by stripping milk. Stripping is therefore mandatory. But a large part of that stripping milk is linked to the mammary gland morphology, not to a problem of effective milk ejection. Selection according to milk production performance has resulted in larger cistern volumes, partly due to the enlargement of the pockets at the base of the udder. Consequently, the teats are higher and their position precludes complete drainage of the mammary gland. Furthermore, that teat position makes the fitting of nozzles more difficult and may induce air intake or bundle disconnection detrimental to the udder health (impact on teats and increased risk of germ contamination). It is therefore crucial, as in dairy cows, to select ewes in consideration of their udder morphology and by choosing animals with teats as vertical as possible, properly draining the udder. Combined with a good oxytocin release, vertical teat placement will warrant effective milking, which can be simplified by automatic disconnecters, a technique known to reduce overmilking and improve teat health in cows. Among the various ewe breeds, some have milk emission kinetics with a single outflow peak, high volume emission (a characteristic of Friesian ewes). If there are fewer of these ewes with oxytocin release at milking than the more highly selected Lacaune ewes, it is nonetheless true that these animals offer large cistern volume and the ability to transfer alveolar milk into cisterns between milkings. This ensures that synthesis will not be hindered and that the secretory potential will not be reduced throughout lactation. In addition, poor setting of the milking machine or the presence of milking-refractory animals will have less impact and milking will be simplified.

The effect of oxytocin release between milkings on the distribution of milk in the udder and on milk yield has been verified. It appeared that if blood oxytocin is maintained throughout the day at the same level as during milking, the storage volume increases in proportion with total milk and the alveolar milk volume slightly decreases and holds. The result is a 18 to 25% increase in milk yield. Whatever the reason, good milk transfer between milkings thus appears to be as important a factor of better milk yield and easier milking as milk ejection during milking. It is worth noting that luteal oxytocin could be among the factors causing that transfer, because milk transfer in the cisterns increases when there is sexual activity. Other milk ejection factors have been evidenced in ovaries, which led us to deepen our knowledge of the relationship that exists between the ovarian sphere and the udder.

Oxytocin titration is not informative on the occurrence of milk ejection because the important factor is the form of release rather than the amount of oxytocin released. Indeed, sustained oxytocin release results in high intermammary pressure during milking and thus quicker and complete draining of the udder. There is also a very small number of cases when oxytocin release occurs and has no effect on the udder. There are multiple reasons for that but the most likely ones are the absence or deactivation of receptors on the mammary gland. Catecholamine release may also occur at the peripheral level, reducing mammary blood flow to a point where the oxytocin level is no longer sufficient to ensure effective alveolar contraction. Considering the costs of oxytocin assays and the necessity to perform several of these tests in the course of one milking, the method should remain experimental or at the most be used to select the best breeding ewes in breeding units.

Ewe Management at Milking

There are a large number of different ways to manage dairy ewes. In the very intensive Mediterranean systems, ewes are managed in the same manner as dairy cows and weaning occurs immediately after lambing, followed by exclusive milking to the end of lactation (150 to 200 days). In that case, the lambs are artificially reared and are difficult to train because they never learn from their mothers. In many cases, however, a variable suckling period precedes exclusive milking. In the most extensive flocks, lambs are suckled to weaning. In intermediate cases, the point is to provide colostrum cover and to await the seasonal opening of specialized creameries such as those of the Roquefort region in France. In that case, however, the milk production in Lacaune ewes, which has doubled in 20 years and largely exceeds the intake capacity of the lambs in the early stages of growth, no longer permits exclusive lamb suckling without hindering lactation. For that reason and, according to some authors, milking has been combined with suckling for complete mammary gland drainage and to train the ewes to come to the milking pen. How to choose between those systems? According to Labussiere’s results, it appears that the more the ewes suckle their lambs, the greater difficulty they have to give their milk to the machine while releasing oxytocin. The drop in milk yield observed at weaning (23 to 35% according to breed) and explained mostly by the reduced frequency of daily drainage (-20 to -25%) but also by the mother-lamb separation effect (estimated at -3 to -7%) inhibiting the ewes’ adaptation to mechanical milking. Mixed management never really reduced the drop in milk yield at weaning. This is clearly explained because our recent studies have shown that as long as the ewe has daily contact with her lamb, she refuses to release oxytocin at milking, whereas she does it without any problem when suckled (selectiveness). The proximity of the lamb in the milking pen (unfeasible in practice) restores the milk ejection reflex, which demonstrates the necessity of the lamb effect (most probably olfactory and visual) for milk ejection to occur. Ewes however get used to the milking pen and passing to exclusive milking is made easier by their calmness. As early as 48 h after lamb separation, the ewes begin releasing oxytocin at milking, contrary to exclusively suckling ewes, a proportion of which will never adapt. The rate of adaptation to milking is also the same as that observed in ewes turned to exclusive milking upon lambing. This latter method however has to be considered with caution. Our studies show that oxytocin release is less effective if the mother does not establish her maternal instinct, i.e., if the first sucklings are not performed. So a 24-h maximum contact between ewe and lamb is beneficial, and the lambs remain easy enough to train for artificial suckling. Although this remains to be verified experimentally, our results and those of “controle laitier” would tend to show milk yield to be higher as mixed management lasts longer. These results could be easily explained by the establishment and repeated stimulation of a strong ejection and secretion reflex, effective in early lactation, which would potentiate the ability of the cellular mechanism to synthesize milk to the end of lactation. Lastly, mixed management permits functional selection based on the morphology of the udder and teats because as a rule the ewes not capable of suckling their lambs are removed from the flock. Consequently, flock homogeneity is greater and milking is easier. Although no reliable data are available in that respect, the users of the various methods have not reported any significant effect on udder pathology.

