Proceedings of the 13th Annual

Great Lakes Dairy Sheep Symposium

November 1 - 3, 2007
Guelph, Ontario
Canada

PROCEEDINGS OF THE 13TH ANNUAL

GREAT LAKES DAIRY SHEEP SYMPOSIUM

NOVEMBER 1 - 3, 2007

GUELPH, ONTARIO
CANADA

PRESENTED BY:

THE DAIRY SHEEP ASSOCIATION OF NORTH AMERICA
(DSANA)

2007 GREAT LAKES DAIRY SHEEP SYMPOSIUM

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2007 Great Lakes Dairy Sheep Symposium

November 1 - 3, 2007, Ramada Inn, Guelph, Ontario

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2:00	**Sheep Milk Cost of Production** Dan Guertin and Tom Kieffer, Wisconsin Sheep Dairy Cooperative
3:00	Break
3:15	**Expectations for Milk Yield and Price of Milk** Yves Berger, University of Wisconsin
4:00	**Nutrition for Optimum Sheep Milk Production** • **Nutrient Recommendations for Ewe Lambs** • **Dairy Sheep Nutrient Recommendations** • **Mineral Recommendations for Sheep** • **TMR and Corn Silage for Sheep Rations** Christoph Wand, Ontario Ministry of Agriculture, Food and Rural Affairs
4:45	**Successful Sheep Milk Product Marketing Strategies** - Stew Cardiff, Shepherd Gourmet - Elisabeth Bzikot, Ewenity Dairy Co-operative - Stephanie Diamant, Milky Way Farm - Petra Cooper, Fifth Town Artisan Cheese Co.
5:45	**Sheep Cheese Presentation and Wine Pairing** Ontario Cheese Society

Fri Nov 2

8:00 am	**Board Buses for Farm and Processing Plant Tours** - Keith Todd, Todd Sheep Company Inc., Lucknow - Eric and Elisabeth Bzikot, Best Baa Farm, Conn - Eric, Elisabeth, Peter Bzikot, Best Baa Dairy Ltd., Fergus
6:15 pm	**Dairy Sheep Association of North America – Annual General Meeting**
7:00 pm	Banquet and Speaker: **Rebuilding the Middle – the Challenges and Opportunities in Local Food Markets** Elbert van Donkersgoed, Executive Director, Greater Toronto Area Agricultural Action Committee

Sat Nov 3

8:00 am	**Parlour Hygiene – Sanitation and Cleaning** Mike Foran and Phil Wilman, Ontario Ministry of Agriculture, Food and Rural Affairs
8:45	**Sheep Milking Equipment – Doing it Right** Gerald Golem, Sales and Technical Support, Penner Farm Services, Ontario
9:30	Break
9:45	**Lamb Health Management** Dr. Paula Menzies, Ontario Veterinary College, University of Guelph
10:30	**Ovine Mastitis: Overview of the Disease and a Guide to It's Control** Dr. George Fthenakis, DVM, University of Thessaly, Greece
12 Noon	Lunch and Speaker **Sardinian Cheese Production and Review of Sheep Milk Research** Claire Mikolayunas, University of Wisconsin
1:30 pm	**Ovine Mastitis: Overview of the Disease and a Guide to It's Control (cont'd)** Dr. George Fthenakis, University of Thessaly, Greece
3:00	**Conference concludes**

COST OF STARTING A DAIRY SHEEP OPERATION

Axel Meister
WoolDrift Farm
Markdale, Ontario, Canada

WoolDrift Farm is located between Markdale and Meaford about 2 hours northwest of Toronto. It is owned and operated by Axel Meister and Chris Buschbeck and their two sons Lucas and Michael.

WoolDrift Farm

We have been in the sheep business since 1989 and started milking sheep in 1994 as one of the first sheep dairies in Canada. Axel has been a founding member and president of the Ontario Dairy Sheep Association and vice-president of the Canadian Dairy Sheep Association and also a founding member of the "Ewenity Dairy Sheep Co-op". We were one of the first farms to import East Friesian embryos into Canada and have been working on the genetic improvement of our flock ever since.

Our ewes are usually pastured during the milking season from April until November or December. We try to maximize milk production off grass with the help of intensive rotational grazing and use only limited amounts of grain in the milking parlour.

At this time the flock consists of about 70 selected purebred East Friesian ewes and 10-15 East Friesian/Rideau crosses going back to our original Rideau Arcott ewes. Currently we have about 20 rams in the flock – we usually select the top ten percent of the annual ram lamb crop for our own use and for sale. The remainder are the best representatives of the various bloodlines that we keep as insurance and to possibly breed back to.

The Breed

The East Friesian Dairy sheep (EF) originated in the Friesland area of Holland and Germany where it has been kept in small numbers for domestic milk production for centuries. However, it also does well in larger flocks. The EF is a greedy and docile sheep that adapts quickly to a parlour routine and it is the major dairy breed throughout the world. It has been used in virtually every sheep milk producing country either as a purebred or to enhance the local breeds. It is a major contributor to prolific breeds like the Rideau Arcott (Canada), the Assaf (Israel) or the British Milksheep (UK).

The East Friesian is the highest producing dairy sheep breed in the world. Its ability to produce large quantities of milk at peak lactation (up to 5 or 6 liters) and to sustain lactation over a long period of time set the EF apart from other breeds. It is very prolific, producing an average lamb crop of 200-250%. In crossbreeding programs the EF produces a fast growing lamb with a desirable carcass that grades well.

Flock Health

The WoolDrift farm flock has been closed since 1993 with new genetics being added through artificial insemination (AI) or embryo transfer (ET) only. We started our Maedi/Visna (OPP) eradication program in 1989 with an annual test and cull routine. The entire flock has been testing negative since 1992. In 2001 we enrolled in the Ontario Maedi/Visna Flock Status Pilot Project and reached "A" status after our annual test in April of 2004. The flock was also enrolled in the Ontario Sheep Health Program where we continuously monitor for other communicable diseases and strive to improve management and bio-security; we have not diagnosed foot rot, orf (sore mouth) or Johne's in our animals. Since its inception in 2005 we have also been enrolled in the National Scrapie Flock Certification Program and received level "C" on Pathway 1 this year (2007).

Goals and Breeding Strategies

Our goal is to improve the performance of our sheep through selection and careful introduction of new genetics. We measure milk yields monthly in the parlour and have fat, protein and somatic cell count analyzed by the Dairy Herd Improvement (DHI) program. We want our ewes to nurse their lambs for 30-40 days, then produce milk on the stand for another 180-220 days mostly on grass. In our selection we take milk weight, components and lactation length into consideration. The lower producing purebred ewes and the unproven ewe lambs are bred to terminal sires to produce quality market lambs. In the past we have been very pleased with Charollais/East Friesian and British Suffolk/East Friesian crosses.

Currently we are marketing about 20 000 kg (44 000 lbs) of milk per year with an average production of 300 kg (660 lbs) per ewe excluding 30 days of nursing. Out of about 150 lambs, 15-25% are retained or sold as breeding stock, the remainder goes for meat at around 100 lbs live weight. The resulting income is about 60% from milk, 40% meat and breeding stock.

Housing and Parlour Type / Milking System

Ewes are kept in loose housing in a bank barn in the winter and on pasture in the summer. Grain is fed inside the barn before lambing and in the parlour during milking season; all hay is fed outside in round bale feeders unless the sheep are in claiming pens after lambing (usually for about 2-3 days). Weaned lambs are housed in a coverall shelter with access to pasture.

We were in the unique position of starting a dairy operation twice (including parlours) because of a forced move in 2000. Our original parlour was a single eight, self-locking, cascading head gate on a movable platform with ramps to get the sheep up and down, combined with a pail-milking set-up. This was a relatively cheap way to get started; the platform was locally built and could be moved into an existing drive shed that was modified to contain a waiting room, the parlour, a milk house and a used walk-in freezer. At the time (1994) we spent about $12,000 for the original set-up and four milking units.

The new parlour is a single 12 quick exit parlour that was built by a local welder to our specifications. We looked at a number of different parlours all over the world from pictures or personal visits and picked the features we liked. Our parlour is located level with the elevated waiting room floor that is constructed from expanded metal and the animals walk down a ramp after milking to leave the parlour. This saves us having to clean the waiting room daily; we now clean below the waiting room floor once a year with a skid steer. We find that the ewes enter easier and train faster to the stall system than to the old head gate system. In particular, nervous ewe lambs adapt better when not 'grabbed around the neck' by a head gate. Another important feature in choosing our design was the absence of hydraulics, motors and complicated parts that break at inconvenient times. The exit gate is balanced to make it easy to open and close with a simple lever. This parlour cost around $5000. The purchase and installation of the pipeline milking system added another $12,000.

The parlour has a two-inch high-line pipeline, six claws and six removable milk meters. The cleaning is done by a timed controller in the milk house. The controller adds acid and disinfectant agents automatically at the appropriate times however the detergent is manually added before starting the wash cycle. One hour before milking the system runs a sanitation cycle. The claws are not cleaned in place so they are brought into the milk house for washing. This way the claws and collection pieces are immersed in the cleaning solutions and cleaned on the inside as well as the outside.

Milk Handling and Storage

From the receiver jar in the milk house the milk is pumped through an in-line filter directly into pails and transferred to the walk-in freezer. Pails are initially filled to about 1/3rd capacity and quick frozen, and later topped up to 15L with more milk. That way we ensure that all milk is cooled down rapidly and frozen solid within hours. We use a 10' x 20' walk-in freezer to freeze and store the milk in 15 L pails. The temperature is set to stay between –15 and –25°C, thus allowing the new milk to freeze rapidly without increases in the freezer temperature and also ensures the stored milk lasts for months without loss in quality. This is important for us as a seasonal dairy since we stockpile milk in the summer and deliver year round to our cheese makers.

A Short History of WoolDrift Farm

1989 WoolDrift Farm starts as a lamb and wool-producing farm with 21 crossbred ewes

1993 The decision is made to convert to a sheep dairy operation

1994 Import of 61 East Friesian embryos and 100 doses of semen
Embryo transfer at SRGenetics
Transcervical AI on 24 Arcott ewes
The first ewes go on the milking stand

1995 32 purebred EF lambs are born
GST-AI results in 29 half-bred lambs
Flushing of 6 EF ewes
Export of rams and frozen semen to the United States
Import of embryos and semen from proven Dutch EF bloodlines.

1996 The second generation arrives
The first Friesians go on to the milking stand
62.5% pregnancy rate reported on embryos exported to the US

1997 40 more purebred lambs are born
Two EF rams enter SRGenetics stud for semen collection
Ongoing embryo transfer and embryo freezing

1998 More promising rams collected at SRGenetics
Flock consists of more than 80 selected purebred East Friesian ewes
Flock enrolled in official Dairy Herd Improvement program in Ontario

2000 A barn fire necessitates the move to our new location in Markdale and the temporary cessation of our milking operation

2002 The new milking parlour finally takes shape – a single 12 rapid exit stand with highline pipeline
Laparoscopic AI with semen from Swiss bloodlines
IVF embryos are transferred

2003 The first full milking season since the fire – we are anxious to gather milk records on our new bloodlines
Some of the first commercially produced IVF lambs are born

2006 Our best season yet, with on average 52 ewes on the stand (varying from 20 to 76) we produce just over 20 000 kg of milk or 1.6 kg (3.5 lbs)/ewe/day over the season.

NOTES

COST OF STARTING A DAIRY SHEEP OPERATION

Liz Livingston
Mistyridge Farm
Sunderland, Ontario, Canada

Mistyridge Farm is owned and operated by Liz and Tim Livingston along with their two sons Tyler and Kyle. Their farm is located about an hours drive northeast of Toronto, near Sunderland. Mistyridge consists of 60 acres including 30 for pasture and 25 for hay. An additional 10 acres are rented for making into hay.

Flock Management

Our flock consists of 120 ewes including replacements which are Dorset and f1 crosses.
The ewes graze from April till November rotating between four pastures. Shearing takes place the first week of January after which our ewes are confined to the barn. During this time they are fed a pound of grain per day and small square bales. All our grains are purchased. Lambing usually starts January 15th. Lambs are weaned at an average of 30 days and then the milking season starts. The lambs are fed creep feed and good quality second cut hay. Ewes receive a pound or less of mixed grain on the stand.

Production

This past season I started milking 50 ewes on March 1st and then added more to the stand as their lambs were ready to be weaned. I finished the season 151 days later milking 95 ewes. This season production averaged 160 litres per ewe. Our ewes generally average 2 to 2.3 lambs per ewe.

Milking

We constructed our milking stand which holds 23 to 26 ewes and works extremely well for us. It takes me around 30 minutes per loading to milk. I use a can milker with 2 milking units. The milk is then strained into pails and frozen in a 10 ft. by 12 ft. walk-in freezer.

Costs and Revenues

The total cost for us to start the dairy was about $20,000 most of which was the building of the milk house and installation of a septic system for waste water. Our freezer cost $5600; the box was used and the cooling units and the door were new. Milk house operation costs around $20 a day which covers hydro for the freezer, vacuum pump and hot water. Installation of our milk stand cost about $300 not including our labour. This past year we have grossed around $500 per ewe with revenues averaging around equal for milk and lamb sales.

SHEEP DAIRY FARM ECONOMIC ANALYSIS
COST OF MILK PRODUCTION UPDATE

Tom Kieffer and Dan Guertin
Wisconsin Sheep Dairy Cooperative
Strum, Wisconsin, USA

Introduction

Like many new agricultural industries, the sheep dairy industry seems to hold out the promise of being a profitable venture for newcomers. With the high milk prices being paid by processors and the premium prices commanded by sheep milk cheeses in the market place, it often seems that this should be an easy business to make a profit. The reality of this promise can be seen by the small number of individuals that stay in the business for five or more years. While there are no official statistics available, our observations of the industry over the last ten years suggest a high attrition rate among sheep dairy farms with only about 30% staying in the business five or more years. The reasons people leave the business are varied, some because of health issues, some because of lack of labor, but most because they were not able to make enough money milking sheep. Worse yet, they didn't have a way to identify why they were losing money and from which facets of their business. The uncertainties of the business don't only affect newcomers, as many of the sheep dairy pioneers in North America, large and small, have also moved on to other activities.

Since a key reason for farms not succeeding in the sheep dairy business seems to be financial, it was evident to us that a method was needed for evaluating the financial outcome of the sheep dairies. In the course of developing this project, we looked at a number of systems that are used by agricultural economists and statisticians to evaluate the financial health of different types of farming activities. These approaches often utilize very sophisticated types of financial analysis and generally look at the financial health of the farm as a whole. In most cases, these approaches cannot be easily applied by an individual farm owner without the assistance of someone who is specially trained on the financial jargon and complex calculations used. Since the sheep dairy industry is still in its infancy, it lacks the necessary funding and farm numbers to develop and administer these types of financial tools.

We realized from the start that no two farm situations are the same, and this would present a number of complicating factors that could not be addressed adequately at this initial stage. Some of these include: Dairy flock size, time of year for lambing(s), weaning system used, management system (confinement, pasture, combination), genetic progress (production per ewe). In addition, some farms carried heavy debt loads, some farms had additional sources of farm income beside milk, and each farm had different levels of direct and indirect costs.

Our goal was to breakdown the components of financial analysis of sheep dairy farms into smaller pieces and then to address these components individually in a way that would be easily used by farms without the need for specialized help. It seemed the first step was to develop a simple, standardized method to calculate the direct cost of milk production. These are the costs that are directly associated with production, and can usually be collected and analyzed without a high degree of complexity. The establishment of a standardized method should make it possible to benchmark the costs of production across the industry and for individual farms to compare their costs with other farms in order to identify areas to focus on for improvement.

Clearly, we realize that by calculating the direct cost of milk production, a farm will not be able to predict success or failure. We also realize that each farm may allocate direct and indirect costs differently across multiple farm enterprises for tax and overall farm budgeting purposes. Our method considers the sheep dairy enterprise as the primary enterprise, therefore all ewe costs are included as dairy costs. The goal of establishing a standardized method for calculating the direct costs of milk production, in isolation from the rest of the farm operation, is to allow a variety of farms with different situations to gauge their direct cost of production against other farms to determine if their cost of production is higher or lower than other farms, to aid a farmer in judging their prospects for overall financial success, and to allow for industry-wide analysis.

By benchmarking the range of costs in each of these categories, farmers will be able to determine how they compare to others in the industry. If, by using the standardized calculation, a farm determines that their cost of production is significantly higher than other farms, that farm will be able to compare their costs across the different categories with other farms to determine in which category(ies) their costs are out of line. By being able to identify problem areas, the farm can concentrate on different ways to bring these costs down. Conversely, if a farm finds that their overall cost of production is at the lower end of the scale, they can help to establish 'best practices' in the sheep dairy industry that other sheep dairy farms can follow to be more successful.

At the 12th Great Lakes Dairy Sheep Symposium last year, we presented a proposed standardized model for calculating the direct cost of sheep milk production. During this presentation, we discussed the types of records needed to calculate the direct cost of production and provided some record-keeping tools designed to keep the process from becoming too cumbersome. Throughout the presentation, there were excellent discussions from the audience on a number of the ideas presented. This was critical since the only way this project could be successful was if the majority of farms understood and agreed with the proposed approach. Following our presentation, we made modifications to the proposed standardized approach based on the audience feedback. The finalized standardized approach and supporting tools were then made available to individuals who expressed an interest in participating.

Of the 20+ farms that initially expressed an interest in participating in this study, only 4 farms collected the information as requested. The presentation at this symposium will provide these results. Although this is not as broad a representation of the sheep dairy industry as we had initially hoped for, the results do demonstrate the wide range of costs across many of the categories. By learning from, and working with, others in the sheep dairy industry, we can all benefit by lowering our costs of production and increasing our profitability.

NOTE: the results that will be presented at the symposium are not included in this paper since we wanted to include as much data from the 2007 milking season as possible in the presentation. The presentation will cover direct costs incurred from Jan 1, 2007 through Sept 30, 2007.

Brief Review of the Core Principles of the Cost of Production Model

Since the attendees at the Great Lakes Dairy Sheep Symposium varies significantly from year to year, depending in large part on the location of the symposium, some at this symposium may not be familiar with the material presented last year. Therefore we provide here a brief overview of the standardized model used to compile the results to be presented.

The standardized categories identified were based on Schedule F from the US Internal Revenue Service Tax Code. A subset of these categories was selected that pertained specifically to the operation of a sheep dairy. The following table shows the expense categories from Schedule F.

12 Car and truck expenses	25 Pension & profit-sharing plans
13 Chemicals	**26a Rent or lease: Vehicles, machinery, and equipment**
14 Conservation expenses	**26b Rent or lease: Other (land, animals, etc.)**
15 Custom hire (machine work)	**27 Repairs and maintenance**
16 Depreciation	28 Seeds and plants
17 Employee benefit programs	**29 Storage and warehousing**
18 Feed	**30 Supplies**
19 Fertilizers and lime	**31 Taxes**
20 Freight and trucking	**32 Utilities**
21 Gasoline, fuel, and oil	**33 Veterinary, breeding, and medicine**
22 Insurance (other than health)	**34 Other expenses (specify):**
23a Interest: Mortgage (to banks)	
23b Interest: Other	
24 Labor hired	

The categories that are in bold type were selected for use in the standardized cost of production model. The categories that are grayed out were determined to either not pertain to the cost of sheep milk production or were deemed to pertain to indirect costs. Within each major category, subcategories could be set-up depending on an individual farm's preferences. Refer to our presentation for the 2006 Great Lakes Dairy Sheep Symposium, at http://www.uwex.edu/ces/animalscience/sheep/ for further detail.