Milking Machine

The milking machine must be stimulating enough to ensure strong milk ejection during the very short milking time. Also, ewe milking includes time-consuming manual operations (stripping and possibly "re-milking") that should be reduced to a minimum, in particular by selecting well-formed udders.

Proper setting of the machine however may help increase the productivity of the milker and at the same time simplify his task. Initially, choosing a pulsation rate as high as 180 ppm was motivated by the need to emulate the natural conditions of lamb suckling as best as possible. All our experiments aimed at comparing pulsation rates from 60 to 180 ppm have shown that milk yield is very slightly higher when the rate is set above 120 ppm. The mechanical milking and stripping milk volumes do not vary significantly, but the most spectacular effect is an increase in the re-milking volume at 60 ppm, whether the pulsation ratio is 33 or 50%. Pulsation ratio trials tend to show that ratios below 50% would incompletely drain the teats. Oxytocin assays elicited significantly lower release in that case, and it can thus be concluded that a pulsation rate below 120 ppm is too low to stimulate Lacaune ewes and does not ensure total drainage and retrieval of all the usable matter. It should be noted also that cup drop is more frequent (with rubber liners) when the pulsation rate is low.

The vacuum pressure chosen is between 36 and 53 kPa. The most recent tests we performed showed that the vacuum effect is mainly sensitive on the percentage of milk retrieved after stripping. This may be due to a disruption of mammary drainage induced by teat elongation, liner clambering and very obvious congestion of the teats. This effect therefore is more a physical one. However, considering that the vacuum pressure setting is a trade-off dictated by the weight of the bundle and the need to prevent it from failing off, the solution could be to operate under lower vacuum pressure (36 kPa) with lighter bundles and better gripping liners (silicone). However, with no air intake at the clamp, the rated vacuum pressure under the teat may transiently exceed the regulator pressure and damage the teat while increasing the leukocyte count. It is therefore recommended to maintain some air intake, even if it means increasing the vacuum reserve slightly. The best trade-off would therefore imply low vacuum pressure (36 kPa) and high pulsation rate (180 ppm) with a 50% ratio. Note that with such a setting the leukocyte count will be higher than with a lower pulsation rate. There is no upper aggression on the mammary tissue. In fact that effect is only sensitive in animals with leukocyte counts above 200,000 cells per milliliter (sterile controlled milk). So the increase in leukocyte count is only the result of the expulsion of the cells contained in the alveoli, through which they enter the udder. This clearly confirms better drainage induced by oxytocin and permits earlier detection of possible udder infections. Lastly, the choice of liner is crucial for optimal application of the machine settings to the teat. There is no impact on milk yield if the milker performs proper stripping. This means that the teat liner has to be chosen carefully to facilitate physical drainage of the udder. Silicone liners appear to reduce cup drops and liner slipping and are therefore recommended. However, the most spectacular effects are produced by the design of the cup and the flexibility of the liner body. Stripping is highly reduced when the cup diameter is increased to restrict teat squeezing at the end of milking. Otherwise air intake is facilitated and cup falls are more frequent. A very hard liner may increase stripping considerably because it moves more slowly and remains open longer than a softer liner. Indeed milk outflow can be accelerated but the effect of that on the teat is deleterious (upper congestion) and the liner clambering is more marked. The flaring pressure for ewe liners is thought to be close to 10 kPa.

A number of factors are yet to be tested or re-tested because of the ongoing standardization of milking equipment for small ruminants. Further advances are still possible through blood oxytocin assays, measurements of teat congestion and udder immunological condition assessment, as indices of the physiological effect of the equipment and of udder health.

Conclusion

Adding the losses in milk and usable matter to those in milker time and discomfort that can be endured unknowingly when operating under poor conditions, the losses can add up to impressive figures (up to 20-25%). It is therefore necessary to use animals with good mammary conformation (large cisterns, well drained by vertical teats at their base), good sensitivity to stimulation by the milking machine, and good and sustained oxytocin release during and possibly between milkings. High milk output at milking will ensue and the working time will be reduced accordingly. In more intensive systems, ewes exhibiting low maternal instinct will be preferred to facilitate weaning and adaptation to mechanical milking. The equipment will be adjusted so as to be stimulating (high pulsation rate) and optimize oxytocin release and increase drainage effectiveness and unaggressive (low vacuum pressure) to avoid tissue congestion and poor teat drainage, which would necessitate additional manual operations. All these operations, by better draining the udder, will ensure and maintain better milk yield throughout lactation, all the more so as they are performed frequently in early lactation. In that respect, mixed management appears to be an additional asset if the right to produce is not restricted.