Tools used to collect data

Several different procedures were discussed for maintaining records during the year. These included the Shoe Box method, the Ledger, the Spreadsheet, and Accounting Software. The general approach is to collect and total on a monthly basis, the direct dairy costs in each of the categories. The **2007 Sheep Milk Cost of Production Data Summary Worksheet** is included at the end of this document.

Calculations Used to Evaluate the Data

The principle calculation for this project is the direct cost of production for sheep milk. This calculation is:

$$\text{Cost per pound of milk produced} = \frac{\text{Sum of all Direct Dairy Expenses}}{\text{Total Pounds of Milk Produced}}$$

In addition to the principle calculation for the cost per pound of milk produced, the following results will be presented:

- the SUM of each Category Expense
- % of the total Annual Expenses in each category
- SUM of Monthly Expenses
- % of the total Annual Expense in each month

These first and second calculated values will allow different farms to compare their costs in each of the individual categories. The third and fourth calculated values will allow each farm to see their cash flow requirements for sheep milk production throughout the year.

Why Should I Care?

Each farmer will be able to answer these questions

- How do my dairy costs of production compare year to year and with other farms, and on my own farm?
- Does it seem that my farm can be profitable? Should I stay in business?
- What can I do to improve my cash flow/profitability?

Sheep Dairy Industry

- Does the current price structure benefit all stakeholders?
- Are changes needed? If so, where?

Conclusion

In the fields of agricultural economics, accounting, and statistics, many models and methods for farm budgeting, recordkeeping and analysis have been developed and are used regularly in the cow dairy, beef, crop farming, and other segments. The tools used vary in scope and complexity from a single enterprise of one farm business, to state and national analysis of whole farm operations. We have studied a variety of resources, models and methods, and have met with several professionals in these fields to gain an understanding of current practices. We have attempted to draw upon this work to develop some relatively simple, farmer friendly tools that we think can be used in the sheep dairy industry.

It is now clear that the farmers currently milking sheep as well as those contemplating entering sheep dairying must ask both, “How much will I be paid for my milk?”, and, “How much will it cost me to produce a pound of milk?” These are essential in determining a farm’s prospect for financial success.

The long-term viability of the sheep dairy industry in North America requires the long term success of its dairy farms. In order for the sheep dairy industry to flourish and grow, we need to identify the critical issues around sustainability and to establish best practices that can benefit individuals and the entire industry. We hope that today’s discussion will be a first step in making this happen.

The cycle of people getting into sheep dairying and then leaving has resulted in no appreciable increase in the number of sheep dairy farms in North America (NA) over the last 5 years. There are still estimated to be about 100 sheep dairy farms in NA, roughly the same number as 5 years ago. Unless we can find a way for people getting into sheep dairying, as well as those already in the business, to be more successful, sheep dairying will remain a curiosity and never reach the critical mass needed to turn it into a thriving industry. Without this critical mass, we will never be able to establish the infrastructure (e.g. effective breeding programs, marketing, distribution ...) that will allow us to have a sustainable industry and compete effectively in the world marketplace.

2007 Sheep Milk Cost of Production Data Summary Worksheet

Shoe Box Codes	Acctg Software Codes	Schedule F Line - Line Description	Type	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	SUM of Category Expense	% of Annual Expenses
Schedule F Expense Codes																	
12	71200	Line 12 - Car and Truck expenses	Expense													0	0%
15	71501	Line 15 - Custom Hire	Expense													0	0%
18	71800	Line 18 - Feed Purchased	Expense													0	0%
20	72000	Line 20 - Freight and Trucking	Expense													0	0%
21	72100	Line 21 - Gasoline, Fuel, and Oil	Expense													0	0%
22	72200	Line 22 - Insurance (other than health)	Expense													0	0%
24	72400	Line 24 - Labor Hired	Expense													0	0%
26a	72600a	Line 26a - Rent/lease Vehicles, Equipment	Expense													0	0%
26b	72600b	Line 26b - Rent/lease Land, Animals	Expense													0	0%
27	72700	Line 27 - Repairs and Maintenance	Expense													0	0%
29	72900	Line 29 - Storage and Warehousing	Expense													0	0%
30	73000	Line 30 - Supplies Purchased	Expense													0	0%
31	73100	Line 31 - Taxes	Expense													0	0%
32	73200	Line 32 - Utilities	Expense													0	0%
33	73300	Line 33 - Vet, Breeding, and Medicine	Expense													0	0%
34	73400	Line 34 - Other (farm) expenses	Expense													0	0%
		SUM of Monthly Expenses		0	0	0	0	0	0	0	0	0	0	0	0	0	
		% of Annual Expenses		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

NOTES

REALISTIC EXPECTATIONS FOR MILK YIELD AND PRICE OF MILK

Yves Berger
Spooner Ag. Research Station
University of Wisconsin-Madison
Spooner, Wisconsin, USA

Introduction

For each type of management and each level of input, the profitability of the dairy sheep enterprise will greatly depend on the amount of milk produced by the flock during the whole lactation. Of course, in a low input system the expected milk production will be lower than in a high input system but in both systems the return per ewe should be maximized. Therefore it is important to know the response of the milking sheep to different management practices in order to see if those management practices could fit in the system chosen by the producer.

Milk Production of Domestic Breeds

Beginning in 1984 several U.S. sheep breeds were evaluated at the University of Minnesota for milk production potential. Ewes were chosen from available breeds and machine milked twice a day following weaning of their lambs at 30 days of age. Ewes were subsequently milked for 120 days. The performance of these breeds over a two year period for milk production and milk composition is shown in table 1. With the exception of the Finn and Romanov breeds, all other domestic breeds studied seems to have an identical potential for commercial milk production. The average daily milk production of all ewes is 0.47 kg per day. With such a low production one wonders if these breeds can be milked economically. An indication that they might not is that the early pioneers of sheep dairying in the US were using popular breeds such as Polypay and Dorset in their first attempt at milking. They were soon looking for ways to rapidly improve their average production. It is not to say, however, that these breeds should be disregarded all together. They have certain advantages that the more dairy type breeds might not possess such as: good adaptation to a wide array of environments, good lamb and/or wool production, ability to breed out of season (Polypay, Dorset), known behavior and widely available at reasonable price. By careful selection, their overall production could increase dramatically. Jordan and Boylan (1988) suggest that by massal selection and screening of the best milking ewes, overall milk production could increase by 30 to 40% in just a few years.

Moreover, a lower milk production could be quite acceptable in some segment of the industry. It is well known that there exists a strong negative correlation between the total amount of milk and the percentage of fat. Generally the higher the production the less fat there is in the milk. Domestic breeds producing a moderate amount of milk do have higher butterfat content. If the dollar value of the milk is clearly dependent on its quality (fat and protein, the sum of them being the total useful dry matter) the discrepancy in terms of milk yield between a pure dairy breed such as the East Friesian and a domestic breed is much reduced in terms of overall return per ewe.

Milk Production of Dairy Breeds of Sheep and Their Crosses

With milk production of domestic breeds being too low to provide a good financial return for many producers, the use of breeds specialized in the production of milk becomes necessary.

Breeds such as the East Friesian from Germany or Holland, the Lacaune from France and the British Milk Sheep from England have been promoted as excellent milk producers. There are other dairy breeds of sheep that could be worthwhile considering but are not available in North America: Awassi, Assaf, Sarda, Chios etc…

Good milk production can be achieved with the East Friesian and the Lacaune but one has to be careful with the production level announced by the promoters of the East Friesian breed. The total milk production of the East Friesian in the US is generally lower than in the country of origin. Table 2 shows the production of the East Friesian breed in Germany and Holland. The data are rather old but are the only reliable one and yet collected on rather small number of animals. There is no doubt, however, that by using the East Friesian or the Lacaune in a crossbreeding system, spectacular improvement can be achieved very quickly. An average milk yield of 160-180 liters per ewe (350-400 pounds) during the milking period following a weaning of lambs at 30 days can be obtained very quickly after starting with an original flock of Dorset type ewes as observed at the Spooner Ag. Research Station.

Milk production at 1st lactation and at 2nd, 3rd and 4th lactation is shown in Table 3. The initial crossbreeding of Dorset ewes with East Friesian or Lacaune doubles the milk production. There is a slight increment in production from 25% dairy breeding to 100% "pure bred" East Friesian or Lacaune. The best crosses appear to be East Friesian-Lacaune crosses with 75 % total dairy breeding, the 25% remaining being Dorset.

Effect of Parity and Age on Milk Production

It is well known that the age and/or parity of the ewe have an effect on milk yield. Generally the maximum milk production does not occur before 3 or 4 years of age. It is generally admitted that a one year old ewe will produce about 44% less milk than a fully mature 4 year old, a 2 year old will produce 24% less milk than a 4 year old and a 3 year old will produce 13% less than a 4 year old. This is important, not only to estimate the average flock production according its age composition but mostly for selection purpose. The milk production of a 1, 2 or 3 year old ewe needs to be adjusted in order to be able to compare its production to a fully mature ewe. Thomas (1996) published those correction factors in the 2nd Great Lakes Dairy Sheep Symposium and they are reported in this article in table 4.

Effect of Lamb Management on Milk Production

Lambs can be managed in three different systems called DY30, MIX and DY1. Each system has an important effect not as much on the milk yield as on the saleable amount of milk from each ewe. In the DY30 system, the ewes are raising their lambs for 30-40 days. The lambs are then weaned and the ewes put at milking twice a day for the rest of their lactation. This system provides the least amount of saleable milk since the lambs are drinking this milk. 25% of the total milk production occurs during the first 30 days of lactation. That means that if a ewe is able to produce 300 liters of milk, 75 liters would go to the lambs and therefore not sold. According to the price of milk it could represent a value of $100-$145.

The Mix system consists of letting the ewes raise their lambs for 30 days but milking the ewe once a day starting a few days after parturition. Milking occurs after a 12 hour separation (overnight) of the lambs from the mother. In this system the lambs are growing well and there is a fair amount of milk available for sale. Unfortunately as long as the ewes are nursing the lambs the milk obtained at milking (machine milking) will be much lower in fat content which is detrimental for the cheese production.

The DY1 system consists of removing the lambs from their mothers at 1 or 2 days of age, raising the lambs artificially on milk replacer and milking the ewes twice a day. This system procures the most saleable amount of milk. Lactation curves for commercial milk production of the three lamb management systems show that, over the whole lactation, the DY1 and MIX systems produced 61 and 38% more milk than the traditional DY30 system. Therefore, according to the level of production of the ewe, the price of milk replacer and the number of lambs born from the ewe, these two systems might be very worthwhile economically.

Table 5 shows the amount of milk obtained from each system as well as their economical value. The table is from McKusick et al., 1999 (5^{th} Great lakes Dairy Sheep Symposium) to which numbers have been adapted to reflect the production of a 2007 dairy ewe as well as the price of lambs and milk. For the MIX system it is assumed that the milk has the same value as the milk of DY1 or DY30. However, because of the low fat content in the milk of ewes of the MIX system, the dollar value of this milk might be lower.

Effect of Photoperiod on Milk Production

A trial conducted at the University of Wisconsin has shown that ewes exposed to short day length before parturition produced more milk with a higher milk fat percentage during the first eight weeks of lactation and more milk (+29 kg) over the entire lactation period than ewes exposed to long day length. The effect of prepartum photoperiod may have contributed to the increase in annual milk production of dairy ewes at the Spooner Ag. Research Station. Some of this increase was attributed to a change in the breeding and lambing season. By moving the lambing season from March-April to January-February, ewes are milking longer during the increasing day length and responding to the increase photoperiod. In addition, winter lambing ewes are experiencing shortened prepartum photoperiod which is an additional factor in increasing milk yield. Therefore, management for decreased prepartum photoperiod maybe a strategy to increase milk production in dairy ewes.

Effect of Supplementation on Milk Production

Another trial at the Spooner Ag. Research Station (2005 and 2006) showed that ewes grazing a mixture of Kura Clover and Orchard grass and supplemented with 0,95 kg per day (0,45 kg at each milking) of corn-soybean meal concentrate, produced 0,25 kg more milk per day than non-supplemented ewes. Supplemented ewes however, had a lower milk fat percentage than non-supplemented ewes. Milk fat is inversely related to fiber content of the diet. Therefore, ewes consuming a low-fiber supplement may have lower total NDF intake, possibly leading to milk fat depression. Supplemented ewes also had lower milk protein percentage than non-supplemented. This might be of some importance when the value of milk is a function of its components (see 2^{nd} part of this paper: Price of milk).

The level of production that a producer can realistically expect depends greatly on the breed of sheep he uses, the level of supplementation, the time of the year of the milking season and the overall management. In a very intensive management with high input (feed, labor, etc…) dairy ewes in North America can produce over 800 pounds of milk in 240-250 days. However, the goal of the enterprise is not to produce the maximum amount of milk. The goal is the **profitability** of the enterprise. This is where true management ability counts the most.

Price of Milk

In North America there is no standardization of the price of sheep milk like there is for cow milk or goat milk. There is no national or even regional standard, no agency balancing the price according to the demand and supply. The price of milk is negotiated between the buyer and the seller. A cheese maker securing a sheep milk supply from different sources might offer different prices according to the source. However, the negotiations revolve around a base price that has been set, rather arbitrarily, in the early days of sheep dairying in North America. Both buyers and sellers, understand well that they are very dependent on each other and that each party needs to be and to stay happy in order to assure the wellbeing and happiness of the other. In 2007, the base price in the US seems to be in the range of $1.65-1.85/kg.

American sheep milk producers should be aware that the price of sheep milk in North America is higher than the price generally practiced in other countries where sheep milk is historically about three times higher than cow milk and two times higher than goat milk. The high price of milk pushes up the retail price of cheese and puts American cheeses in a difficult position to compete with European cheeses. The exception would be the price of sheep milk in France for the manufacture of Roquefort. Table 6 shows the price of sheep milk in North America and in different European countries. The United States, Canada and the United Kingdom have the highest prices for milk while Sardinia (Italy), making 90% of the Pecorino Romano, most of it exported to the US, has the lowest.

Because of a small market, tight supply and lack of organization, sheep milk, in the US at least, is sold strictly on volume without any consideration to the solid content (fat and protein), bacteriological quality or somatic cell count. The Wisconsin Sheep Dairy Cooperative sells only grade A milk (the milk has to be below 100,000 bacteria/ml with a somatic cell count (SCC) inferior to 1 million/ml). The cooperative which has a Dairy Plant status also has the IMS status (Interstate Milk Shipment) which allows WSDC to ship grade A milk to any state. The buyers of the milk, however, do not require any more control. Requests have been made, however, by different cheese makers for the establishment of some sort of component pricing which would be fair to all parties. In the proceedings of the 10^{th} Great Lakes Dairy Sheep Symposium, Jaeggi et al. (2004) reported that seasonal changes have a significant impact on milk composition, thereby affecting cheese yield and that cheese yields were directly related to the level of fat and casein in the initial milk. The results of their study also showed that the Van Slyke-Price cheese yield formula could be effectively used to predict cheese yield for hard-pressed and soft cheeses made from sheep milk. Cheese yield is a vital component of profitability for cheese makers. Payment of milk could then be based on cheese yield. It is also well established in the scientific literature that although the amount of somatic cells in the milk does not have a direct effect on cheese yield, it does affect the pH, the coagulation time and the protein recovery time, making low somatic cell milk more efficient for cheese making (Pirisi et al., 2000). Therefore any payment system based on cheese yield should have a somatic cell component.

The Van Slyke-Price formula

$$\text{Cheese Yield} = \frac{[(RF \times \%\ \text{Fat in Milk}) + (RC \times \%\ \text{Casein in Milk})] \times RS}{(100 - \%\ \text{Moisture of cheese})}$$

Where:

	Hard cheese	Soft cheese
RF = the fat recovered in cheese	0.84	0.82
RC = the casein recovered in cheese	0.96	0.96
RS = Other milk solids and added salt recovered in cheese	1.08	1.01

Casein = 78% of total protein
Jaeggi et al. 2004

Table 7 shows the evolution of the value of milk throughout the season according to the cheese yield calculated by the Van Slyke-price formula. Those are real data from a real Wisconsin farm although the payment of the milk was not made according to cheese yield. The assumptions were that the base price was US $1.65/kg for milk with 6.5% fat, 5% protein and SCC more than 300,000 but less than 700,000 and with a pressed cheese yield of 16%. Milk with less than 300,000 SCC was given a $.02 premium and milk with more than 700,000 was given a $ .02 penalty. The cheese yield, and, therefore, the price of milk, varies during the milking season according to the fat and protein percentage in the milk as shown in Figure 1. In our example, however, because of the different quantities of milk delivered to the cheese plant by the producer, the total payment to the producer calculated on cheese yield would have been more than the total payment based on volume alone at $1.65/kg throughout the season. Yet, this particular producer had a fairly high somatic cell count lowering the price of his milk. With a lower somatic cell count, the payment of milk based on components would have been much more profitable for the producer. Figure 2 shows that the price of milk is at its lowest when the quantities of milk delivered are at their peak because of lower fat and protein content. It appears then, that producers would be well rewarded with high component percentage and low cell count and penalized when the somatic cell count increases and component percentage decreases. Payment of milk on components and somatic cell count is certainly worthwhile for both producers and cheese makers even considering the increased complexity of book keeping.

Conclusion

It has been shown by the early pioneers of sheep dairying in North America that milking domestic breeds might not be financially rewarding enough because of short lactation and low milk production. The introduction of dairy breeds became a necessity and crossbred animals showed spectacular improvement in their milking ability. The total milk production is also very much dependent on the overall management of the flock, the season of lambing and the level of nutrition. Because of the effect of many different factors it is difficult to estimate the possible milk production of a flock. To the question “how much milk can I expect from this ewe?” the only possible answer is: it depends.

Milk price in North America varies from region to region but seems to be in the range of $1.65 to $1.90 per kg (or liter). For the time being frozen milk has the same value as fresh milk and is purchased (or sold) strictly on volume. Component pricing should be established for more fairness to the producer and cheese maker. A payment system based on cheese yield would be quite feasible.

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Table 1. Least-Square means for several milk traits by breed (1989-1990). Milking period only.

Breed	***Milk (liters)***	***Fat (%)***	***Protein (%)***	***Lactose (%)***	***Solids (%)***
Overall mean	57	6.6	5.8	4.7	17.9
Suffolk	69	6.7	5.9	4.7	18.1
Finnsheep	44	6.1	5.5	4.5	16.7
Targhee	62	6.9	5.9	4.8	18.4
Dorset	61	6.3	5.7	4.5	17.2
Lincoln	53	6.8	5.8	4.7	18.0
Rambouillet	65	6.6	6.1	4.9	18.3
Romanov	44	7.1	5.9	4.8	18.6
Outaouais	54	7.3	6.1	4.6	18.7
Rideau	77	6.6	5.8	4.8	18.0

W.J.Boylan (1995)

Table 2. Milk production of East Friesian and Lacaune ewes in their country of origin.