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EARLY EXPERIMENTAL RESULTS FOR GROWTH OF EAST FRIESIAN CROSSBRED LAMBS AND REPRODUCTION AND MILK PRODUCTION OF EAST FRIESIAN CROSSBRED EWES

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Summary

Dorset-cross adult ewes were mated to either East Friesian (EF) crossbred rams (two 1/2 EF, 1/2 Arcott Rideau rams and one 3/4 EF, 1/4 Arcott Rideau ram) or purebred Dorset rams. East Friesian-sired lambs were heavier at birth and at 60, 120, and 142 days of age. No effect of breed of sire was found on fertility and prolificacy of the ewes to which they were mated. Ewe lambs born from these matings were raised and bred at seven months of age to Dorset rams. East Friesian crossbred ewes were no more fertile than Dorset-type ewes, but they produced more lambs (+.26 lambs/ewe lambing) at birth. Survival and growth of their lambs were found to be similar. In 1996, East Friesian crossbred and Dorset-type ewe lambs were machine milked after weaning their lambs at 34 days of age. East Friesian crossbred ewe lambs had a longer lactation than Dorset-type ewe lambs (120 versus 95 days, respectively) and produced approximately twice as much milk (210 versus 110 lb., respectively) with a slightly lower butterfat content. The greater lamb and milk production of East Friesian crossbred ewes indicates a good adaptation of these animals to the north central American environment.

Introduction

While dairy sheep production has a long tradition in many countries, the countries of North America are without a sheep dairying heritage. U.S. domestic sheep breeds have not been selected for commercial milk production. Experimental studies in the U.S. (Boylan, 1989) reveal some differences between breeds for commercial milk production. Among available breeds, Dorset, Rambouillet, Targhee, and Suffolk would be expected to have above average milk yield. However, the milk yields of these breeds pale in comparison to the yields reported for European and Mideastern breeds selected for milk production over many years. The East Friesian breed stands out as the highest performing dairy breed with milk yields of 1200 to 1400 lb. in 220 to 260 day lactations (Alfa-Laval, 1984). The East Friesian breed has been used widely in crossbreeding systems with local breeds to improve milk production. The Assaf breed was formed in Israel by crossbreeding the East Friesian with the Awassi breed (Goot, 1986). The Tahirova in Turkey was formed by crossing the East Friesian with the local Kivircik (Sonmez et al., 1976). In France, Flamant et al. (1975) reported an average milk production of first generation Friesian x Lacaune ewes of 50% more than pure Lacaune ewes. However, the adaptation of the East Friesian to some environments has been cause for concern. Gootwine and Goot (1996) reported a low milk production of pure East Friesian ewes and of crossbred ewes with a high level of East Friesian breeding in Israel. Similarly, studies made by the Research and Experimental Center for Sheep Husbandry in Mountainous Areas (CREOM, 1988) showed that a gain in milk production by using the East Friesian was not always present, but the loss in butterfat and protein was always present with East Friesian breeding.

The East Friesian breed started to appear in the U.S. in 1993 via Canada. Since 1996, with the relaxation of the rules for importation, a greater number of pure East Friesian animals are now available in the U.S. An in-depth study of the production of East Friesian crossbreds in terms of lamb and milk production is now possible. The first results obtained at the Spooner Agricultural Research Station of the University of Wisconsin-Madison are presented in this paper.

Material and Methods

Growth of lambs sired by East Friesian crossbred rams or Dorset rams.

In September and October of 1993, 1994 and 1995, a total of 385 crossbred ewes of 1/2 Dorset, 1/4 Romanov (or Finn) and 1/4 Targhee breeding were exposed to either East Friesian (EF) crossbred rams (two 1/2 EF, 1/2 Arcott Rideau rams and one 3/4 EF, 1/4 Arcott Rideau ram) or to Dorset rams. After birth, all lambs had access to a 19% crude protein creep feed. In general, lambs were weaned at about 8 weeks of age. Lambs raised on milk replacer were weaned at an average age of 28 days. Three to four weeks after weaning, all lambs were switched to a 13% crude protein ration in a self-feeding system. All lambs born in the spring of 1994 were sold for slaughter or as breeding stock. All females born in the spring of 1995 and 1996 were removed from the self-feeding system at about five months of age and given a more conventional ration of alfalfa hay and corn until they were exposed to rams at seven months of age. All males were left intact, raised until they reached 120 to 130 lb., and sold for slaughter.