Authors	***Breed***	***Country***	***Number of ewes***	***Milk production (kg)***	***Days in Milk***
Mulhberg 1933	East Friesian	Germany	97	734 (suckling + milking)	263
Buitekamp 1952	East Friesian	Germany	287	576 (suckling + milking)	245
Brauns 1953	East Friesian	Germany	70	388 (suckling + milking)	255
Olivia Mills 1989	East Friesian	Holland	15	577 suckling:190 milking: 387	225 (52 + 173)
UPRA Lacaune 1994	Lacaune	France	143747	249 Milking only	166

Table 3. Milk production of Dorset and crossbred dairy ewes at the Spooner Research Station. Production corresponds to the milking period only after suckling their lambs for 30 days. (EF = East Friesian, L = Lacaune).

	Lactation	n	Milk yield (liters)	Milking period (days)	% fat	% protein
Dorset (no dairy)	1	27	37	52	5.0	4.42
	2, 3, 4	29	87	92	5.88	5.2
¼ EF, ¾ Dorset	1	15	99	96	4.58	4.41
	2, 3, 4	170	196	144	5.49	4.9
½ EF, ½ Dorset	1	179	101	104	5.22	4.58
	2, 3, 4	369	200	158	5.74	4.88
½ L, ½ Dorset	1	82	100	103	6.36	5.02
	2, 3, 4	180	180	152	6.79	5.32
¾ EF, ¼ Dorset	1	80	121	115	5.28	4.47
	2, 3, 4	139	218	166	5.6	4.69
¾ L, ¼ Dorset	1	51	107	107	6.16	4.88
	2, 3, 4	80	211	161	6.52	5.18
7/8 EF and EF	1	62	115	111	5.14	4.39
	2, 3, 4	76	227	181	5.41	4.56
7/8 L and Lacaune	1	15	130	131	6.53	5.09
	2, 3, 4	12	205	168	6.6	5.12
¾ dairy EF x L x Dorset	1	116	143	129	5.6	4.6
	2, 3, 4	206	253	183	6.22	5.03
100% dairy EF x L	1	203	166	141	5.55	4.6
	2, 3, 4	253	252	180	5.9	4.86

Table 4. Multiplicative adjustment factors to adjust milk yield to a mature ewe (Thomas 1996).

Ewe age, years	Adjustment factor
1	1.44
2	1.24
3	1.13
4 to 7	1.00
8 and older	1.04

Table 5. Milk production for each lamb management system and their economical value.

	Price ($)	**Receipts ($)**	**Expenses Over DY30 ($)**	**Weight (Kg)**	**Returns (Expenses - Returns) ($)**	**Returns Relative To DY30 ($)**
Milk						
DY1	1.35	459	16.2[1]	340	442.8	+ 55.3%
MIX	1.35	390	10.6[2]	289	379.4	+ 33.1%
DY30	1.35	285	0.0	211	285.0	0.0%
Lambs 2lambs/ewe						
DY1	2.64	230.2	58.4[3]	87.2	171.8	- 32%
MIX	2.64	240.2	0.0	91	240.2	- 5.2%
DY30	2.64	253.4	0.0	96	253.4	0.0%
Total System[4]						
DY1		689.2	74.6		614.6	**+ 14.2%**
MIX		630.2	10.6		619.6	**+ 15.1 %**
DY30		538.4	0.0		538.4	**0.0%**

[1] Labor to milk one ewe twice daily for 30 days
[2] Labor to, once daily, separate the ewes from the lambs and milk one ewe for 30 days
[3] Cost of milk replacer, labor and supplies to raise 2 lambs artificially
[4] For one lactating ewe and her 2 lambs

Table 6. 2007 price of milk per liter or kg in different countries. (Price in Euros were converted in US dollars with the exchange rate of 1 Euro = 1.36 US dollars)

Countries	**Price of cow milk (US $)**	**Price of goat milk (US $)**	**Price of sheep milk (US $)**
USA	0.396	0.64	1.5-1.8
Canada	0.53	0.72-0.80	1.5-2.0
UK	0.34		1.4 – 1.8
France (Roquefort)	0.397	0.69	1.45
France (Pyrenees)			1.25
Spain	0.397	0.56	1.07
Portugal		0.57	1.36
Greece	0.53	0.75	1.02
Italy		0.60	0.95
Italy (Sardinia)			0.36
Israel		0.90	1.25

Table 7. Value of milk and payment to producer according to cheese yield or strictly volume at $1.65/kg. (A real example).

Date	**Kg milk delivered**	**BF %**	**Prot %**	**SCC**	**Correction for SCC**	**Estimated Cheese Yield (%)**	**Milk value $/kg**	**Milk value after correction for SCC ($)**	**Payment according to cheese yield ($)**	**Payment according to volume only ($)**
17-Feb	1872.73	6.5	5.09	620	0	16.41	1.669	1.669	3125.21	3090
24-Feb	1886.36	6.71	5.19	430	0	16.86	1.714	1.714	3233.28	3112.5
28-Feb	2056.82	6.63	5.16	280	+.020	16.70	1.698	1.718	3533.61	3393.75
10-Mar	1853.18	6.85	4.97	290	+.020	16.78	1.706	1.726	3198.58	3057.75
14-Mar	1600.91	7.03	5.05	420	0	17.15	1.744	1.744	2791.25	2641.5
17-Mar	1597.73	6.88	5.07	590	0	16.95	1.724	1.724	2753.78	2636.25
24-Mar	1514.55	6.93	4.98	570	0	16.91	1.719	1.719	2603.49	2499
28-Mar	1531.82	7.01	4.87	560	0	16.88	1.716	1.716	2629.00	2527.5
31-Mar	1349.09	6.99	4.82	590	0	16.79	1.706	1.706	2302.22	2226
4-Apr	1537.73	6.77	4.75	630	0	16.37	1.664	1.664	2558.47	2537.25
7-Apr	1528.18	6.73	4.83	500	0	16.41	1.669	1.669	2549.82	2521.5
14-Apr	1556.82	7.24	4.89	610	0	17.25	1.754	1.754	2730.24	2568.75
18-Apr	1437.73	7.36	4.73	530	0	17.22	1.750	1.750	2516.46	2372.25
21-Apr	1339.55	7.07	4.65	730	-.02	16.68	1.696	1.676	2244.65	2210.25
25-Apr	1583.18	7.17	4.67	320	0	16.85	1.713	1.713	2712.77	2612.25
3-May	1863.64	7.28	4.78	600	0	17.16	1.745	1.745	3251.95	3075
9-May	2064.55	6.69	4.69	560	0	16.17	1.644	1.644	3393.32	3406.5
12-May	1564.09	6.38	4.47	580	0	15.41	1.567	1.567	2451.08	2580.75
19-May	2125.45	6.82	4.79	510	0	16.49	1.677	1.677	3563.85	3507
23-May	2179.09	6.38	4.73	540	0	15.76	1.602	1.602	3491.20	3595.5
26-May	1579.55	6.34	4.71	540	0	15.67	1.593	1.593	2516.84	2606.25
6-Jun	2145.45	6.42	4.69	650	0	15.77	1.603	1.603	3438.72	3540
16-Jun	1966.36	6.43	4.6	580	0	15.66	1.592	1.592	3130.79	3244.5
20-Jun	1936.82	6.59	4.6	620	0	15.90	1.616	1.616	3130.61	3195.75
23-Jun	1345.45	7.24	4.52	710	-.02	16.76	1.704	1.684	2265.56	2220
30-Jun	1257.73	6.3	4.43	650	0	15.24	1.550	1.550	1948.98	2075.25
4-Jul	1803.64	6.79	4.72	680	0	16.36	1.663	1.663	2999.05	2976
7-Jul	1428.18	6.66	4.8	680	0	16.27	1.654	1.654	2362.08	2356.5
14-Jul	1328.18	6.42	4.57	730	-.02	15.61	1.587	1.567	2080.75	2191.5
18-Jul	1632.27	6.22	4.58	770	-.02	15.32	1.558	1.538	2509.99	2693.25
21-Jul	1325.91	6.56	4.65	640	0	15.92	1.619	1.619	2146.07	2187.75
28-Jul	1282.27	6.42	4.71	690	0	15.79	1.605	1.605	2058.67	2115.75
4-Aug	1269.09	6.46	4.78	780	-.02	15.94	1.621	1.601	2031.78	2094
12-Aug	1568.18	6.86	5.04	750	-.02	16.88	1.716	1.696	2660.41	2587.5
15-Aug	1037.73	6.63	5.26	580	0	16.83	1.711	1.711	1775.93	1712.25
18-Aug	908.182	6.69	5.23	720	-.02	16.88	1.716	1.696	1540.64	1498.5
25-Aug	1039.55	7.26	5.54	760	-.02	18.14	1.844	1.824	1896.50	1715.25
29-Aug	813.182	7.6	5.7	710	-.02	18.86	1.917	1.897	1542.87	1341.75
15-Sep	855.909	8.08	6.05	830	-.02	20.04	2.037	2.017	1726.43	1412.25
TOTAL									**111,863.68**	**110,283.0**

Figure 1. Evolution of the fat %, protein % and cheese yield throughout the milking season on a farm with winter lambing and DY1 lamb management.

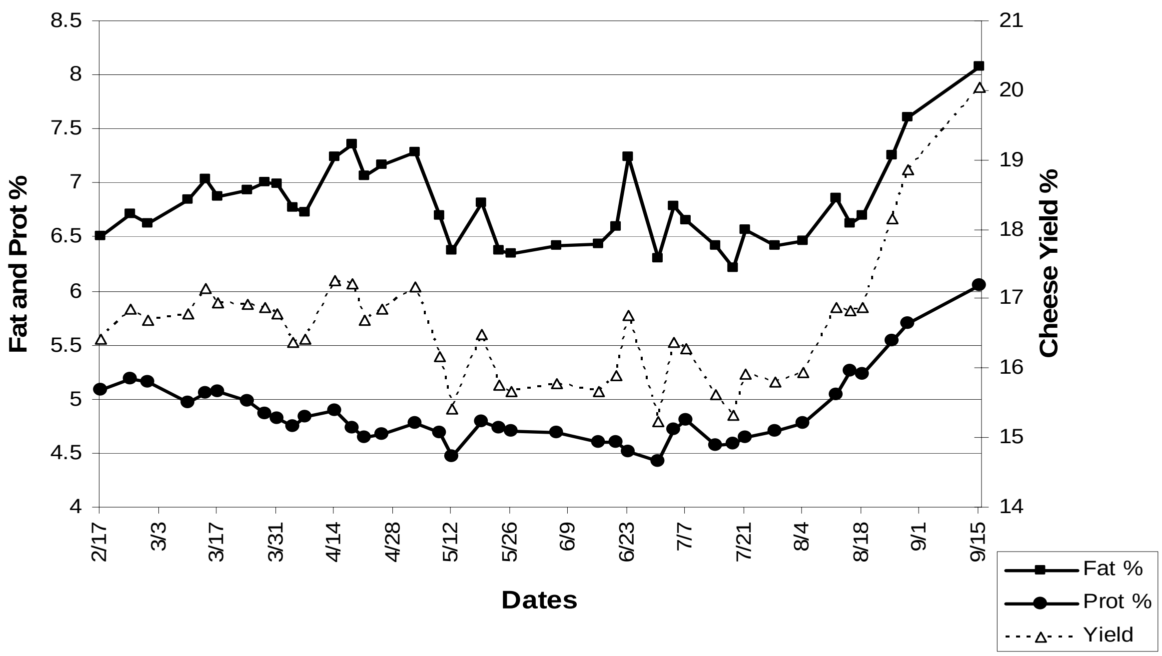
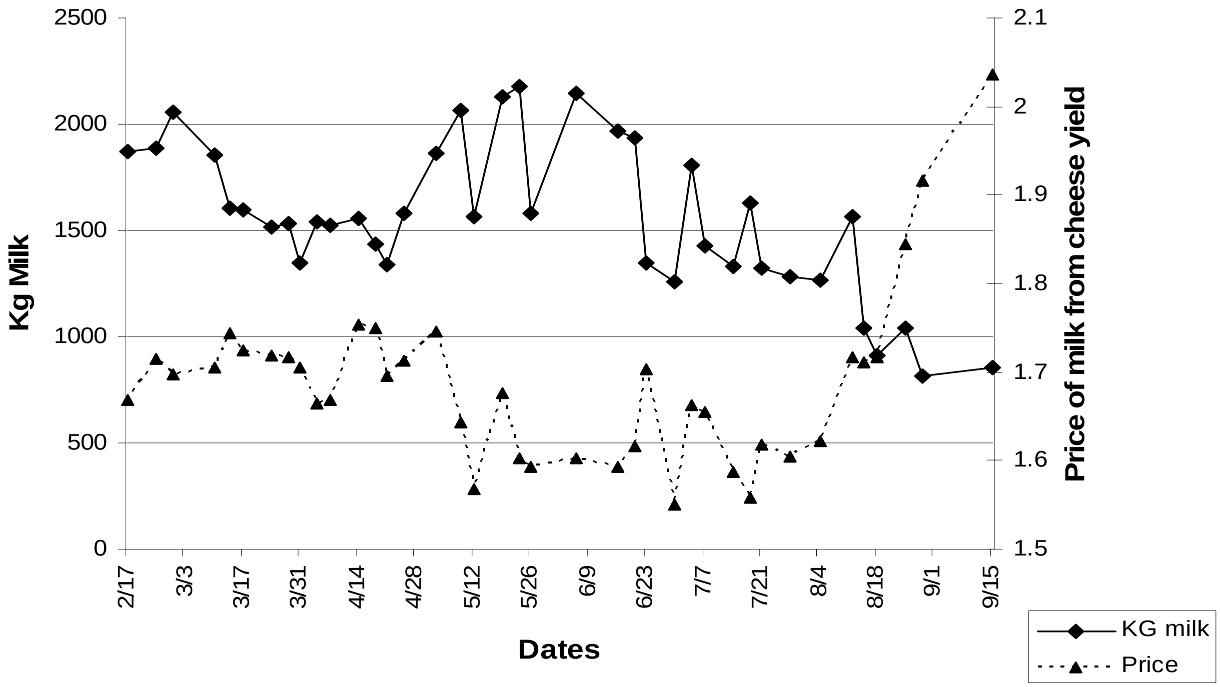


Figure 2. Evolution of the quantities of milk delivered to the cheese plant and price of milk from cheese yield throughout the milking season on a farm with winter lambing and DY1 lamb management (correction for SCC included).



NOTES

NUTRIENT RECOMMENDATIONS FOR EWE LAMBS BASED ON NATIONAL RESEARCH COUNCIL (NRC) 2007

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General

- Intake predictions have been increased in the development period and first gestation, but reduced in early first lactation
- Energy predictions have been increased in the development period and first gestation, but reduced in early first lactation
- Protein is up in the development period. Protein is down as animals approach 'maturity' (late gestation and lambing) as with all mature animals throughout NRC 2007
- Phosphorus (P) recommendation is up 25 to 60 % for all ewe lambs through first lactation, which is against the trend for mature animals in NRC 2007
- Calcium (Ca) is down, except a marginal increase in first lactation
- Vitamin E is up in NRC 2007 by 9 to 22 times relative to NRC across ewe lambs, declining as lactation sets in
- Vitamin A is up two-fold in the developmental and breeding period, and cut by half in gestation and lactation

Ewe Lamb Comparisons: new vs. old recommendations

Scenarios assume 50 kg (110 lb) animal at BCS=3

Growth, Flushing and Breeding: 2007* vs. 1985 – (1985 assumes 120 g/d gain, 2007 assumes 250)

- Intake up 6%
- Energy up ~ 40%
- Crude Protein (CP) up ~ 12%
- Ca down 9%
- P **up** ~60%
- Vit A **up** ~ 2 times
- Vit E up 22 times

Table 1. Requirements for 50 kg Ewes Lambs in growth, flushing and breeding across NRC 1985, OMAFRA's Sheep Ration Formulation Program (SRFP) 2001 and NRC 2007.

	Gain (g/d)	**DMI (kg/d)**	**TDN intake (kg/d)**	**CP intake (g/d)**	**Ca g/d**	**P g/d**	**Vit E IU/d**
NRC 1985	120	1.5	0.88	136	4.8	2.4	22
SRFP 2001	159 *(0.35 lb)*	1.59 *(3.5 lb)*	0.98 *(2.17 lb)*	191 *(0.42 lb)*	5.9	3.1	48
NRC 2007*	250	1.59	1.26	156	4.4	3.8	500

** Table 15-2 Growing Lambs & Yearlings: Age = 8 months, Maturity = 0.8*

Late Gestation, Twins: 2007* vs. 1985 – (1985 assumes 130 to 175% lambing at 225 g/d gain, 2007 assumes 191 g/d gain bearing twin lambs)

- Intake up 4%
- Energy up ~ 25%
- CP down ~ 10%
- Ca **up** ~ 25%
- P **up** ~ 40%
- Vit A down ~ 45%
- Vit E up 12 times

Table 2. Requirements for 50 kg Ewes Lambs in late gestation across NRC 1985, two different assumptions in SRFP 2001 and NRC 2007.

	Gain (g/d)	**DMI (kg/d)**	**TDN intake (kg/d)**	**CP intake (g/d)**	**Ca g/d**	**P g/d**	**Vit E IU/d**
NRC 1985	225	1.6	1.06	204	7.9	3.9	24
SRFP 2001 – 130-175%	227 *(0.50 lb)*	1.59 *(3.5 lb)*	1.05 *(2.31 lb)*	204 *(0.45 lb)*	7.8	3.9	48
SRFP 2001 – twins	-100 *(-0.22 lb)*	1.86 *(4.1 lb)*	1.19 *(2.63 lb)*	281 *(0.62 lb)*	6.5	4.5	70
NRC 2007*	191	1.66	1.32	183	9.7	5.6	280

** Table 15-2 Yearling Farm Ewes: Late gestation, twin lambs*

Early Lactation, Twins: 2007* vs. 1985 – (1985 assumes 1st 6-8 weeks at 50 g/d loss, 2007 assumes 26 g/d loss producing 1.18 to 2.05 kg milk/d)

- Intake down ~ 20%
- Energy down ~ 20%
- CP down ~ 10%
- Ca up ~ 3%
- P **up** ~ 25%
- Vit A down ~ 45%
- Vit E up 9 times

Table 3. Requirements for 50 kg Ewes Lambs in early lactation with twins across NRC 1985, SRFP 2001 and NRC 2007.