Birth weight and weight at 60, 120, and 142 days of age (142 day weights for males only) were analyzed. The effects of sire (EF crossbred or Dorset), age of dam (1 to 5 years), type of birth (single, twin, or triplet), and year of birth (1994, 1995, or 1996) were determined. The effects of type of rearing (single, twin, triplet, artificial rearing) were also determined for weights at 60, 120, and 142 days of age.

Reproductive performance of East Friesian crossbred and Dorset-type ewe lambs.

All ewe lambs born in February and March 1994 (48 East Friesian crossbreds and 48 Dorset-type) were exposed to East Friesian crossbred rams between September 19 and October 24, 1994. All ewe lambs born in April, 1995 (104 East Friesian crossbreds and 50 Dorset-type) were exposed to Dorset rams between October 3 and December 6, 1995.

In both years, ewe lambs were kept in outside paddocks and fed first-cut haylage ad libitum. One-half lb. of corn was added one month prior to the start of lambing. Ewes were brought into a barn five days before the onset of lambing. General lambing management practices were observed. Lambs born in 1995 were weaned at about eight weeks of age. Lambs born in 1996 were weaned at an average of 34 days. In both years, lambs had access to a 19% crude protein creep ration from eight days after birth. Three to four weeks after weaning, lambs were switched to a 13% crude protein, high concentrate ration in a self-feeding system. All males were left intact and kept on this system until they reached a slaughter weight of 120 to 130 lbs. Females kept for replacement were removed from the self-feeding system at five months of age and given alfalfa hay ad libitum and .50 lb. of corn daily.

Ewe lambs in the two years were pooled together for the analysis of their reproductive performance. However, lambs born in 1995 were analyzed separately from lambs born in 1996 since their breed of sire and management were different.

The effects of breeding of the ewe (East Friesian crossbred or Dorset-type) was determined for all traits pertaining to the ewe lambs. For the lamb traits of birth weight, weight at 60 days (lambs born in 1995), weight at 34 days (lambs born in 1996), and weight at 120 days, the effects of breeding of the dam (East Friesian crossbred or Dorset-type), type of birth (single, twin, or triplet), type of rearing (single, twin, or artificial rearing), and sex (male or female) were determined. Type of rearing, of course, was not analyzed for birth weight.

Milk production of East Friesian crossbred ewes and Dorset-type ewes.

All ewe lambs born in 1995 and lambed in the spring of 1996 were machine milked. Their lambs were weaned at an average of 34 days, and the ewes were milked twice per day at 6 a.m. and 5 p.m starting on the day of weaning. Milking occurred in a 12 x 2 milking parlor with indexing stanchions (formerly known as a CASS system). Milking was performed with a high-line pipeline with six milking units. Pulsation was set at 120/minute with a 1:1 ratio and a vacuum of 37 kpa. Individual daily milk production was determined every 28 days at an evening milking and the milking the following morning using the Waikato testing jar. Individual milk samples were taken at the morning milking only. Samples were analyzed for butterfat by a State of Wisconsin certified laboratory. Milk recording was performed according to the international regulations for milk recording in sheep published by the International Committee for Animal Recording (ICAR, 1992).

An estimate of total milk production for a lactation was calculated using the following formula (Thomas, 1996):

Estimated milk yield = [production 1st test day x no. days between start of milking and 1st test day]

+ [(prod. 1st test day + prod. 2nd test day)/2 x no. days between 1st and 2nd test day]

+ [(prod. 2nd test day + prod. 3rd test day)/2 x no. days between 2nd and 3rd test day]

+ .....

+ [prod. next to last test day + prod. last test day)/2 x no. days between next to last and last test day]

+ [prod. last test day x no. days between last test day and end of milking].

Milking was discontinued after test days when the total milk production from both evening and morning milkings fell below .45 lb. The estimated total milk production and lactation length was for the milking period only with no estimate of milk production during the nursing period. The effects of breeding of ewes (EF crossbred or Dorset-type), number of lambs born, number of lambs raised to 30 days, and weight of ewes at the start of milking were determined for the lactation traits. Out of 130 ewes that were milked, records of eight ewes were deleted because of health problems or recording errors.

The East Friesian crossbred rams used in this study were two 1/2 East Friesian, 1/2 Arcott Rideau rams purchased in 1993 from a Canadian producer in British Columbia and one 3/4 East Friesian , 1/4 Arcott Rideau ram purchased from the same producer in 1994. The semen used to produce the 1/2 East Friesian rams came from Switzerland (name of sire: ODO 310 OD). The semen used to produce the 3/4 East Friesian ram also came from Switzerland (name of sire: Garfield 5074L).

Results and Discussion

Growth of lambs sired by East Friesian crossbred rams or Dorset rams.

Lambing performance of ewes mated to East Friesian crossbred rams or Dorset rams as well as the survivability of their lambs until weaning are shown in Table 1. Breed of ram had no effect on the fertility and litter size of the ewes to which they were mated. Lambs from the two sire groups had a similar survival rate from birth to weaning of 85 to 87% indicating that East Friesian crossbred lambs are no more or less vigorous than Dorset crossbred lambs.