	Gain (g/d)	**DMI (kg/d)**	**TDN intake (kg/d)**	**CP intake (g/d)**	**Ca g/d**	**P g/d**	**Vit E IU/d**
NRC 1985	-50	2.1	1.39	282	6.5	4.7	32
SRFP 2001	-100 *(-0.22 lb)*	2.31 *(5.1 lb)*	1.59 *(3.50 lb)*	372 *(0.82 lb)*	8.7	6.0	70
NRC 2007*	-26	1.65	1.10	255	6.7	5.8	280

** Table 15-1 Yearling Farm Ewes: Early lactation, twin lambs*

DAIRY SHEEP NUTRIENT RECOMMENDATIONS
BASED ON NATIONAL RESEARCH COUNCIL (NRC) 2007

Christoph Wand
Beef Cattle & Sheep Nutritionist, Ontario Ministry of Agriculture, Food & Rural Affairs
Woodstock, Ontario, Canada

General

- NRC 2007 is in the business of describing dairy ewes for the first time
- Only real point of comparison is OMAFRA's Sheep Ration Formulation Program (SRFP) 2001 (Dr. John Cant and C. Wand) assumptions or other bovine dairy formulation programs
- Intake predictions have been reduced, particularly in early lactation
- Energy predictions have been reduced throughout lactation
- Protein is up across lactation; in particular about 25% higher in early and mid-lactation. Therefore ration protein content will be significantly higher (2-6 percentage points, depending on stage and production).
- Calcium (Ca) and Phosphorus (P) recommendations are down significantly. Reductions for Ca bring it to about 2/3 of previous, and P to 80% of previous levels across the board
- Vitamin A was not reported on in SRFP; this parameter is now scientifically based for dairy sheep
- Vitamin E is up in NRC 2007 by 4 to 4.5 times relative to SRFP 2001, despite SRFP's aggressive Vitamin E push in dairy sheep

Dairy Sheep Comparisons: new vs. old recommendations

Scenarios assume 80 kg (176 lb) animal at BCS=3

High Production – 3.00 kg/d : 2007* vs. SRFP 2001 – (SRFP assumes 50 g/d loss at 2.0 to 3.0 L **or** 3.0 to 4.0 L/d each at Grazing or Confinement in 180 lb. ewes, NRC 2007 assumes 3.01 kg/d in Late Lactation with 60 g/d loss in 80 kg ewes)

- Intake down ~ 12%
- Energy down ~ 10%
- Crude Protein (CP) up ~25%
- Ca down ~ 35%
- P down ~20%
- Vit E up 4 times

Table 1. Requirements for 80 kg early lactation ewes across SRFP 2001, at four assumptions, and NRC 2007.

	Gain (g/d)	DMI (kg/d)	TDN intake (kg/d)	CP intake (g/d)	Ca g/d	P g/d	Vit E IU/d
SRFP 2001 2.0 to 3.0 L/d - Grazing	50 *(-0.11 lb)*	3.27 *(7.2 lb)*	2.06 *(4.55 lb)*	367 *(0.81 lb)*	19.8	13.3	100
SRFP 2001 2.0 to 3.0 L/d – Dry Lot	50 *(-0.11 lb)*	3.27 *(7.2 lb)*	1.95 *(4.30 lb)*	367 *(0.81 lb)*	19.8	13.3	100
SRFP 2001 3.0 to 4.0 L/d - Grazing	50 *(-0.11 lb)*	3.67 *(8.1 lb)*	2.51 *(5.53 lb)*	454 *(1.00 lb)*	24.5	16.1	125
SRFP 2001 3.0 to 4.0 L/d – Dry Lot	50 *(-0.11 lb)*	3.67 *(8.1 lb)*	2.39 *(5.28 lb)*	454 *(1.00 lb)*	24.5	16.1	125
NRC 2007	-60	3.04	2.01	522	13.8	12.0	448

**Table 15-1. Mature Ewes: Early Lactation (Parlor production only; milk yield = 2.37 to 3.97 kg/d)*

Moderate Production – 2.01 kg/d: 2007* vs. SRFP 2001 – (SRFP assumes 0 g/d gain at 1.0 to 2.0 L **or** 2.0 to 3.0 L/d each at Grazing or Confinement in 180 lb. ewes, NRC 2007 assumes 2.01 kg/d in Late Lactation with 0 g/d gain in 80 kg ewes)

- Intake down ~ 3%
- Energy down ~ 13%
- CP up ~25%
- Ca down ~ 35%
- P down ~15%
- Vit E up 4.5 times

Table 2. Requirements for 80 kg mid-lactation ewes across SRFP 2001, at four assumptions, and NRC 2007.

	Gain (g/d)	DMI (kg/d)	TDN intake (kg/d)	CP intake (g/d)	Ca g/d	P g/d	Vit E IU/d
SRFP 2001 1.0 to 2.0 L/d - Grazing	0	2.86 *(6.3 lb)*	1.76 *(3.89 lb)*	272 *(0.66 lb)*	15.0	10.5	100
SRFP 2001 1.0 to 2.0 L/d – Dry Lot	0	2.86 *(6.3 lb)*	1.65 *(3.64 lb)*	272 *(0.66 lb)*	15.0	10.5	100
SRFP 2001 2.0 to 3.0	0	3.27 *(7.2 lb)*	2.21 *(4.87 lb)*	390 *(0.86 lb)*	19.8	13.3	100

L/d - Grazing							
SRFP 2001 2.0 to 3.0 L/d – Dry Lot	0	3.27 *(7.2 lb)*	2.10 *(4.62 lb)*	390 *(0.86 lb)*	19.8	13.3	100
NRC 2007	0	3.14	1.67	421	10.8	10.0	448

**Table 15-1. Mature Ewes: Mid-Lactation (Parlor production only; milk yield = 1.59 to 2.66 kg/d)*

Low Production – 0.99 kg/d: 2007* vs. SRFP 2001 – (SRFP assumes 50 g/d gain at 0.5 to 1.0 L **or** 1.0 to 2.0 L/d each at Grazing or Confinement in 180 lb. ewes, NRC 2007 assumes 0.99 kg/d in Late Lactation with 59 g/d gain in 80 kg ewes)

- Intake equal
- Energy down ~ 20%
- CP up ~7%
- Ca down ~ 35%
- P down ~20%
- Vit E up 4.5 times

Table 3. Requirements for 80 kg late lactation ewes across SRFP 2001, at four assumptions, and NRC 2007.

	Gain (g/d)	**DMI (kg/d)**	**TDN intake (kg/d)**	**CP intake (g/d)**	**Ca g/d**	**P g/d**	**Vit E IU/d**
SRFP 2001 0.5 to 1.0 L/d - Grazing	50 *(0.11 lb)*	2.86 *(6.3 lb)*	1.47 *(3.24 lb)*	231 *(0.51 lb)*	10.3	7.7	100
SRFP 2001 0.5 to 1.0 L/d – Dry Lot	50 *(0.11 lb)*	2.86 *(6.3 lb)*	1.36 *(2.99 lb)*	231 *(0.51 lb)*	10.3	7.7	100
SRFP 2001 1.0 to 2.0 L/d - Grazing	50 *(0.11 lb)*	2.86 *(6.3 lb)*	1.91 *(4.22 lb)*	322 *(0.71 lb)*	15.0	10.5	100
SRFP 2001 1.0 to 2.0 L/d – Dry Lot	50 *(0.11 lb)*	2.86 *(6.3 lb)*	1.80 *(3.97 lb)*	322 *(0.71 lb)*	15.0	10.5	100
NRC 2007	59	2.82	1.5	310	7.9	7.2	448

**Table 15-1. Mature Ewes: Late Lactation (Parlor production only; milk yield = 0.85 to 1.35 kg/d)*

MINERAL RECOMMENDATIONS FOR SHEEP
BASED ON NATIONAL RESEARCH COUNCIL (NRC) 2007

Christoph Wand
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General

- Other than those expressed in other macronutrient commentaries (Ca and P) the range of mineral recommendations is not largely different between NRC 1985 and NRC 2007 with the exceptions to be discussed below
- Recommendations have been 'tightened-up' for several minerals such that a wide range as seen in NRC 1985 is no longer advised, rather a more specific number is given per production class
- When relevant production classes* for Ontario are subjected to a regression on mineral recommendations based on dry matter intake (DMI), the revised sodium (Na), magnesium (Mg), potassium (K), sulphur (S), iodine (I), zinc (Zn) and copper (Cu) are highly correlated to intake (r^2>0.80)
- These classes* are:
    - Growing lambs including feedlot, yearling ewes, wethers and rams
    - All phases of production for mature ewes in farm settings (vs. range)
    - Dairy ewes
- High strong correlation (r^2=0.75) between intake and requirement is also seen for cobalt (Co)
- For Ontario production classes, weak correlations exist between dry matter intake and selenium (Se), Iron (Fe), and manganese. This means that minerals either need to be specifically designed for the relevant production classes, or over-formulated
- Chloride (Cl) recommendations have been added; these are moderately correlated to intake (r^2=0.55), but this nutrient has no previous stated requirement
- The toxic threshold for copper has been reduced

Sodium, Chloride and Magnesium

- The regression on NRC 2007 data suggests 0.06 % Na meets requirements for Ontario conditions across classes. This compares to NRC 1985 which stated the range was 0.09 to 0.18 percent
- The graph suggests 0.11 % Mg meets requirements for Ontario conditions across classes. This compares to NRC 1985 which stated the range was 0.12 to 0.18 percent
- NRC 1985 provided little guidance on Cl. This regression would suggest 0.08% would be a good assumption for requirement, but would easily be met with forages and Na salt sources

Potassium and Sulphur

- The regression of K and S requirements for Ontario assumptions provide solid correlations to DMI
- K requirement is now suggested to be 0.50 % (NRC 2007) compared to NRC 1985 which suggested a range of 0.50 to 0.80 percent
- The NRC 2007 recommendation for sulphur is 0.16 %, within the range of 0.14 to 0.26 percent which NRC 1985 provided

Figure 1. Correlations of DMI and grams per head per day recommendations for Na, Cl and Mg levels for common Ontario production classes.

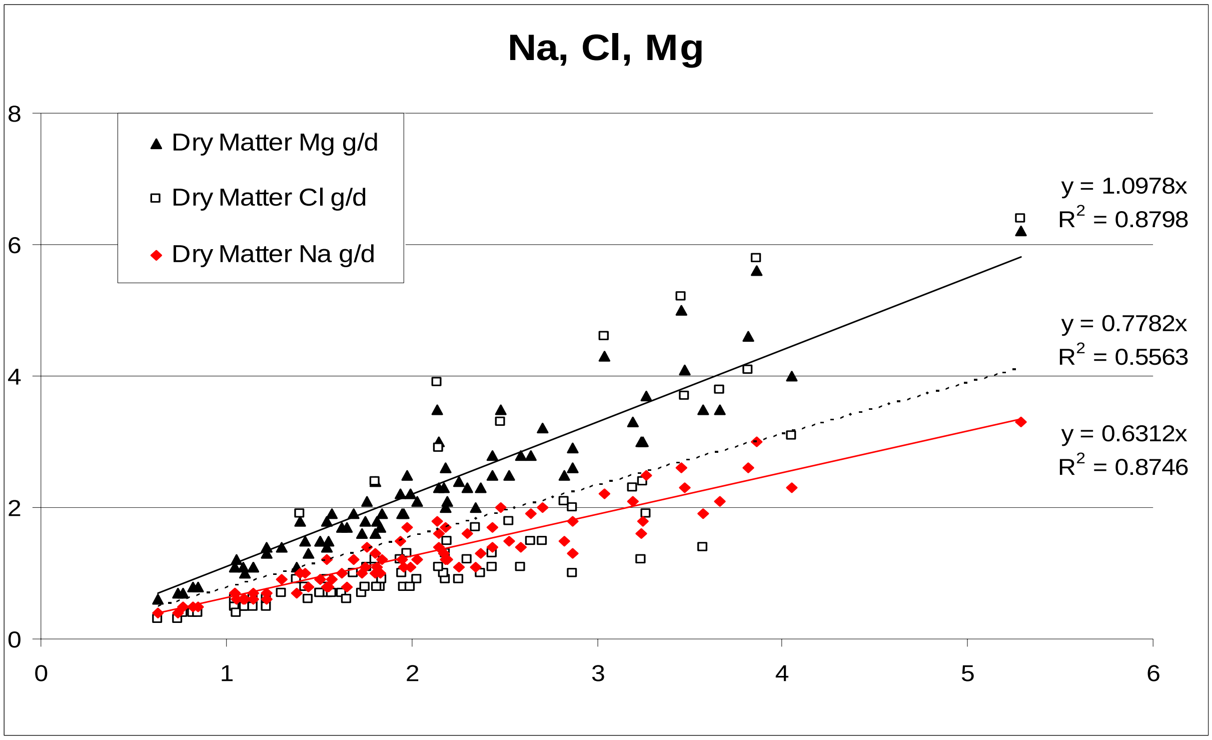
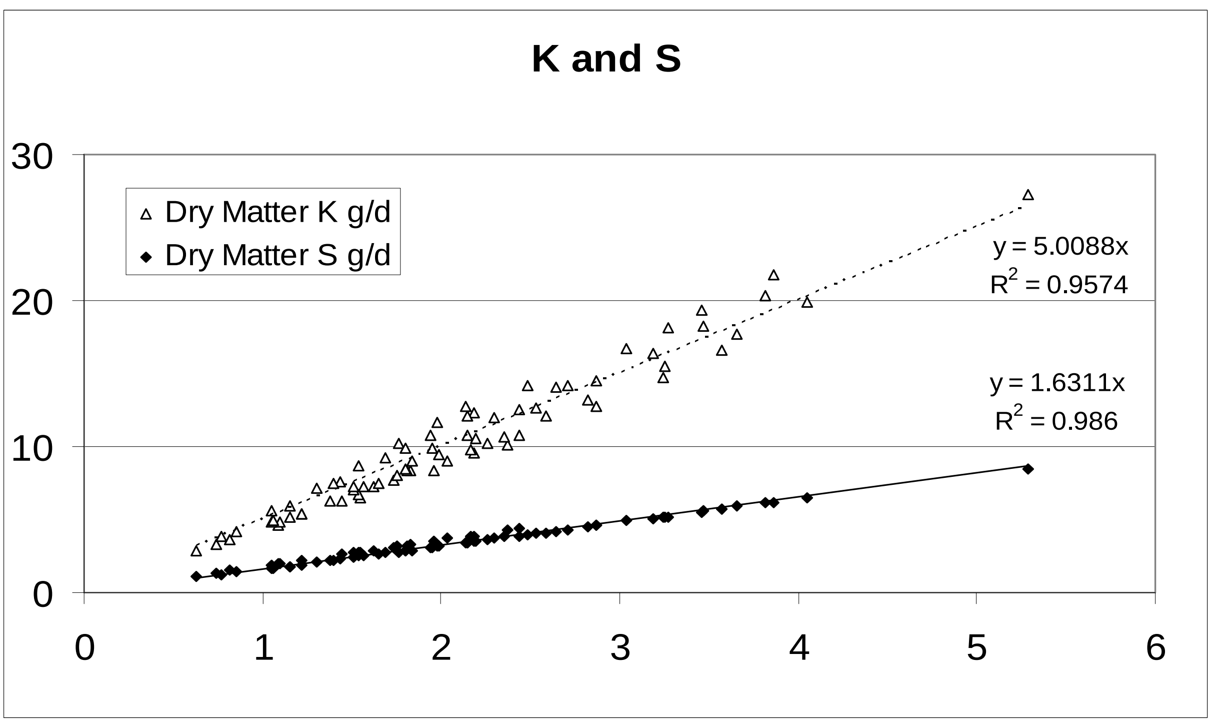


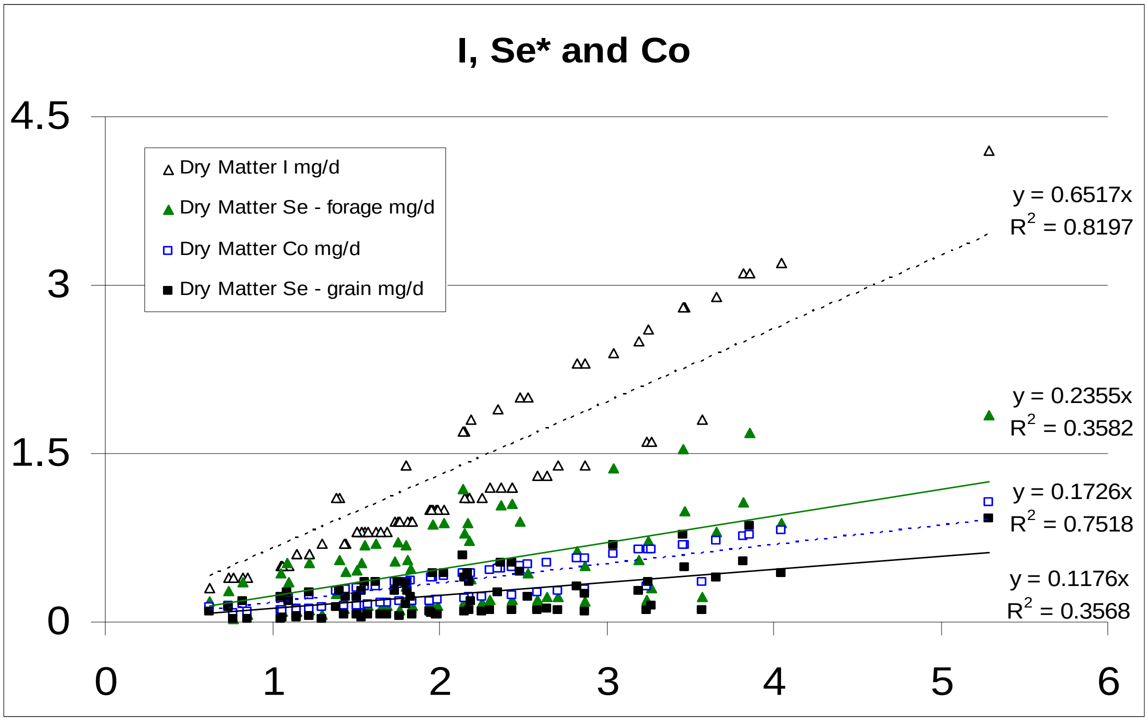
Figure 2. Daily K and S requirements in g/day correlated to DMI for common Ontario production classes.



Iodine, Selenium and Cobalt

- The regression for I provides a strong relationship of 0.65 mg/kg (0.65 ppm). However, it is clear that the values above the line are all lactating animals, all those below are the remaining classes within the data set. This compares to a range established by NRC 1985 of 0.10 to 0.80 mg/kg. The toxicity limit is unchanged at 50 ppm (mg/kg).
- Although a weaker correlation, the data shows a moderate correlation revealing 0.17 mg/kg Co requirement. This is within the NRC 1985 recommendations of 0.1 to 0.2 mg/kg, and toxicity remains at the same suggested level of 10 ppm ration
- Selenium is more troublesome in this comparison. NRC 2007 has provided two recommended levels depending on whether the diet is forage or concentrate; the apparent differences are really functions of digestibility/availability coefficients. Neither the forage nor concentrate recommendations correlate well to DMI. The requirement in NRC 2007 has been restated as 0.1 to 0.3 mg/kg with an upper toxicity of 5 ppm. This compares to the range and toxicity NRC 1985 suggested of 0.1 to 0.2 and 2 ppm respectively

Figure 3. Daily I, Se and Co requirements in mg/day correlated to DMI for common Ontario production classes to yield ppm (mg/kg) equations.

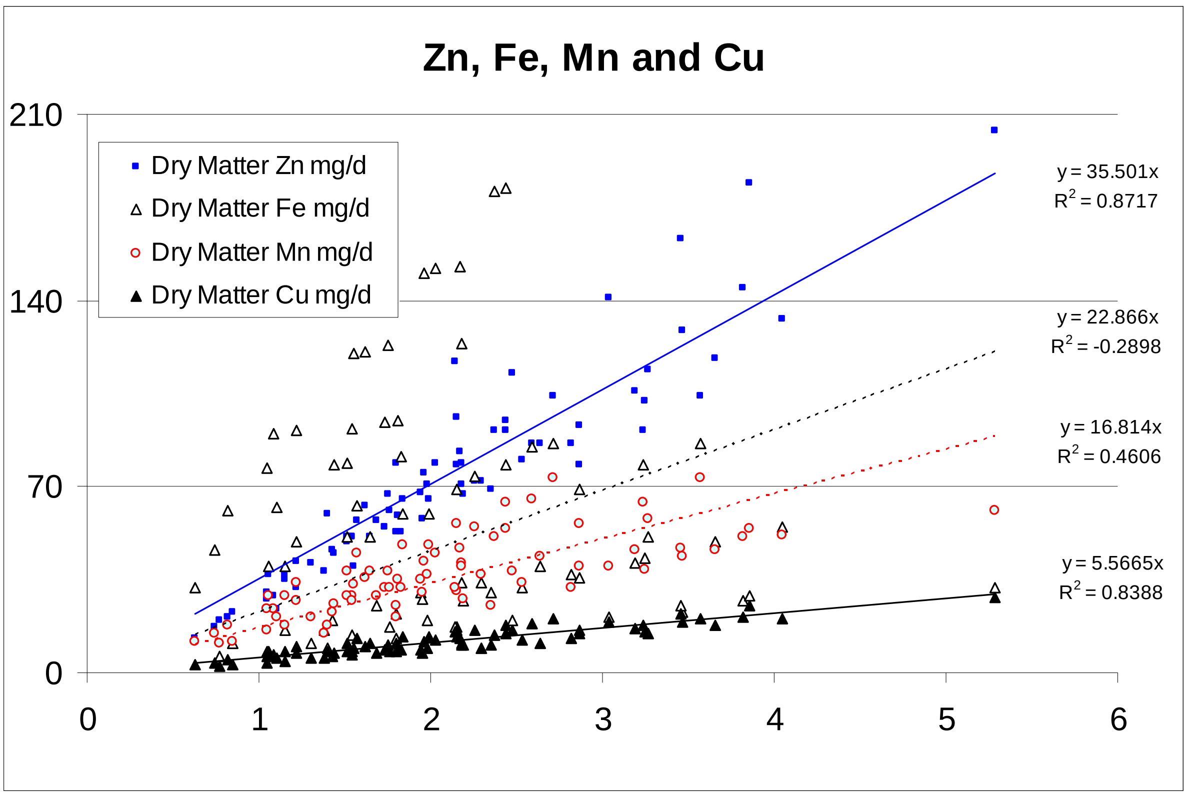


Zinc, Iron, Manganese and Copper

- Zn levels are well correlated to intake in the Ontario production classes at 36 ppm for NRC 2007 data. This is higher than NRC 1985 suggested at 20 to 33 ppm. Toxicity threshold has been reduced from 750 mg/kg or ppm in NRC 1985 to 300 mg/kg in NRC 2007
- Iron (Fe) recommendations bear no relationship to intake, rather are a function of production stage. Fe levels are highest for growing animals (approaching 75 ppm), intermediate for gestating animals (20-30 ppm), and lower for lactating animals (some under 15 ppm) within NRC 2007. Ultimately, these appear to be a function of tissue deposition. Previous recommendations suggested a range of 30-50 ppm (NRC 1985).

- Neither the NRC 2007 test nor these data (which suggest 17 ppm Mn) give clear guidance for rules of thumb on Manganese. NRC 1985 suggested a range of 20 to 40 ppm with a toxicity threshold of 1000 ppm. With the revision of that toxicity margin to 2000 ppm (mg/kg) for Mn, it would strongly suggest formulating in the previously recommended range, or on a case by case basis
- The threshold for Cu toxicity has been reduced to 15 ppm in NRC 2007 from 25 ppm previously. This is assuming normal Molybdenum and S levels. This 10 mg/kg reduction clearly gives direction to increase caution. At the same time, the data in the NRC 2007 regression suggests the requirement now sits at 6 ppm compared to the range of 7 to 11 ppm suggested by NRC 1985, although the 2007 document's text suggests requirement values similar to previous.

Figure 4. Daily Zn, Fe, Mn and Cu requirements in mg/day correlated to DMI for common Ontario production classes to yield ppm (mg/kg) equations.



Fluorine

- Recommendations for Fluorine (Fl) have been added for the first time
- The suggestion is that the requirement is 1.2 mg/kg diet dry matter, with toxicity occurring above 60 ppm

NOTES

TMR AND CORN SILAGE FOR SHEEP RATIONS

Christoph Wand
Beef Cattle & Sheep Nutritionist, Ontario Ministry of Agriculture, Food & Rural Affairs
Woodstock, Ontario, Canada

TMR - Disadvantages

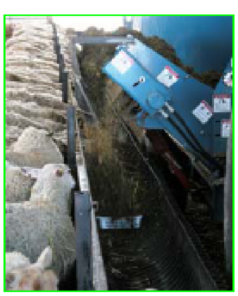
- Cost of equipment
- Ration balance point, grouping strategies
- Ration formulation, feed analyses, and silage moisture
- Limited dry hay use

Vertical Mixers – *the hay issue*

Vertical Mixers

Add 2-5% NaCl (mixing salt)

Mobile Mixer – *bunk sampling*



Pans in Bunk – *feed as normal*

TMR - Advantages

- ✓ Wide variety of feedstuffs, commodities
- ✓ Less sorting, steady state rumen conditions
- ✓ Incorporation of vitamins/minerals, additives or grain ➔ UREA
- ✓ **Improved production per unit concentrate**
- ✓ Reduced digestive upsets (acidosis, off-feed, laminitis) ?

Quasi-TMR or Poor Man's TMR:

How Does it Perform?

a


Haylage & Corn Silage

'Mix Performance' by Starch

CV = 9.34 % ✓

CS & Fat Ewes…

- Corn silage (CS) grain content appears more productive than dry corn
- I see more fat ewes than thin ones
  - Inconsistent shearing practices in accelerated flocks
  - Body Condition Score (BCS) assessment appears to be underutilized (even experienced shepherds)
  - Underestimation of the value of CS

CS and TMR

- Use of fermented feed is a labour and energy status advantage
- Look out for fat ewes; management is required
- Lots of opportunity beyond acidosis control

NOTES

MARKETING BY EWENITY DAIRY CO-OPERATIVE

Elisabeth Bzikot
Chair, Ewenity Dairy Co-operative
Conn, Ontario, Canada

Ewenity Dairy Co-operative was born immediately after the 6th Great Lakes Dairy Sheep Symposium in 2000. At that time, five Ontario dairy sheep producers met with a processor from Winnipeg, Manitoba. The plan was to jointly ship frozen milk to Manitoba more efficiently than each could individually. In fact no milk was shipped to Manitoba, but the Co-operative was incorporated in June of 2001 with five members. The aim of Ewenity was, and still is, to obtain the best returns possible for its members' milk.

All our member producers are "ideal" in that they all endeavour to produce wholesome clean milk with the knowledge that quality of the end product will improve their returns. We do not currently differentiate the price paid on the basis of components, but we are considering a premium for high solids milk.

In order to expand our market we have bought into the various trends such as the movement towards local foods, sustainable agriculture and animal welfare standards, and so have become accredited by relevant organizations. By doing this, we benefit from more exposure and also have our "genuineness" confirmed. We do not use hormones, antibiotics as a growth stimulant or genetically modified organisms, and we avoid the use of pesticides and artificial fertilizers. With this aspect in mind the farmers have been certified with Local Food Plus.

Our product range consists of a fairly wide range of soft and firm cheeses as well as yogurt and ice-cream. The aim is to provide as wide a range of products as possible to meet different demands. For example, the health food market requires basics such as yogurt and feta, but insists on vegetarian rennet. People who are intolerant to cows milk are able to enjoy the ice-cream. And the gourmet market enjoys cheese for its own sake. These more discriminating consumers are prepared to pay a high price for the right product. Here we sell our Ramembert, our Brebettes and Ewedas, all made with calf rennet.

With the advent of our own (Best Baa) processing facility, we are excited at the prospect of expanding our product range in the near future. We do our own distributing, selling and wholesaling to stores and restaurants as well as retailing at our own store and farmers' markets. We decide on the price of the products by comparing them to similar products and estimating what the market will bear. We do not aim to be the cheapest but always try to have consistently high quality and reliable delivery.

All our Co-op members have medium sized flocks (100 or so ewes) and their return from the milk is about equal to the income from the lamb sales. The Co-op has in recent years sold all its members' milk successfully.

Initially, marketing was very slow. We sold very little and the quality of the products was not always consistent. Now however, after six years of learning, we supply about sixty stores and sell retail from our Best Baa Farm store, as well as at several farmers' markets and to restaurants.

NOTES

MARKETING BY FIFTH TOWN ARTISAN CHEESE COMPANY
Handmade Fine Cheese. Sustainable Design. Prince Edward County Terroir

Petra Cooper
Fifth Town Artisan Cheese Company
Picton, Ontario, Canada

Who Are We?
The Fifth Town Artisan Cheese Company was designed to be positioned as a mid-sized artisan and niche producer of fine, high quality, hand made cheeses using fresh, locally produced goat and sheep milk. Situated on 20 acres of agricultural land on the eastern ridge of Prince Edward County, the 4600 square foot facility enhances the practice of artisan cheese making with advanced sustainable design. The project aims to be Platinum accredited under the Leadership in Energy and Environmental Design (LEED) program. The facility includes two aging caves which are underground. It is being designed to conform to Federal regulations and hope to achieve federal licensing within 6 months of our launch.

The Milk:
The facility will work with 100% fresh milk sourced from local farms. In the case of sheep milk, we plan to work primarily with fresh milk (versus frozen curd). We will be picking up the milk ourselves every other day. We expect to be processing 6000-7000 litres of goat milk per week and approx 800-1200 liters of sheep milk per week in year one. We plan to triple these levels of production in 5 years or less.

With the input of local producers who intend to supply, a milk agreement was drafted and reviewed by many others including regulators. Elements include the usual basic milk quality requirements and outlines how pick ups are handled as well as pricing. Incentives are in place for higher quality milk (low total plate count), use of non GMO feed, and for farms who achieve Certified Humane certification.

The Product:
At launch, we will start with approx 5-7 products and derivations thereof. However, over 2 years, our product line will expand to include several other fresh cheese varieties, additional soft ripened cheeses, a washed rind, as well as an expanded hard cheese line. Some cheeses will be only offered in certain seasons. As a new business, it will take us some time to solidify which cheeses we should stick with or drop. The facility was built with flexibility in mind. We can turn on a dime!

Our goal is to source all finishes including herbs, and wines or beers from county growers. Products are premium priced.

Target Market:
Our cheese will appeal to environmentally conscious "green" consumers, gastronomes, culinary tourists plus the Lifestyles of Health and Sustainability (LOHAS) segment. Distribution will occur through several channels: On site, wholesalers, internet cheese retailers, traditional retailers, fine dining restaurants, inns, and hotels.

NOTES

TODD SHEEP COMPANY

Keith Todd
Farm Manager
Lucknow, Ontario, Canada

Todd Sheep Company Inc. is owned and operated by Keith and Valerie Todd, and Hugh and JoAnn Todd (Keith's parents).

Buildings

A 50 cow tie stall farm was purchased in April 2005 and converted from a tie stall barn into a centre drive through alley suitable for feeding TMR with a feed cart. A new parlour, milk room and holding area were built and milking started in August 2005. In the fall of 2006 two new barns were constructed; a 40' X 160' barn for milking ewes and a 56' X 112' lamb barn. Both barns have automated curtains and roof vents. The milking parlour is a double 32 with rapid exit gates.

Milking Operations

Todds are milking approximately 500 ewes year round consisting of East Friesian and upgrades from Rideau Arcott. DHI milk recording is done every 6 to 8 weeks to assist with breeding stock selection. Some top ewes are now reaching as much as 1000 litres per lactation.

Lamb Rearing

Lambs are reared artificially on milk replacer fed through automatic machines. Each lamb is given approximately 3.5 to 4 square feet of pen space. Lambs are weaned off of milk at 30 to 35 days of age at which point their ration switches solely to pelletted feed. Hay is introduced at around 6 weeks of age. The lamb rearing room is heated with propane during the winter months.

History

Keith is the third generation of Todd's to be a sheep farmer. The Todds currently still have 75 meat breeding sheep where Hugh and JoAnn live. Keith was a sheep specialist with Land O' Lakes prior to the milking sheep venture. He also has livestock nutritional experience with dairy and beef cattle. Keith is an accomplished sheep judge having judged approximately 75 shows between Halifax and Vancouver.

BEST BAA FARM

Eric and Elisabeth Bzikot
Owner/Operators
Conn, Ontario, Canada

Best Baa Farm is a 150 acre family farm located in the snow belt area of Southern Ontario. We (Eric and Elisabeth Bzikot) bought the farm nine years ago after moving to Ontario from Manitoba.

We currently have 120 British Milk Sheep ewes. All feed and litter requirements for these animals and their offspring are grown on the farm. We avoid the use of pesticides and artificial fertilizers. The crops grown are alfalfa, winter wheat, oats and barley. All the work is done by us with our own equipment. The grazing for the ewes is provided by 15 acres divided into six paddocks. The sheep come home to the light and water every night as a safeguard from predators.

The buildings are adapted from a former horse barn. Milking is done in a twelve stand rapid exit parlour custom built locally. The milk is pipelined into a cooler tank and then transferred into pails and frozen and stored at -20°C.

The British Milk Sheep flock originated from embryos in 1999 (25 lambs were born). New blood is introduced by the importation of semen from the United Kingdom. We lamb our flock in January/February. The early date has provided the most milk and the lambs are robust enough to withstand the humid smog of June/July outside in paddocks. Although we intend to wean at five to six weeks of age, pressure of work prevents us from doing so until later. Even so, the ewes will produce 300 liters in the lactation ending in October.

The milk is sold through Ewenity Dairy Co-operative. The ram lambs are mainly sold for meat and most of the females are sold as replacements. Using the above methods of farming, we have been able to achieve our ambition of earning a living without resorting to large scale operations. We have more individual contact with the animals resulting in higher performance and greater satisfaction for ourselves.

BEST BAA DAIRY LIMITED

Eric, Elisabeth and Peter Bzikot
Owner/Operators
Fergus, Ontario, Canada

This plant, intended for processing sheep milk, is located in an industrial condominium in Fergus, Ontario. After three and a half years of planning and wading through red tape and regulations it made its first batch of cheese (Feta) in June of 2007.

The 2000 square feet of floor area are divided into an office and washroom, boiler room, shipping area and work area. There is also a dry-storage area. It processes milk produced by members of Ewenity Dairy Co-operative. As Ewenity supplies all its milk frozen in pails, there is a freezer for holding a reserve of milk on hand. There are also three coolers, set at different temperatures for different functions.

The central piece of equipment is a 500 litre pasteurizing vat. It is heated by a boiler using natural gas through a system of heat exchangers. During the cooling cycle, some of the heat is recovered for future use.

Currently we are producing Eweda (Gouda recipe), Feta, Ramembert, Brebettes, and Fergies. The three latter named are mold ripened cheeses. We also make a fresh cheese called Brebis Frais and an herb coated cheese for which we have not yet decided on a name.

NOTES

PARLOUR HYGIENE – SANITATION AND CLEANING

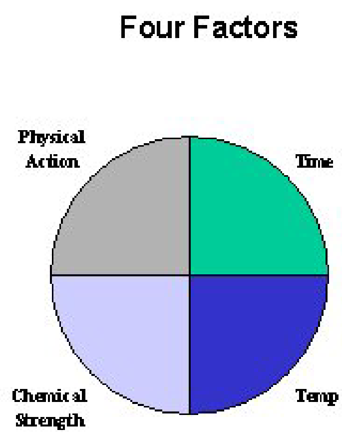
Mike Foran
Raw Milk Specialist, Ontario Ministry of Agriculture, Food & Rural Affairs (OMAFRA)
Guelph, Ontario, Canada

Cleaning Basics
In order to provide high quality milk to the market place, milking equipment must clean up perfectly after each milking. The four basics of cleaning are time, temperature, chemical concentration and physical action. These factors are important in each cycle or 'step' of a cleaning program, whether equipment is washed manually or cleaned-in-place (CIP).

Sanitation 4X4

Four Cycles of a Cleaning Program

1. Pre-Rinse
2. Hot Wash
3. Acid-Rinse
4. Sanitize



Step 1 - Rinsing milking equipment surfaces.
This step removes 90-95% of milk solids. The high solids content of sheep milk make this step particularly important. Water temperature should start between 43°C and 49°C (110°F and 120°F). If water temperature drops below 38°C (100°F) milk fat will solidify back onto the milk line. A rinse temperature above 140°F may bake on milk protein. The first rinse should be an open cycle and not re-circulate. Use of a pre-rinse divert valve will eliminate recirculation of milk soil and reduce the load that must be removed during the wash cycle.

Step 2 - Hot chlorinated alkaline wash
Dairy detergents require hot water to work effectively. The alkali in the cleaner reacts with milk fat breaking it down and suspending it in the cleaning solution. The chlorine component breaks up or 'peptizes' the milk proteins which can then be suspended in the wash solution for removal. Dairy detergents also contain sequestering agents or chelating agents which tie up hard water minerals such as calcium and magnesium. Chelating agents prevent minerals from precipitating out of solution and depositing as films on the milk contact surfaces. Dairy detergents also contain surfactants which decrease the surface tension of the solution and assist in penetrating

the milk soils. Stick to approved dairy cleaners. Over time non-dairy cleaners have been shown to be ineffective at controlling the development of films and residues on equipment.

The **start** temperature of the wash cycle should range between 71°C and 76°C (160°F to 170°F). Water temperature at the end of the cycle must be **absolutely no less than 49°C (120°F)**. Circulation time is usually 6 to 10 minutes. Adequate end temperature is more important than precise wash solution contact time.

The amount of detergent used depends on volume of water and water hardness. Hard water can reduce the effectiveness of dairy cleaning products. Most labels will specify amounts to use per quantity of water, according to grains of water hardness. A water softener is recommended for hardness over 20 grains. The pH of the caustic cleaning solution should be between 12 and 13. The active alkalinity needs to be in the 600 ppm to 900 ppm range. Bulk tank cleaning requires active alkalinity in the higher range. Your chemical supplier should provide a wash procedure chart, which reflects the types and amounts of cleaners required for each cycle of the pipeline and automatic bulk tank cleaning programs.

Water temperature is one of the first places to investigate if you run into cleaning and/or bacterial problems. The water heater needs to be adequately sized for your requirements. The actual amount of hot water available from a tank is about 70% of its capacity. Using hot water for other uses (e.g. mixing milk replacer) can reduce the availability of hot water for pipeline washing. Recovery rates will vary depending on your specific heater. The time between a pipeline wash and a bulk tank wash needs to be long enough to allow the water heater to recover. Water heater problems can go undetected for a long time if you do not monitor wash temperatures. Calcium and magnesium salts can accumulate in water heaters and reduce heating capacity to below adequate. A burnt out bottom element is a frequent problem. Buildups in water pipes and screens can also restrict the flow of water to the wash control box causing improper temperatures at the wash sink.

Unplanned admissions of air into the milking system cools wash water very rapidly and may cause poor slugging action. Maintain water level in wash sink so that suction lines never draw air. The pipeline must also be free of air leaks at joints and milk inlets.