Table 1. Lambing performance of ewes mated to East Friesian crossbred rams or Dorset rams and survival of lambs.

	Sire Breed	
Trait	**East Friesian crossbred**	**Dorset-type**
Number of ewes at breeding	223	163
Number of ewes lambing	209	152
Number of lambs born*	554	383
Number of lambs alive at weaning	486	343
Fertility	93.7%	93.2%
Lamb survival	87.7%	85.5%
Litter size adjusted for age of dam	2.41 ± .03	2.45 ± .04

* Includes lambs born dead.

The growth of lambs sired by the two types of rams is presented in Table 2. East Friesian-sired lambs were significantly heavier at birth, 60 days, 120 days and 142 days of age than the Dorset-sired lambs. These results suggest that relative to Dorset rams, East Friesian-Arcott Rideau cross-bred rams will sire faster growing lambs.

Table 2. Least square means for weights of lambs born from ewes mated to East Friesian crossbred rams or Dorset rams.

	Sire Breed	
Trait	**East Friesian crossbred**	**Dorset-type**
Birth weight, lb.	9.7 ± .09[a] (541)[c]	9.0 ± .11[b] (378)
Weight at 60 days, lb.	52.4 ± .7[a] (477)	46.9 ± 1.5[b] (335)
Weight at 120 days, lb.	97.9 ± 1.1[a] (406)	91.5 ± 1.1[b] (304)
Weight at 142 days, lb. (males only)	123.4 ± .9[a] (224)	120.6 ± 1.1[b] (135)

a b Within a row, means with a different superscript are statistically different ($P < .05$).
c Values in parentheses are the number of lambs.

Reproductive performance of East Friesian crossbred and Dorset-type ewe lambs and growth of their lambs.

Lambing performance of the two types of ewe lambs is presented in Table 3. East Friesian crossbred ewe lambs were heavier at mating (126.5 versus 118.8 lb.) at an average age of 223 days. A slightly higher proportion of East Friesian crossbred ewe lambs lambed (94% versus 90%) at a similar age of 371 to 373 days. East Friesian crossbred ewe lambs produced significantly more lambs (+.26 lambs/ewe lambing) than contemporary Dorset-type ewes. Number of lambs weaned per ewe mated was 1.6 for East Friesian crossbreds and 1.3 for Dorset-type ewe lambs. Gootwine and Goot (1996) found similar results when comparing East Friesian crossbred and Awassi ewes. In their study, East Friesian crossbred ewes produced .30 more lambs than pure Awassi ewes.

Table 3. Lambing performance of East Friesian crossbred and Dorset-type ewe lambs.

	Dam breeding	
	East Friesian crossbred	**Dorset-type**
Number of ewes at mating	122	96
Weight of ewes at mating, lb.	126.5 ± 1.1[a]	118.8 ± 1.3[b]
Age of ewes at lambing, days	373 ± 1.5	371 ± 1.7
Weight of ewes at weaning, lb.	142.8 ± 1.8	137.1 ± 2.6
Fleece weight, lb.	7.7 ± .15	7.3 ± .20
Fertility	94.3%	89.6%
Litter size	1.80 ± .05[a]	1.54 ± .06[b]
Survival rate of lambs	94%	93%
Number of lambs weaned/ewe mated	1.6 ± .06[a]	1.3 ± .07[b]

[a b] Within a row, means with a different superscript are statistically different ($P < .05$).

Growth of lambs produced by the two ewe groups is presented in Table 4. Lambs from East Friesian crossbred ewe lambs were significantly heavier at birth, 30 days (1996), and 60 days (1995). The greater weaning weights of lambs from East Friesian cross bred dams compared to Dorset-type dams may be due to superior genes for growth from the East Friesian/Arcott Rideau compared to the Dorset, superior milk production of the East Friesian, or a combination of both. At 120 days, lambs from East Friesian crossbred ewes were heavier in 1996 but not in 1995. Perhaps when lambs were weaned at 30 to 34 days of age (1996), the greater weaning weight of the lambs from East Friesian crossbred ewes allowed them to express optimum growth to 120 days, while lambs from Dorset-type ewes, being smaller at 30 days, had a slower growth or a setback just after weaning. When lambs were weaned at 60 days (1995), lambs from East Friesian crossbred dams still had heavier weaning weights than lambs from Dorset-type dams but weights of both groups were heavy enough to allow good post weaning growth, and lambs from Dorset-type ewes actually exhibited some compensatory gain.

Table 4. Least square means for weights of lambs produced by East Friesian crossbred or Dorset-type ewe lambs.

	Dam breeding	
	East Friesian crossbred	**Dorset-type**
Birth weight, lb.	9.5 ± .11[a] (253)[c]	8.6 ± .15[b] (134)
Weight at 30 days, lb.		
1996 only	29.0 ± .5[a] (158)	25.3 ± .7[b] (67)
Weight at 60 days, lb.		
1995 only	49.1 ± 1.3[a] (74)	44.7 ± 1.3[b] (56)
Weight at 120 days, lb.		
1996	94.2 ± 1.5[a] (146)	86.7 ±2.2[b] (59)
1995	96.1 ± 2.2 (57)	96.6 ± 2.2 (54)

[a b] Within a row, means with a different superscript are statistically different ($P < .05$).
[c] Values in parentheses are the number of lambs.

Milk production of East Friesian crossbred and Dorset-type ewes during their first lactation.

Lactation length, total milk production, and total fat production are presented in Table 5. It was found that number of lambs born and number of lambs reared by a ewe did not have an effect on the lactation traits. This agrees with the results of Gootwine and Goot (1996) and Barillet (1989). Barillet demonstrated that ewes who raised two lambs had a higher peak of production but a quicker decline compared to ewes who raised one lamb so there was no difference in total milk production between ewes that had raised one or two lambs.

East Friesian crossbred ewe lambs had a longer lactation (120 versus 95 days) and produced about twice as much milk as Dorset-type ewe lambs (210 versus 110 lb.) which is more than the 50% increase in milk production reported by Flamant et al. (1975) for East Friesian x Lacaune ewes over Lacaune ewes. If the total milk production of first lactation ewe lambs is 30% less than second and third lactation ewes, the milk production of the Dorset-type ewes used in this study is very similar to the production of adult Dorset ewes (70 liters in 130 days) reported by Boylan (1989) in the U.S., but much lower than the production found by Geenty (1978) (122 liters in 170 days) in New Zealand.

Ninety-five percent of East Friesian ewe lambs and 92% of Dorset-type ewe lambs had a lactation (milking period only) longer than 50 days. Eighty-three percent of the East Friesian ewes had a lactation longer than 100 days compared to only 50% of the Dorset-type ewes.

Table 5. Lactation length, total milk production, and total butterfat production of first lactation East Friesian crossbred and Dorset-type ewe lambs.

	Breeding of ewe	
Trait	**East Friesian crossbred**	**Dorset-type**
Number of ewes	89	33
Length of lactation, days	120 ± 3^{a}	95 ± 4^{b}
Total production, lb.	210.3 ± 8.6^{a}	109.8 ± 13.9^{b}
Total fat, lb.	$12.1 \pm .4^{a}$	$7.3 \pm .9^{b}$
Percent fat	$5.7\% \pm .1^{a}$	$6.0 \pm .1^{b}$

[a b] Within a row, means with a different superscript are statistically different ($P < .05$).

Figure 1 presents the change in milk production and butterfat percentage throughout the milking period. East Friesian crossbred ewes started the milking period at a 40% higher milk production than Dorset-type ewes. With the exception of the fourth test day, East Friesian crossbred ewes and Dorset-type ewes had a similar rate of decline of approximately 20% per test period (28 days). The percentage of fat in the milk was inversely related to the milk production in both types of ewes, which is in agreement with the scientific literature.