Physical action or ‘slugging’

Most modern pipeline systems rely on slugs of cleaning solution, making full contact with the inside circumference of the pipeline, to provide scrubbing action. If your system has an air injector, proper adjustment is essential to ensure adequate contact and velocity of circulating solution. The air injector open time determines the distance traveled by the slug. The open time should be just long enough to cause the slug to travel to the receiver jar before it breaks up. The air injector closed time determines the amount of water drawn in and initial slug length. Slug volume should be about 1/3rd the volume of the receiver. Slug velocity needs to be 25 to 30 feet per second. The following signs indicate there may be an issue with the air injector location or timing:

- The water level in the receiver does not change during the cleaning cycle
- The milk pump never shuts off during the cleaning cycle

- The system “traps out” (the ball valve in the sanitary trap shuts off system vacuum during one or more wash cycles)
- A large volume of water drains from the distribution tank when the vacuum pump is shut off after cleaning
- Air is drawn into the system at the wash sink.

Drainge is important
Wash temperatures as well as chemical concentrations can be adversely affected by residual water from previous cycles. All secondary drains, especially from the receiver must be large enough to drain completely before the next cleaning cycle. All milk lines and wash lines need adequate and continuous slope to allow for complete drainage between cycles. Inadequate drainage in the system results in mixing of solutions between cycles thereby neutralizing or diluting cleaning chemicals as well as affecting solution temperatures. Poorly drained equipment encourages bacteria growth between milkings.

Step 3 – Acid rinse
This cycle neutralizes alkali residues and prevents mineral deposits. The acid rinse leaves the pipeline with an acidic pH (pH 4.0 or less) which suppresses bacterial growth. Water temperature is not critical in this cycle but should comply with label recommendations as posted on the wash chart. An acid rinse also increases the life of inflations and gaskets. If an acid rinse is not completed, rubber ware starts to ink quickly.

Step 4 - Sanitize
This cycle is completed to eliminate bacteria that may grow on equipment surfaces between milkings even after being well cleaned and acid rinsed. The sanitize cycle should be completed just prior to milking, but after installation of an inline milk filter. The cycle time is 3 to 4 minutes.
Types of sanitizers:

- **Chlorine** is the most popular dairy sanitizer. It has activity at low temperatures, is relatively cheap, leaves minimal residue or film and has broad spectrum effectiveness. Chlorine is minimally affected by hard water. A maximum of 200 ppm chlorine should be used just prior to milking. The major disadvantage to chlorine is corrosiveness, which is accelerated at high temperatures. Avoid using hot water in the sanitize cycle, cold or tepid is acceptable. The activity of chlorine is reduced by organic load and by alkaline pH. **Note - Chlorine sanitizers must never be mixed with acid cleaners because of the production of deadly chlorine gas!**

- **Iodine** also has broad spectrum microbial activity. Iodine sanitizers mixed with a surfactant are termed iodophores. Organic matter has less affect on iodophores than on chlorine. Iodophores have more residual activity than chorine. A concentration of 12.5 to 25 ppm is recommended for iodophore sanitizers. The major disadvantage of iodine is that it can cause staining, particularly on plastics. Iodine vaporizes at temperatures above 120ºF / 49ºC. Loss of activity is pronounced at high pH.

- **Peroxyacetic Acid** (PAA) is stable at use strengths of 100 to 200 ppm. These sanitizers are non-corrosive and tolerate hard water. PAA solutions have been shown to be useful in removing biofilms. PAA solutions have a pungent odour. The disadvantage of peroxyacetic acid is the cost.

Bulk Tank Cleaning

Bulk tank cleaning involves the same cycles and temperatures as pipeline cleaning. Often bulk tanks are a more difficult vessel to clean than a pipeline. Achieving a 120º F / 49ºC end temperature of the hot wash can be challenging. Automatic bulk tank washers deliver a spray of cleaning solution which sheets over the surface. There is much less shear force or physical action as compared to pipeline slugging. The sprayball or jet tube must deliver cleaning solutions to all interior parts of the bulk tank. Watch for plugged spray heads and incomplete drainage between cycles.

Listed below are areas where cleaning problems frequently occur in bulk tanks:

- outlet and valve
- plug and plunger rod
- under the bridge and lid
- dipstick and dipstick socket
- corners of a square tank
- agitator paddles

Residual Films

Cleaning failures usually result in a visual buildup or residual film in some part of the milking equipment. There are two broad categories of residual films:

- **Organic Films** are usually composed of fat and/or protein. Beads of water hanging on the top side of the pipeline or receiver jar may indicate a fat film. Protein films can appear as a blue rainbow colour or, a brownish slime (applesauce) when mixed with milk fat. Organic films are alkaline soluble. Protein films are chlorine soluble.

- **Inorganic Films** are typically hard water minerals such as calcium, magnesium and iron. Mineral films have a rough porous texture and are invisible when wet. Inorganic films are usually acid soluble.

Films can often be diagnosed by scrubbing a small area with concentrated acid or alkaline solutions.

- **Microbiological films** can form under certain conditions. These films are called biofilms and can be very difficult to remove. Often there is no obvious residue but the stainless lacks the sheen of a clean surface and may appear a dull grey colour. A group of bacteria known as pseudomonads are often linked to biofilms. Cleaners and sanitizers with strong oxidizing properties, such as those containing peroxyacetic acid, have proven to be effective in biofilm removal.

Observe Cleaning Cycles

If a cleaning problem is suspected begin troubleshooting the simplest things first. Observe one complete cleaning cycle (pipeline and bulk tank). Note times and temperatures of each cycle. Verify amounts of cleaners used and if possible chemical concentration (ie pH).

A hand held thermometer is essential. A visual inspection of the milk contact surfaces requires a strong flashlight and is particularly important for bulk tank examination. Remember stainless steel usually looks clean when wet. Allow surfaces to dry prior to visual inspection.

Planning a Parlour

Keep it compact. Parlour design should minimize milkline, washline and airline lengths. Every extra foot of pipeline increases the chances of complications arising for cleaning. The length of pipeline from the milkhouse to the parlour needs to be minimized. This will reduce heat loss during cleaning and reduce water volume requirements. Milkline diameter does not need to be larger than 2” for dairy sheep.

Keep it simple. Additional components such as milk meters can be difficult to clean. These can be valuable management tools however be prepared to deal with cleaning complications.

Milk Quality Infosheet: Pipeline Cleaning System Guidelines

Cycle	Purpose	Temp. Range	Management Tips
1st - Pre-rinse Milkline	• removes 90-95% of milk solids • removes residual milk and dirt • warms up milk line	• warm water, start temperature should be 43°C-60°C (110°F – 140°F) • temperature at the end of cycle ideally should be above 38°C (100°F)	• do not re-circulate water — milk fat will redeposit below (100°F)
2nd - Washing the Milkline with Chlorinated Alkaline Detergent	• removes fat, protein and other organics, including a large number of bacteria	• start temperature of wash cycle should be 71°C-76°C (160°F-170°F) to dissolve fat in milk line • water to be no less than 49°C/120°F at end of wash cycle	• amount of detergent depends on volume of water used and water hardness • follow manufacturer's recommendations as written on milk house wash chart • pH of cleaning solution used during wash cycle should be between 11-13, and its chlorine content from 100-200 ppm • minimum 20 slugs/wash • flow rate of 7-10 m/sec or 23-33 ft./sec.
3rd - Rinsing the Milkline with Acid Rinse	• removes detergent residues • prevents build-up of mineral deposits • lower pH levels inhibit bacterial growth between milkings • helps keep rubber parts in good condition	• water temperature must comply with manufacturer's recommendation as posted on wash chart	• acid rinse pH should be between 2.5-3.5 • never mix an acid detergent with a chlorine-based product — mixing could produce an extremely toxic lethal gas
4th - Rinsing the Milkline with a Sanitizer	• To disinfect system prior to milking	• warm water 110°F – 140°F (43°C – 60°C)	• use a solution containing 100-200 ppm chlorine • run cycle just prior to milking **(no more than 30 minutes prior to milking)** for 3-4 minutes.

References:

Reinemann, Douglas J. Dairy Operators Guide to Milking Machine Cleaning and Sanitation, NRAES Conference, January 2001.

Reinemann, Douglas J., Grea M.V.H. Wolters, and Morten Dam Rasmussen, Review of Practices for Cleaning and Sanitation of Milking Machines, Pacific Dairy Conference, Japan, November 2000.

NOTES

SHEEP MILKING EQUIPMENT – DOING IT RIGHT

Gerald Golem
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Tara, Ontario Canada

Introduction

Gerald Golem is a 30-year trained Bou-matic dairy milking equipment specialist who has spent the past five years exclusively working with goat and sheep milk producers. Gerald is employed by Penner Farm Services (formerly H. Nicholson and Son) of RR # 2 Tara and has extensive knowledge to share with beginner and experienced producers about milking procedures and equipment.

Presentation Topics

- V.I.P. - Vacuum, Inflations and Pulsation
- Principles of Good Milking
- Why Special Vacuum Levels
- Regulators
- Inflations - How Do They Work?
- Vacuum Line Sizing
- Milk Pipeline Sizing
- Vacuum Pump Sizing
- Stimulation

Milking Equipment

- Bucket Milking Systems
- Bucket Cluster Washing
- Vacuum and Equipment Set-Up
- High line versus Low line
- Washing Parlour Equipment
- Rapid Exit Parlours
- Milk Yield Indication

Question & Answer Period

NOTES

LAMB HEALTH MANAGEMENT – TRYING TO KEEP LAMBS ALIVE AND HEALTHY UNTIL WEANING

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Introduction

Lamb losses are often quite high in sheep production, with many studies reporting that over 20% of lambs born are either stillborn or die prior to 2 months of age. In today's markets – each lamb lost can have a value of over $100.00 as a meat animal and potentially more as a dairy animal. In a flock of 100 ewes giving birth to 1.8 lambs/ewe – this can represent an annual potential loss of revenue of $4,000 or more. A stillbirth rate of 3% and a pre-weaning lamb mortality rate of 5% are very achievable by the average producer. The presentation will outline some of the reasons that lambs die, and some specific health management practices that will reduce mortality.

Many of the topics covered below are covered in more detail in the excellent manual **Practical Lambing and Lamb Care, 3rd edition. Andrew Eales, John Small and Colin Macaldowie. Blackwell Publishing, Ames, Iowa 2004**. I strongly encourage all sheep producers to purchase and read this text.

Why Do Lambs Die?

There are many diseases that can affect the ability of the lamb to survive. Whether or not those diseases occur and how much sickness and death they cause, can vary depending on how they are managed. In dairy sheep operations, there are several different ways lambs are raised: on the dam until weaning at 30 to 60 days of age; on the dam until 7 days of age and then reared on milk replacer; on the dam only for 24 hrs and then reared on milk replacer; and finally allowed to nurse the dam only part of the day (e.g. overnight) and then restricted access so that the ewe can be milked. Regardless of type of management, there is always opportunity to reduce the level of disease and its impact on lamb survivability.

A summary of the most common diseases of lambs and the age at which they occur is given in Figure 1. It is important to note that the risk period for the lamb mortality begins well before the lamb is born. For a disease to develop, (or not develop) there has to be in place sufficient risk factors and determinants of disease. It is important to know what those factors are because that is how we plan to control or prevent disease by changing to factors to favour the animal's health. Table 1 categorizes the important diseases of young lambs and some of the risk factors that are important in determining whether disease occurs. They are divided into risk factors and determinants of the host, (i.e. the lamb); the agent (e.g. an infectious agent or a nutritional component); and the environment.

What is Health Management?

It is those procedures that are performed to reduce the risk of:

1. The animal developing disease even though disease exists in the flock or farm, i.e. reducing the amount of disease in a group of animals.

2. Modifying the risk factors that influence whether the disease develops in an individual animal or in the flock.
3. Eliminating the disease agent from the farm so that the disease cannot develop.

It can involve any or all of the following procedures: depopulation; test and remove; isolation; vaccination; prophylactic or metaphylactic medications; disinfection and biosecurity. Below is a summary of health management procedures designed to reduce the risk of disease and mortality occurring in pre-weaned lambs.

THE GESTATING EWE

Control of Abortion Diseases:

If the annual abortion rate in the flock exceeds 5% of pregnant ewes, or if several ewes abort in a short period of time, it is important to have those abortions investigated by the flock veterinarian and the local diagnostic laboratory. Control measures must be targeted to the disease that is causing the problem, so do not institute these measures without a diagnosis. Some of the more common health management strategies are:

- **Use of a vaccine** to control abortion due to *Chlamydophila abortus* or *Campylobacter fetus* or *jejuni*. The vaccines are boostered annually usually before breeding.
- **Use of antibiotics** in late gestation to control some of the infectious causes of abortion. The risks of using long term antibiotics are residues in the milk after lambing and the development of antimicrobial resistance. Consult your vet.
- **Control of toxoplasmosis** by reducing kittens in the barn and fields, by preventing soiling of sheep feed, pasture and bedding with cat feces, and by feeding an ionophore such as monensin (15 mg/head/day) or decoquinate (2 mg/kg bw / day) throughout gestation. This must be done by veterinary script (Canada).
- Assure that the gestating ewe diet contains **adequate iodine** and that it is fed so that the ewe consumes adequate amounts, e.g. added to ewe supplement or incorporated into a salt mineral premix.

Optimizing the Birth Weight and Fat Stores of the Newborn Lambs:

The last trimester of pregnancy is critical for the lamb when it does most of its growing. Being short-changed during this period will cause the lambs to be born small (< 3 kg birth weight) and with insufficient fat stores to give it energy to get up and nurse. This is special fat, called brown fat and – in a lamb born to a well fed ewe in a warm environment, can supply its energy needs for over 12 hours. If fat stores are inadequate, the lamb may starve out in as little as 5 hours and in less time if the environmental conditions are cold.

- **Pregnancy Scanning**. There is an obvious benefit to knowing if a ewe is pregnant or not. Also avail yourselves of the expertise that we have in Ontario with respect to scanning for fetal numbers. This will help to formulate rations that are appropriate for the number of fetuses being carried. Don't over feed the ewe carrying a single as birth weight may be high enough to cause a difficult lambing. Don't underfeed the ewe carrying multiples as those lambs will be small and thin and much more at risk of hypothermia and hypoglycaemia.
- **Increasing Energy and Protein to the late gestation ewe**. Much has been written on the proper nutrition of late gestation ewes. It is critical not only for lamb growth but also udder development and manufacture of colostrum. As well, ewes that enter the last month of

pregnancy in poor body condition are also prone to developing pregnancy toxaemia and may have other metabolic diseases which interfere with lamb health.

Optimizing Quality and Quantity of Colostrum Produced by the Ewe:
The lamb must get its neonatal immunity from the ewe's colostrum. If the quantity is sufficient without quality, the lamb may still not be protected. Some strategies are:

- **Vaccination of the ewe against pulpy kidney and tetanus.** This must be done on an annual basis with a multi-way vaccine for clostridial diseases. The vaccine when first given, must be given twice – usually about 4 to 6 weeks apart (read the label!), and then boostered annually. This booster is best given 4 to 2 weeks prior to the first expected lambing date. Vaccinating later means that the colostrum is already in the udder and the vaccine will not improve the level of protective antibodies for the lamb. The vaccine should contain antigens of *Clostridium perfringens* type D (pulpy kidney) and *Clostridium tetani* (tetanus). The vaccines contain many more antigens but those are the most important for lambs.
- **Shearing** of the ewe can be done at the same time at vaccination as long as the ewe has protection from wind and cold for a few weeks. Shearing has many benefits: it increases the amount the ewe eats so that the fetal lambs will be a better size when born; the udder and rear of the ewe are cleaner so that the lamb doesn't get a mouthful of manure-coated wool tag when looking for the udder; it reduces the humidity in the barn which is a risk factor for lamb pneumonia; and it keeps the udder cleaner for milking later on. Some dairy breeds have no wool on the tail but shearing is still beneficial for them as well.
- **Control of mastitis** during the dry period will not only improve colostrum production but also the subsequent lactation of the ewe. Stocking density and ventilation is important during lactation and these same rules should be applied to the late gestation ewe. Stocking density of 2 m^2 per ewe; an airspace of 7 m^3 per ewe; with a ventilation rate of 47 m^3/hr has been shown to improve udder health and milk production of dairy ewes in Italy. Treatment of the ewe during the dry period can be done with intramammary infusion products or with injectable tilmicosin. Consult your veterinarian regarding the advisability of using these extra-label products in your dairy flock.
- **Nutrition of the ewe** – as above – is critical to the lamb's growth in utero. White muscle disease, caused by a deficiency of selenium and vitamin E, can be prevented in the neonatal lamb by proper supplementation of the ewe during pregnancy. Selenium will cross the placenta right into the lamb during pregnancy whereas vitamin E needs to be ingested from the colostrum. With proper supplementation of the ewe, there is no need to inject lambs. Work with your nutritionist to make sure the correct amounts are in the ewe's ration.

Management of Dystocias (Difficult Births):

- Know when your ewes are going to lamb. This can be done by:
  - Restricting the time the ram is with the ewes
  - Using a ram marking harness and recording breedings
  - Having the ewes scanned and estimate fetal age
  - House the late pregnancy ewes close so appetite and behaviour can be closely monitored
  - Observe the ewes at least once / day for udder development starting ~ 1 week before first expected lambing date.

- Keep lambing supplies on hand including gloves, sterile lubricant, lamb puller etc. Be clean and use a disinfectant soap, gloves and lots and lots of lubricant. Review management of dystocia with your vet if not experienced.
- Observe ewes as frequently as can be managed, i.e. at least every 4 to 6 hours. This includes the middle of the night. Although it is advantageous to have ewes that "do it on their own", you have already invested considerably in keeping the pregnant ewe bred, housed and fed – the lamb is your profit! If she needs assistance, cull her after the lamb is weaned or at the end of her lactation.
- Intervene if
    - Only part of the lamb appears, e.g. only the head, just the tail, just one leg.
    - After the water breaks, there is no progress for 30 minutes
    - The ewe has been lambing for more than 90 minutes.
- Be gentle! It's very easy to cause damage to the lamb or ewe.
- If you cannot feel the lamb (e.g. closed cervix) or gentle manipulation will not correct or produce a lamb, call your veterinarian.
- A lamb delivered from a prolonged or assisted lambing is at VERY HIGH RISK of mortality from hypothermia / hypoglycaemia and should receive special attention. Remember, every weaned lamb is worth money – now more than ever. Your efforts will be rewarded.
- Resuscitation of the newly delivered lamb that is not breathing can be done by clearing the airway and reviving it. Swinging or hanging upside-down should be kept to a minimum as this put stress on the diaphragm. Rub the lamb vigorously with a clean towel. Cold water in the ear stimulates it to shake its head and breath in sharply (try it on yourself!). Mouth-to-mouth should not be done because of the risk of zoonotic disease. If you wish to try inflating the lungs, consult your vet for the best technique.

LAMB HEALTH MANAGEMENT

Improving Passive Transfer of Antibodies from the Colostrum to the Lamb

When Mother Nature is working well, the lamb will be on its feet in a few minutes, attracted to the smell of the waxy gland in the inguinal region next to the udder, and to the curve of the ewe's abdomen. These are cues the lamb uses to locate the teat. The ewe assists this process by licking and nudging the hind end of the lamb towards the teat. This stimulates a sucking response. Ideally the lamb should be ingesting colostrum within an hour of being born. But we need to be prepared to intervene if things don't go well. This may involve:

- Putting the ewe and her lambs in a claiming pen to assist with bonding.
- Make sure the ewe's udder is clean and dry. Crutching or shearing will help this.
- Checking the ewe's udder to detect mastitis and to strip the plugs from her teats.
- With a weak lamb or a nervous ewe that won't allow suckling, strip the colostrum and hand-feed the lamb. Stripping can be done by tipping the ewe up, cleaning the udder and teats and milking into a clean container. She should be able to provide a litre or more. Oxytocin can be used to help let milk down. Consult your vet for recommendations on its use. Hand-feeding can be done by bottle, or if the lamb is weak – by stomach tube. How to stomach tube a lamb can be found in many publications.
- How much colostrum is enough? If the average weight of a newborn lamb is 4 kg (slightly less than 10 lbs), and the lamb needs to ingest 20% of its body weight in the first 24 hrs of life – this means ~ 200 mL / kg bw or a total of 800 mL in the first 24 hrs. It is impossible

for a lamb to consume this in 1 feeding – but the first feeding should be ~ 50 mL / kg or 200 mL for a 4 kg lamb. If the lamb is still too weak to nurse effectively, repeat this feeding every 6 hrs for the first day.

- Make sure that in the first 24 hrs, this is the first milking colostrum only. Colostrum from a ewe that lambed yesterday contains insufficient antibodies.
- Timing is critical! The lamb can only absorb antibodies for the first 24 hrs of life – but, although this sounds like a lot of time – sooner is much, much better than later. Issues of concern are:
  - If the lamb first ingests bacteria or viruses from the environment or dirty udder, then it doesn't matter how much colostrum it ingests later – it won't be protected from their effects.
  - The ability of a lamb to absorb colostrum decreases over time so that waiting even a few hours will impair the lamb's ability to absorb antibodies.
  - Hand feeding a weak lamb may make the difference between success and failure preferably by stomach tube. Be clean about how you hand feed the lamb.
- What about using cow colostrum? It is fine with the following provisos:
  - It must be first milking colostrum only as well.
  - Use only from a healthy, older cow without mastitis.
  - Many diseases that can infect cows can also infect sheep and can be transferred in the colostrum, e.g. Johne's disease, bovine leucosis virus – so pick your "donor" cow carefully. Cows should be vaccinated against clostridial diseases if you choose to use cow colostrum routinely.
  - Occasionally cow colostrum contains antibodies that attack the lambs' bone marrow and the lambs become very anaemic within a few weeks of birth. When freezing cow colostrum, label the cow id and don't use if an issue – or pool colostrum from several cows to dilute any potential issue.
- What about colostrum replacements? There must be a concentrated source of antibodies in the product. It should use serum or colostrum as a source and have listed that it contains 100 g / litre of IgG (antibodies). Any substitute without antibodies may keep the lamb alive for a day or 2, but they generally die of septicaemia or other disease within a week or two.
- What about freezing colostrum? Absolutely. Freeze in an ice cube tray and then transfer to a labelled freezer bag. This will facilitate thawing. Use a warm water bath to thaw. Too hot will destroy the antibodies. It is best used within 6 months. If older, you will have to increase the volume to overcome the loss of antibodies.

Protecting the Lamb from Disease:

In the first 24 hours

- Colostrum intake and ewe-lamb bonding is most critical to ensuring lamb survival.
- If the lambs are to be removed at birth for artificial rearing, then it might be simpler to do this as soon as you can.
  - Make sure lamb is hand-fed colostrum as described above.

Preventing Navel Ill & Joint Ill:

  - Dip the navel in a 2.5% tincture of iodine solution (alcohol-based rather than water-based) at birth. Don't use teat dips or udder wash products. Make sure the whole navel up to belly is included. A non-return teat dipper can be used (label for lamb navels only) or a disposable paper cup (Dixie cup). Use fresh dip on each lamb.

    - If joint ill is still a problem in the lambs and navels are being dipped properly, there may be bacteria in the soil such as Erysipelas. Have the lamb joints cultured by your vet and discuss environmental clean-up or the use of prophylactic antibiotics.
- Identify the lamb by ear tag or paint branding and record.
- Weigh the lamb and record.
- Record any particulars with regards to difficulty of lambing, health of ewe, status of litter-mates.

Preventing White Muscle Disease:
- If the ewe has not been properly supplemented with selenium and vitamin E during pregnancy, the lamb can be injected at birth with a suitable product. Do not inject in the muscles of the hind leg as this may damage the nerve. Inject under the skin of the neck with a sterile needle. Read the label directions and only use if it indicates it is appropriate for new-born lambs. Use the label dose only (e.g. ¼ cc of 3 mg Se / ml product)!
    - There have been several cases of over-dosing newborn lambs at birth with selenium and vitamin E. This will result in death.
- After 24 hrs when the lamb has consumed adequate colostrum and only if it is strong and healthy:
    - Tail dock breeds with long, woolly tails.
    - Castrate if males are to be raised for meat and kept over 5 months of age into the fall.

In the First Week of Life

Artificially Reared Lambs:
- Hand feed 3 to 4 times per day for the first few days if weak. Each feeding should be at 50 ml/kg bw. Keep in a warm, draft-free location in the barn that can be frequently disinfected if diarrhoea should develop. Although a head lamp is great to help dry off lambs after birth, do not use afterwards as this will encourage piling and may lead to pneumonia.
- If strong at 3 days, move to a lamb bar but continue to pay close attention to the lambs' feeding behaviour. The care you take now to make sure the lamb gets up and suckles from the lamb bar, will pay back in improved lamb survival and growth.
- Only use high quality milk replacer products developed specifically for lambs (e.g. 22% milk protein and 28% fat). Cow milk and calf milk replacer doesn't have enough energy for lambs.

Preventing Hypothermia / Hypoglycaemia:
- This disease can be prevented if the lambs are drinking enough (see above) and are in an environmentally suitable area (draft free and dry).
- Stocking density, airspace and ventilation is critical as outlined previously above.
- If with dams, keep lambs < 7 days close so they can be observed frequently (4 times per day) for abomasal fill and attitude. If the lamb is empty, wrinkled and tucked-up then prompt treatment using the Moredun method[1] will save many lives.

Preventing Abomasal Bloat:
- Feed cold and free-choice to reduce gorging too much milk at once. Feeding free-choice will increase intakes as well as growth rates and decrease losses from bloat.
- Adding 1 cc of 37% formalin to each litre of milk will reduce the growth the bacteria in the milk but may also reduce intakes.

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[1] http://www.omafra.gov.on.ca/english/livestock/sheep/facts/info_hypobroch.htm

- Work has been done on feeding acidified milk to kids (adding formic acid to obtain a pH of ~ 4.5) and a fact sheet describing how it has helped kid rearing is published at: http://www.omafra.gov.on.ca/english/livestock/goat/news/dgg0604a2.htm. This is to decrease bacterial growth in milk that is fed free-choice in a lamb bar.

Preventing Diarrhoea:

- Diarrhoea disease agents are shed by the ewe and build up in the environment over the lambing season. When a lamb becomes ill, it sheds even more of the disease agent and contaminates the lambing pen and wherever else it is housed.
- Control of diarrhoea is a function of optimizing passive transfer of antibodies, keeping the environment clean and preventing exposure of newborn lambs to the disease agent from the older lambs.
- **If an outbreak of diarrhoea occurs:**
    - Move pregnant ewes into a new lambing area and;
    - Clean and disinfect the old lambing area before using again;
    - Do not add newborn lambs to the pens containing sick lambs but start a new area that is clean;
    - If possible, have different people tend to the affected pens of lambs from the newborn lambs. If not, then have different coveralls between groups and wash hands with a disinfectant soap (e.g. chlorhexadine).
    - Any equipment used between groups of affected and healthy lambs should be disinfected first.
    - Diarrhoea can be treated with oral electrolytes used in treating calf diarrhea. Consult your veterinarian on how to do this.

Up to Weaning

Preventing and Controlling Pneumonia:

- As listed in table 1, the risk factors for pneumonia in lambs are not difficult to understand. The organisms responsible for making the lamb sick are already present in most animals, but the environmental conditions and general lamb health can determine if the animal gets sick or not.
- What is difficult is observing lambs closely enough to determine if they are ill. If you jump in the pen, then even a very sick lamb may jump up and run away.
- Watch from outside the pen and observe abnormal behaviour and stance that may indicate it is sick, e.g. tucked up, separated from the group, not up at lamb bar or feeder when other lambs are, head down.
- What you often won't see in the acute stage of the disease is heavy breathing, nasal discharge and coughing – those come later after the lamb has been sick for 3 to 5 days (if it is still alive).
- Catch the lamb and take its temperature. A normal temperature for a lamb is 39 to 39.5^0 C. (about 103^0 F.) If the temperature is 40^0 C or above (104^0 F.) then the lamb has a fever. Set up a treatment protocol with your veterinarian on how to treat lambs with pneumonia.
- Treating lambs with antibiotics in the feed or water is often done but has significant risks: Lambs that are ill don't eat or drink enough to get a therapeutic dose so are under treated. Using that antibiotic often will result in resistance and it won't work when you really need it.

Preventing and Controlling Coccidiosis:

- There are few – if any – flocks that do not have some level of coccidiosis in the lambs. Like neonatal diarrhoea, the disease agent builds up in the environment so that new lambs, housed with older animals are more likely to develop severe disease.
- The following measures will help to reduce the oocysts (eggs) in the environment:
    - Lambing area should be cleaned and disinfected prior to lambing.
    - If on pasture or dry lot, consult your veterinarian about scripting in a coccidiostat to the late gestation ewe ration (Canada only) to prevent ewes from shedding oocysts around lambing time.
    - Make sure feeders (hay and grain) are designed so lambs cannot defecate into them. Make sure water source is clean and free of manure contamination. Fence off manure piles and any runoff or low lying wet areas of the dry lot or pasture.
- Lambs should be offered a palatable creep feed from 2 weeks of age with a coccidiostat scripted into it. Bovatec is licensed for lambs in Canada and the USA and works well if lambs consume sufficient to receive a therapeutic dose of 1 mg/kg bw of lasalocid. Deccox is not licensed for lambs (active ingredient is decoquinate) but can be prescribed by a veterinarian (Canada). Never mix these drugs into feed at home, but rather have them incorporated into the feed at a mill so that the mixing is even and the drug cannot settle out.
- If you are concerned that the lambs are not eating enough creep to get a therapeutic dose of the coccidiostat, weigh the lambs to get an average weight for the group, weigh the amount of feed being consumed on a daily basis and calculate the actual dosage they are eating. There are ways to increase intake of creep ration but lambs < 30 days of age that are nursing ewes are difficult to convince sometimes to eat grain rather than mother's milk.
- Consult your veterinarian if it appears that your coccidiostat is not working, i.e. lambs > 5 weeks have diarrhoea, pasty stools, are poorly grown and pot bellied and feces submitted for parasite numbers show very high counts of oocysts.

Controlling Gastrointestinal Parasites in Pre-Weaned Lambs:

- Only lambs at pasture or a dry lot with grassy sections that allow grazing, are at risk of being infected with gastrointestinal nematode parasites. Lambs raised indoors or during the winter months are not at risk.
- Because of the risks of parasites developing resistance to drenches, do not treat the lambs (or ewes) unless it is necessary to control disease.
- Ewes increase shedding of parasite eggs at lambing and so contaminate the environment for the lambs (peri-parturient egg rise). If lambing at pasture can be avoided, then this contamination can be confined to the barn or drylot.
- Because it is important not to over treat and to monitor the infection in the lambs and ewes, have your vet involved in any program. Monitoring is best done by taking fecal samples from your lambs, i.e. individual packets of fresh feces from 8 to 10 lambs of the group. The vet or laboratory will perform fecal egg counts and give you an idea if treatment is necessary.
- The de-worming must be done accurately, i.e. calculated on the actual weight of your lambs (dose to the heaviest lambs in the group) and administered using a drench gun that is calibrated correctly. Under dosing will result in resistance to the dewormer. Use drugs which are licensed for sheep or prescribed by your vet.

- It is important not only to consider the infection in the lamb but the refugia (egg and larval load) on pasture. Eggs can survive over winter under the snow and the infective larvae can survive for over a month during warm and moist weather.

Preventing Urinary Stones in Lambs:

- Most stones in young lambs are due to too much phosphorus and not enough calcium in the diet and are not common when still receiving milk or milk replacer.
- Signs may appear like constipation, i.e. straining as well as depression. Treatment is often unrewarding.
- Calcium phosphorus ratio of the diet should be ~ 2:1 and lambs must have fresh, palatable water all the time. Addition of sodium chloride to the diet will help increase water consumption. Vitamin A should be added to the diet if no fresh forages are available.

Preventing Pulpy Kidney in Lambs:

- The spores of the bacteria *Clostridium perfringens* type D are very common in the environment so lambs are always at risk of this disease – which most commonly presents as sudden death and rarely as a lamb with neurological signs.
- If the ewes are properly vaccinated as outlined above, then the lamb is protected through the antibodies in the colostrum, until about 3 months of age.
- At that time all lambs that will be retained past 4 months should be vaccinated with a multi-way clostridial vaccine – exactly according to the label recommendations. Lambs that will enter the breeding flock will need to receive a booster once/year to remain protected.

Summary

Lambs are a bonus in most dairy sheep operations but still a very important part of farm income – particularly at the prices of 2007. The effort you put into improving survivability of lambs, will pay back many times.

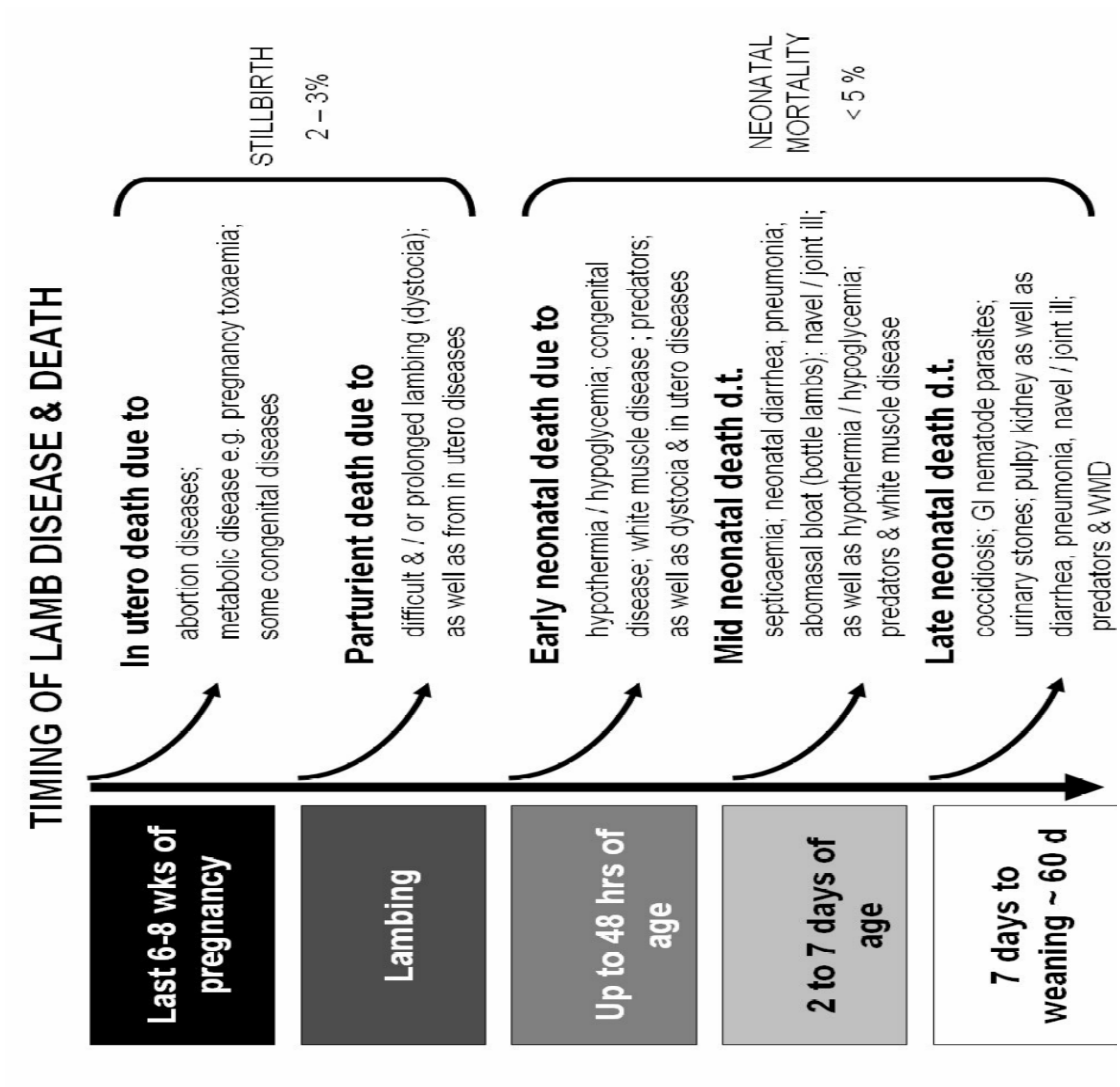
Table 1. Determinants of common diseases of pre-weaned lambs and predisposing risk factors.