Figure 1

Milk production at each control taking ewes having at least four controls

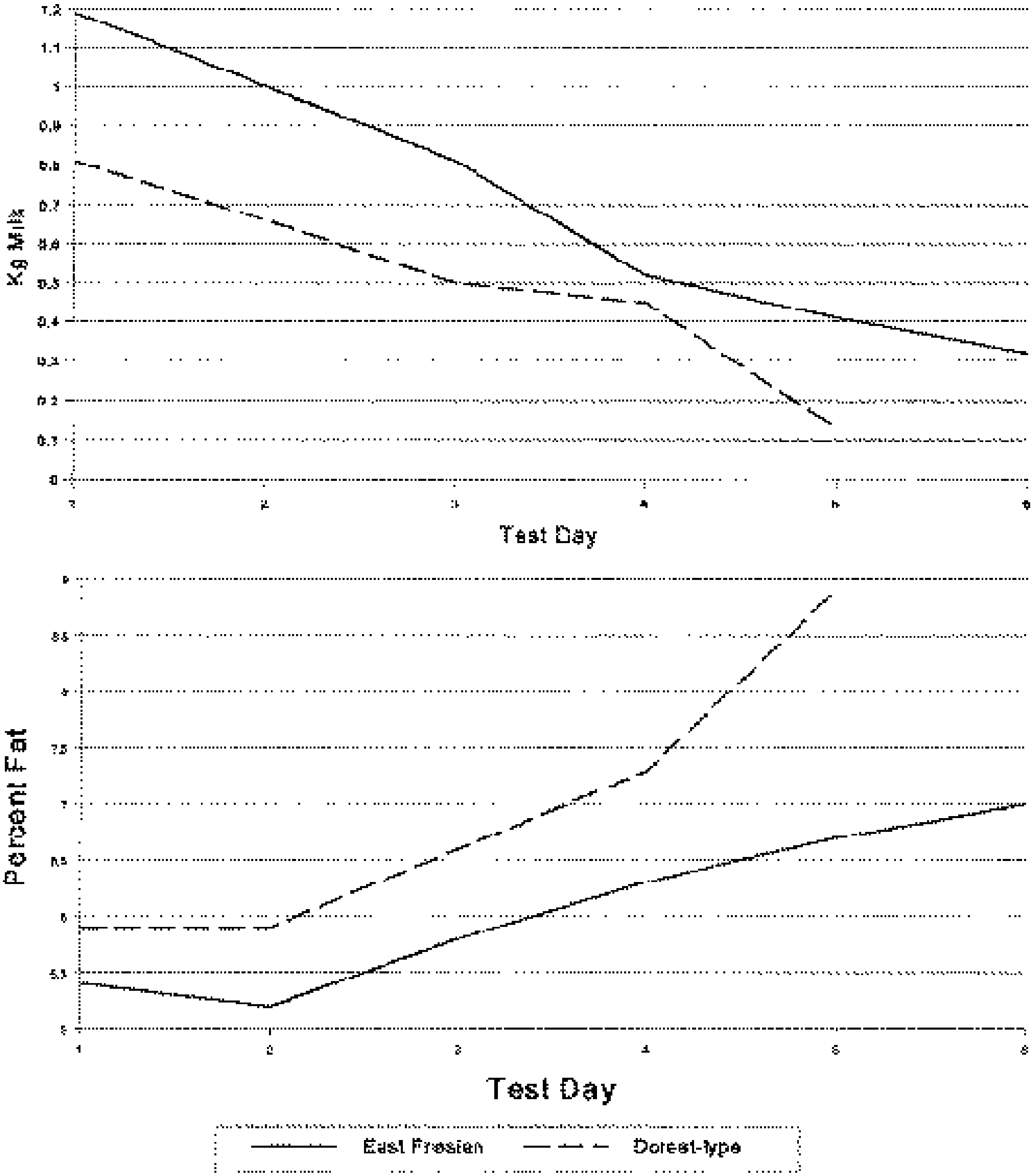

Figure 2 presents the percentage of ewes in different milk production ranges. Eighteen percent of East Friesian crossbred ewes gave less than 110 lb. (50 kg) of milk and 36% gave more than 220 lb (100 kg.) . Fifty-eight percent of Dorset-type ewes gave less than 110 lb. of milk, and only 2% gave more than 220 lb. kg. These results indicate that Dorset-type ewes may not be worth milking on a commercial basis unless a severe screening of the best milking ewes is performed. East Friesian crossbred ewes, offer more possibilities as milking ewes. A decent level of production could be achieved after eliminating only the 18% lower producing ewes.

Assuming that the East Friesian crossbred rams used in this study (50% and 75% East Friesian) came from a lineage with an average milk production of 880 lb. (400 kg.), the crossbred ewes of this study are at their expected level of production. These results are encouraging and denote a good adaptation of East Friesian crossbred animals to the environment of north central America.

Conclusions

East Friesian crossbred rams sired heavier and faster growing lambs than Dorset rams. East Friesian crossbred ewes were more prolific than Dorset-type ewes, and growth of lambs from East Friesian crossbred ewes was greater than the growth of lambs from Dorset-type ewes. Milk production of East Friesian crossbred ewes during the milking period was almost twice that of Dorset-type ewes, and by eliminating approximately 20% of the lower producing East Friesian crossbred ewes, decent levels of production can be achieved that make them worthwhile milking on a commercial basis. The high prolificacy, good growth of their lambs, and a decent milk production of East Friesian crossbred ewes indicates good adaptation to the north central American environment.

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AN EXAMPLE OF A DAIRY SHEEP BUDGET

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Some Assumptions on Costs and Returns

Lambing in Late Winter or Early Spring
(per ewe - all lambs shorn before sale)

DEVELOPMENT OF THE DAIRY SHEEP MILKING PARLOR AT THE SPOONER AGRICULTURAL RESEARCH STATION

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In April 1995, the College of Agricultural and Life Sciences, University of Wisconsin-Madison gave the green light to conduct sheep dairy research at its Spooner Agricultural Research Station. Soon after the authorization was given, construction of a milking parlor and milk room began. In April 1996, the new facilities were operational, and 130 ewes were milked twice a day during the first season.

Milking Parlor

The milking parlor is a double twelve indexing stanchion with high-line pipeline and six milking units. The design of this parlor should permit the milking of 150 ewes per hour.

The indexing stanchions are equipped with a feed hopper, lock-in head gate, and a roll-back system. Feed delivery, headgate, and roll-back are controlled by a pneumatic system. Index stanchions are designed so that there is enough room between the headgate and the edge of the pit for the ewes to choose any stanchion they wish. As soon as the 12 ewes are locked in the headgate, the system is rolled back so that the rear end of each ewe is just at the edge of the pit. The stanchions were imported from Italy by Alfa-Laval Agri. The shallow pit (no more than 30" deep) is centrally located with a set of stanchions on each side. In order to accommodate such equipment, the minimum size of the parlor should be no less than 24 feet long and 22 feet wide. The pit is 16 feet long, 4 feet 6 inches wide, and 30 inches deep.

Milking Equipment and Procedures

All milking equipment has been purchased from Alfa-Laval Agri which has much experience in sheep dairying in Europe. However, there are several other firms which also manufacture quality dairy sheep equipment. Except for the milking units and pulsators, the equipment is standard to the dairy cow industry including the automatic washing system.

The pulsation rate is set at 120 per minute with a ratio of 1:1 and a vacuum level of 11 in. of Hg or 37 KPA. The electronic pulsator control panel allows for a pulsation rate of 60, 90, 120, or 180 pulsations per minute and a ratio of 1:1 or 2:1.

The milking procedure is simple. Upon entrance to the parlor, each ewe takes its place, and the stanchion is rolled back. The six milking units are put on alternate ewes on one side. When the milker puts the sixth miking unit on, she/he comes back to the first ewe, does a rapid massage of the udder, removes the milking unit, and places it on the ewe to the left. When the 12 ewes are milked, the milking units are swung to the other side of the pit and the same procedure is repeated. When the 12 ewes on one side are milked, they are released, and 12 more take their place while the

12 on the other side are being milked. Therefore, there is no interruption in the milking procedure. There is no washing of the udder before milking, but a post-dipping after milking is recommended.

With two persons, the time required to milk 100 ewes with this system is 1 hour and 20 minutes.

This time includes:

- 20 minutes for getting ready (sanitizing the system) and clean up after milking
- 10 minutes to feed hay to the ewes
- 40 minutes of actual milking

Milk Handling

The milk is received in a bulk tank and immediately cooled down to 40°F. After milking, the milk is poured in five gallon FDA food approved pails and frozen in a chest freezer. Delivery of the milk is done when the freezing and storage capacity is full. There seems to be little or no effect of freezing on the quality of cheese, which is a major advantage as long as the milk marketing system is not better organized.

Individual milk production is recorded monthly using the DHIA Waikato milk meter jar. Regular bulk tank samples are sent to a certified laboratory for checks on bacteria, somatic cell count, drug residue, and sediment. During the first season of milking, the bacteria count was low (less than 25,000) but the somatic cell count was high (more than 800,000).

Since all the milk produced is sold to a cheese plant for the manufacture of cheese, the Spooner Agricultural Research Station is licensed as a Grade B dairy farm. Persons interested entering the sheep dairy business should contact their local dairy inspector before starting any construction to be sure that everything meets the required standard.

Total Cost of the Milking Parlor and Milk Room

It is important to note that the cost shown below includes the construction of a totally new building and all new milking equipment. Cost could be drastically reduced by renovating an old building and buying used equipment (pipe line, pump...). Moreover, the Spooner Agricultural Research Station received an organizational discount on the purchase of the milking equipment which a producer may not be able to secure.

Construction of parlor and milk room:

- Foundation	$ 3,827.51
- Sewer	$ 236.22
- Plumbing	$ 294.46
- Electricity	$ 1,770.50
- Frame and trusses	$ 3,809.41
- Doors and windows	$ 1,267.24
- Roof and siding	$ 2,010.60
- Inside finishing	$ 1,193.11
Subtotal	$ 14,408.54

Milking equipment:

- Parlor stanchions	$	4,800.00
- Milking equipment	$	10,200.00
- Wiring (labor and parts)	$	450.00
- Bulk tank and installation	$	1,000.00
Subtotal	$	16,450.00

Other equipment:

- Heater	$	165.01
- Deep freezers (2)	$	1,040.00
- Water heater (80 gallons)	$	481.00
- Steps in pit	$	62.88
- Guillotine doors	$	27.44
- 4 HP air compressor	$	329.00
Subtotal	$	2,105.33
TOTAL	**$**	**32,963.87**

Names and Addresses of Sheep Milking Equipment Manufacturers:

Westfalia
Attn: Jim Parker
1862 Bummel Dr.
Elk Grove Village, IL 60007

J.R. Roberts, Export Representative
Fullwood and Bland, Ltd.
Ellesmere, Shropshire
United Kingdom,SY12 9DF

Bob Borchert
Schlueter Co.
3075 Streb Way
Cottage Grove, WI 53527

Gascoigne Milking Equipment, Ltd.
Attn: Mr. L.J. Harland
Edson Road Roundmills
Blasingstoke, Hampshire RG21 2YJ
England

The Coburn Company, Inc.
PO Box 147
Whitewater, WI 53190

Alfa-Laval Agri International AB
Sheep Dairy Equipment Division
S-147 00 Tumba
Sweden

Randy Rheingans
Alfa-Laval Agri, Inc.
13 Woodhaven Ct., NE
Rochester, MN 55906

Major Farms
RFD #3 Box 265
Putney, VT 05346
(802) 387-4473

Roger Steinkamp
La Paysanne, Inc.
Gascoigne Equipment Dealer
Route 3 Box 10
Hinkley, MN 55037