AGENT	HOST	ENVIRONMENT
Abortion diseases resulting in abortions, stillbirths and weak lambs that are more difficult to keep alive:		
Infectious Abortion Diseases		
Presence of one or more of abortion disease agents, e.g. *Chlamydophila abortus; Toxoplasma gondii; Coxiella burnetii; Campylobacter spp*	The ewe is infected during or prior to pregnancy and has no immunity to these diseases, thus allowing infection of the foetal lamb to occur.	The lambing grounds become contaminated. Carrier sheep are mixed with naïve ewes. Other hosts (e.g. cats, birds, rodents, etc) bring the disease into a group of naïve ewes.
Iodine Deficiency Abortion		
Low dietary iodine	Pregnant ewe has normal dietary need for iodine.	Iodine source not present, not palatable or easily consumed. Increased iodine needs from some diets.
Dystocia (difficult lambing)		
	Too large fetus; ewes too small, too fat; too thin; ewe has metabolic disease, e.g. pregnancy toxaemia, hypocalcaemia	Inadequate observation of lambing ewes; untimely or improper intervention if slow to lamb.
Hypothermia / Hypoglycaemia (chilling / starvation)		
	Low birth weight (< 3 kg); high birth weight (> 5 kg); weak from abortion disease; weak or injured from dystocia	Inadequate late gestation nutrition; mis-mothering (behavioural, mastitis, lack of claiming area); inclement weather; dirty, wet environment.
White Muscle Disease		
Sufficiently low dietary selenium (Se) & or vitamin E so that disease occurs	Growing lamb has normal dietary need for Se and vitamin E without which its physiology cannot operate normally. Free radicals accumulate and damage muscle.	Ontario has inadequate soil Se so that feeds also have inadequate Se. Vitamin E degrades in stored forages after 1 month. The pregnant ewe & /or growing lamb is not properly supplemented either through the feed or injection to meet needs.
Septicaemia		
Opportunistic bacteria present in environment, feces or carrier animals, e.g. *E. coli, Staphylococcus aureus, Streptococcus spp, Erysipelas*, *M. haemolytica*.	Inadequate colostrum intake in the first few hours of life to provide protection of the lamb in the neonatal period. Lamb may be weak from other disease (abortion) or	Poor gestational nutrition, mastitis, mis-mothering may also contribute to inadequate colostrum quality and quantity and thus intake. Dirty environment, failure to disinfect

AGENT	HOST	ENVIRONMENT
	dystocia and so isn't aggressive about nursing. The bacteria may enter through the umbilicus or through the oral cavity.	the umbilicus (navel) allow for access of opportunistic bacteria.
Navel Ill / Joint Ill		
As with septicaemia	As with septicaemia but the lamb may have had enough colostrum to prevent septicaemia. Usually the bacteria enter through the umbilicus & may circulate to different organs such as the joints, liver, lungs & / or kidneys.	A dirty environment and an open, unprotected navel are the dangerous combination as with septicaemia.
Neonatal Diarrhea		
Presence in the environment of the lamb of one or more of the following disease agents that cause diarrhea: diarrhea causing strains of E. coli; rotavirus; coronavirus; cryptosporidia	Neonatal lamb with a naïve immune system. *E. coli* usually affects lambs 2 to 7 days of age, whereas the others can cause disease 2 days up to 3 weeks of age. Inadequate colostrum quality or quantity intake may contribute.	Build-up in the environment of these disease agents, particularly in the lambing and neonatal lamb housing area. Mis-mothering may contribute. If workers don't practice hygiene and biosecurity can be transmitted from sick lambs to newborn lambs.
Pneumonia		
Presence of opportunistic bacteria in lamb. *Mannheimia haemolytica* is resident in the throat of lambs but doesn't cause pneumonia without other factors. *Mycoplasma ovipneumonia* is also carried by sheep but doesn't cause disease without other factors. Viruses such as RSV or PI3 may contribute but usually not to severe pneumonia.	Young lamb with a naïve immune system. Inadequate colostrum quality or quantity intake may contribute. If stressed from another disease (e.g. coccidiosis, orf / soremouth) or inadequate nutrition, may weaken the lamb's ability to fight off disease. Lambs are usually older than 1 week but no upper age limit on susceptibility.	Environmental risk factors are many including: ammonia build-up from dirty wet bedding, temperature fluctuations, high stocking density, high humidity, drafts, insufficient air changes, inclement weather, transportation, mixing of groups of animals, shearing in cold temperatures, sudden feed changes.

Abomasal Bloat		
Presence of Sarcina spp – a ubiquitous highly fermentative bacteria found in the soil. When the bacterial spores have a nutrient source (e.g. warm milk), they multiply rapidly and produce large amounts of gas as a by-product.	Pre-ruminant lambs usually on milk replacer which is generally less digestible than whole milk. The abomasum in lambs < 3 weeks of age is not very acidic so that bacteria can survive better than in older lambs.	Milk replacer fed warm and in such a manner that the lamb drinks large volumes very quickly. Bacteria proliferate in the warm, undigested milk in the abomasum. The gas produced by the bacteria causes sudden expansion of the abomasum and acute death.
Coccidiosis		
Presence of oocysts (eggs) in the environment of the pathogenic species of coccidia that affect lambs. Eggs can survive for long periods in moist, cool conditions (e.g. in barns and barnyards).	Sheep & lambs greater than 1 week of age that have no immunity to coccidia. Disease is seen from as young as 4 to 5 weeks of age up to yearlings, depending on the environmental risk factors. Can develop immunity within a few months but if heavily diseased may be chronically affected. If stressed (e.g. pneumonia, soremouth, transport) disease may be worse.	Environment that favours ingestion of feed or bedding that is contaminated with coccidia oocysts. This includes poor feeder design that allows defection in feed, presence of heavy shedding, chronically affected lambs, surface water contaminated with manure, shedding adults, dirty bedding, etc.
Gastrointestinal Parasites		
Presence of eggs or infective larvae of sheep gastrointestinal parasites. Presence of sheep that are shedding eggs onto pasture of these major parasites: haemonchus, ostertagia, trichostrongyle	Although lambs tend to be more at risk of becoming clinically diseased with these parasites, adults are also at risk. Need to be at pasture or in a dry lot with some vegetation.	Pasture contaminated with eggs and infective larvae. High stocking densities increase the likelihood of infection. Warm, wet weather increases survival of infective larvae. Mild, snowy winters also likely increase the survival of eggs and larvae over winter. Ewes at lambing time can be a significant source of contamination of pasture with eggs. But chronically infected lambs are likely the biggest source

Urinary Stones		
Triple phosphate stones are most common seen (white and gritty like sand – often with mucus). Less common are calcium carbonate stones (golden bebe sized).	Male lamb or adult, castrated or intact	For triple phosphate stones: diet high in phosphorus and low in calcium (e.g. grain), water supply inadequate or dirty, inadequate salt intake. For calcium carbonate: usually associated with a diet high in legumes such as alfalfa.
Pulpy Kidney		
Presence of the spores of *Clostridium perfringens* type D bacteria in the soil or contaminating the feed. This organism won't cause disease without the host and environmental risk factors.	Lambs from 5 weeks up to adults can be at risk if no immunity from vaccination. Usually not seen younger than that because of colostral antibodies. Lambs eating well are at higher risk because eating more.	Diets that are high in undigested carbohydrates (e.g. grain, lush pasture) give a substrate in which the bacterial spores grow into bacteria in the upper small intestine, which in turn produce the toxins that kill the lambs.


TIMING OF LAMB DISEASE & DEATH
Last 6-8 wks of pregnancy
Lambing
Up to 48 hrs of age
2 to 7 days of age
7 days to weaning ~ 60 d
In utero death due to
abortion diseases;
metabolic disease e.g. pregnancy toxaemia;
some congenital diseases
Parturient death due to
difficult & / or prolonged lambing (dystocia);
as well as from in utero diseases
Early neonatal death due to
hypothermia / hypoglycemia; congenital disease; white muscle disease ; predators; as well as dystocia & in utero diseases
Mid neonatal death d.t.
septicaemia; neonatal diarrhea; pneumonia; abomasal bloat (bottle lambs); navel / joint ill; as well as hypothermia / hypoglycemia; predators & white muscle disease
Late neonatal death d.t.
coccidiosis; GI nematode parasites; urinary stones; pulpy kidney as well as diarrhea, pneumonia, navel / joint ill; predators & WMD
STILLBIRTH
2 – 3%
NEONATAL MORTALITY
< 5 %

OVINE MASTITIS:
OVERVIEW OF THE DISEASE AND A GUIDE TO ITS CONTROL

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Introduction

Mastitis is the inflammation of the mammary gland. It may be caused by various microorganisms and is characterised by presence of bacteria and increased leukocyte counts in mammary secretion and from pathological changes in the mammary tissue.

Mastitis is one of the most important diseases in sheep flocks. It raises welfare concerns, it is difficult to control and it has significant economic impact. In most cases, it is the outcome of bacterial invasion into the mammary gland, through its teat. Under these circumstances, bacteria multiply and produce toxins; thus, an inflammatory reaction follows.

Reports of the disease have appeared from all countries of the world. Nevertheless, most current research is carried out in countries with dairy sheep, obviously due to the significant economic impact of the disease for dairy flocks. Nevertheless, there are still various features of the diseases, which are not known. People assume similarities between bovine mastitis and the disease in ewes. Although, this can be occasionally true, there are many physiological and husbandry differences between the two animal species. Therefore, findings should not be directly extrapolated from one species to another.

Economic impact of mastitis

The economic impact of mastitis is due to the following reasons:

- Death of sick ewes.
- Loss of one mammary gland and requirement for early culling of ewes; average annual culling rate due to mammary abnormalities is 5%.
- Replacement costs for animals culled as a consequence of mastitis.
- Veterinary expenses.
- Increased mortality and suboptimal growth of lambs.
- Significantly decreased milk yield, which can be even up to 50%.
- Reduction of milk quality, as a result of altered composition; in case of mastitis fat, casein and lactose contents in milk are reduced, therefore the cheese-making properties are of inferior quality.
- Discard of milk; presence of bacteria producing toxins noxious to humans or presence of antibiotics after treatment, render the milk unsuitable for human consumption or processing.
- Reduced fertility of affected ewes; damage to the mammary gland and the ensuing inflammatory process may affect the ewes' reproductive status.

Clinical features
In ewes, the disease occurs with a variety of clinical signs, as well as with a subclinical form, where no clinical signs are present. When taking into account the severity and the duration of the disease, one can distinguish three forms of clinical mastitis: hyperacute, acute and chronic.

The hyperacute form is characterised by mammary and systemic signs: fever (>41.0 ^{o}C), increased heart rate, indifference, lack of rumination, isolation and loss of appetite. The onset of signs is abrupt and the course of the disease very rapid. Ewes may be milked normally in the evening and found dead next morning. Usually, hyperacute mastitis results in death of the sick ewe.

In acute mastitis, mammary signs predominate, whilst systemic signs -if present at all- are mild. These are fever, isolation from the rest of the flock and lack of appetite. In > 95% of cases, only one mammary gland is affected. Initially, the mammary secretion changes; it becomes thicker or contains flakes or clots and then may become serum-like, or contain puss. Lameness is useful for identification of affected animals in a flock. The affected mammary gland is hot, enlarged and painful. The supra-mammary lymph nodes are enlarged. Frequently, there is discolouration of the skin of the udder. The skin around the teat is red, subsequently becoming blue and cold. This discolouration then extends to the whole udder skin and occasionally to the abdominal or the inner thigh skin. Sometimes, it may be accompanied by air under the skin or even expressed from the udder. Development of mastitis in the other mammary gland can also ensue.

The disease may result to necrosis of the mammary gland, followed by sloughing off a part of the parenchyma and healing characterised by ulceration. Healing of the skin can take several weeks. Induration of the mammary parenchyma or abscess formation within the mammary gland may also occur. These abscesses can result in frequent relapses of the disease throughout lactation. Chronic mastitis can lead to teat scarring and blockage, characterized by presence of a cord-like structure lengthwise into the teat and manifested by difficult expression of milk. Finally, clinical disease may turn to subclinical mastitis.

Clinical mastitis is a particularly painful condition. It causes a lot of distress to the affected ewe. In view of that, some views have been expressed that perhaps ewes in particularly severe condition or in which the diseases is considered incurable, would preferably be euthanized.

"Dry-ewe" mastitis is usually detected when ewes are examined at the end of lactation or immediately after lambing. The disease is usually manifested with intramammary abscesses, diffuse induration, nodules and cysts within the mammary parenchyma. It has a slow course with no striking features and requires a detailed clinical mammary examination for detection. Very rarely it would lead to death of an animal. Such cases may be consequences of subclinical mastitis-cases, which remained undetected during lactation, only to be found later during a subsequent thorough mammary examination.

Traditionally, in subclinical mastitis there are no clinical signs. Characteristically, bacterial isolation, increased leukocyte counts and milk yield reduction are the important features. Milk yield reduction is due to destruction of mammary epithelial cells caused by pathogenic agents. There is also significant reduction of milk fat, casein and lactose content. Subclinical mastitis can affect the sucking patterns of ewes and sucking lambs; such changes might be used to detect the disease clinically (therefore, redefining the term "subclinical").

It is noteworthy that clinical features of mastitis are not characteristic for the causative bacteria. Moreover, each causal agent may cause a variety of clinical signs. For example, changes caused by *Staphylococcus aureus* or *Mannheimia haemolytica* (the two major causal agents) are essentially the same.

The disease can occur at any point of lactation period. However, there is an increased risk for development of the disease at the week immediately post-lambing, as well as after weaning of lambs and beginning of ewe-milking.

Causative Agent
In most cases, mastitis is caused by bacteria. The most frequent aetiological agents are as below.

Staphylococci. *Staph. aureus* subsp. *aureus* is the principal aetiological agent of clinical mastitis in dairy ewes (>75-80% of cases) and an important aetiological agents in mutton-type ewes (~40% of cases). Coagulase-negative staphylococci (mainly *Staph. epidermidis* and *Staph. simulans*) are the principal aetiologic agents of subclinical mastitis (~65% of cases). The organisms are transmitted to the mammary gland during milking, from the hands of milkers or from the clusters of the milking machine.

M. haemolytica and *M. glucosida.* *M. haemolytica* and *M. glucosida* are important aetiological agents in mutton-type ewes (~40% of cases). The organism is actually transmitted from the sucking lamb (where it is part of the normal respiratory flora) to the mammary gland.

Mycoplasmas. *Mycoplasma agalactiae* is the causal agent of contagious agalactia, a serious disease causing mastitis, kerato-conjunctivitis, arthritis, pneumonia and abortion in ewes, prevalent in countries around the Mediterranean sea. Other mycoplasmas involved in mastitis are *M. bovigenitalium*, *M. bovis*, *M. californicum*, *M. canadense*, *M. capricolum* subsp. *capricolum* and *M. mycoides* subsp. *capri*. These organisms either enter the mammary gland through the teat or alternatively are transported there with the blood.

Escherichia coli. *E. coli* is responsible for most cases of mastitis in the immediately post-lambing period, when ewes are confined in lambing pens. This is an environmental organism and infects the mammary gland through the teat.

Arcanobacterium pyogenes. *A. pyogenes* is the principal aetiological agent of "dry-ewe" mastitis.

Maedi-Visna virus. Maedi-Visna virus affects the mammary gland and causes extensive induration ("wooden udder"), accompanied with reduction in fat content.

Other microorganisms. A variety of other bacteria (e.g., *Clostridium perfringens*, streptococci, *Brucella* spp., *Corynebacterium* spp., *Serratia macrescens*, *Listeria* spp.) or yeasts (*Aspergillus fumigatus*, *Candida krusei*) can also occasionally cause mastitis.

Predisposing factors
A variety of factors have been identified that predispose animals to the disease. These are summarised here below:

Environmental factors: Flies may transmit bacteria from teats of affected animals to those of healthy ones. Dirt contaminating the teats may predispose to infections with environmental bacteria. The incidence of the disease is considered to increase with presence of intense winds.

Genetic factors: The heritability of resistance to mastitis is small (h_2=0.05), therefore selection of resistant animals is very difficult. There are also some breeds, e.g., Merinos, Booroola-Merinos, Finnish-Landrace, Rambouillet, considered to be resistant to the disease. Differences between two breeds of dairy sheep in Greece, have been attributed to differences in teat defenses between the two breeds.

Anatomical factors: Increased thickness of the teat may contribute to an easier entry of bacteria into the mammary gland. Such teats may also lead to dripping of milk, which can support bacterial entry into the mammary gland.

Housing conditions: Grazing in muddy soils is believed to predispose to mastitis. *E. coli* is considered to cause mastitis predominantly in housed ewes, whilst staphylococci do not prevail in such ewes. However, confinement of ewes with a housing space of $<7\ m^2$ available for each ewe, is considered to predispose ewes to mastitis.

Milking process: An incorrect milking process or technique is the single most important predisposing factor for mastitis. Badly regulated milking machines predispose ewes to mastitis, especially at the end of lactation period, when milk yield is reduced and the machine should be appropriately adjusted. Ewes milked thrice daily may develop mastitis easier than others milked twice daily, due to the stressing of the mammary gland. Frequent milking also provides increased chances for mammary infections. Omission of post-milking teat disinfection contributes to increase bacterial infections and mastitis. Inadequate hygiene conditions during milking
(e.g., dirty hands of milkers, wrong cleaning procedures of milking system) predispose to mastitis.

Parity number: Mastitis is more prevalent in older ewes. The incidence of the disease increases as lactation period advances, presumably because chances of infection increase. The beginning of the dry-period is also a crucial period for increased infections, because a) the intrinsic defences of the mammary gland subside and b) the applicator tip of the various "dry-ewe" preparations used may promote entry of bacteria into the teat, subsequently causing mastitis.

Ethological factors: Cross-sucking by lambs (i.e., sucking of many ewes by the same lamb) predisposes to transfer of bacteria from one ewe to another. Multiple sucking of one ewe by two or three lambs predisposes to teat injuries and consequently to reduction of teat defences and mastitis. Large lambs can also injure the teats of their dams and predispose them to the disease.

Nutritional factors: Zinc-deficiency lead to impaired keratin function in the teat, thus reduced local defences and consequently mastitis. Selenium- and/or vitamin E-deficiency can lead to impaired leukocytic mobilisation and killing by leukocytes, thus facilitating development of the disease; in fact, administration of selenium to deficient ewes has helped to prevent the disease in such animals. Consumption of estrogen-rich feedstuffs or of gossypol-rich feedstuffs or of moulded feedstuffs can predispose to mastitis. In all cases, the various pathways leading to disease are associated with a reduction of ewes' resistance to pathogens.

Disease factors: There is now clear experimental and field evidence that teat lesions (injuries, viral lesions, teat bites etc.) predispose to mastitis, as a consequence of the impairment of the local defence mechanisms present in the teat. Skin chapping (observed during cold period or during improper milking technique) increases the surface of the teat surface and leads to increased numbers of pathogens, which can subsequently invade the mammary gland easier.

Transmission and pathogenesis

The majority of research on ovine mastitis has aimed to clarify the role of staphylococci and *M. haemolytica*, as these organisms are the major causal agents of the disease.

As mentioned above, the staphylococci usually enter into the mammary gland during milking. Bacteria present on the hands of the milkers or on teat cups can attach themselves on the teat apex.

M. haemolytica is part of the normal bacterial flora residing on the tonsils of lambs. During sucking and as the teat comes into contact -even for a moment- with the tonsils of the lamb, the bacteria attach onto the teat skin.

As mentioned above, teat injuries or fissures increase the total surface of the skin, therefore, the bacteria have more opportunities to attach themselves and multiply. Furthermore, the milk droplet -which usually remains at the teat end after the milking process, especially if no disinfectant is applied- can provide an excellent substrate, which helps bacteria to multiply.

In any case, the organisms attempt to invade into the teat duct, in order to colonize the epithelial cells and multiply. Subsequently, they can ascend towards the mammary parenchyma. In general, the conditions at the teat duct are supportive of the bacterial growth and multiplication. The keratin lining of the teat is composed of fatty acids and kationic proteins, which have antibacterial properties and make-up a first line of defence against the invaders. Simultaneously, the cellular defence mechanisms of the ewe are also being mobilised. It is noteworthy that this is an area, where limited work has been carried out and thus, has not been fully understood. Much of the information is assumed from similar knowledge obtained from work performed in cows.

When the invading bacteria come into contact with the resident cell population in the teat (mainly macrophages), cytokines are secreted by the leukocytes. These signal to other cells of the animal (neutrophils, lymphocytes) and facilitate their influx into the teat and the mammary tissue. Recent work has detected an area of increased cellular activity present around 2 to 4 mm from the teat orifice. This area appears to be a lymphoid follicle. The aim of that structure seems to be similar to analogue structures observed in other mucosal sites of sheep, being classified as a Mucosa-associated-lymphoid-tissue (MALT).

MALT are present in all the portals of entry of the animal (bar the urogenital tract) and play a key role in limiting infections at an early stage. In the teat (teat-associated-lymphoid tissue), it is located at the border between the teat duct and the teat cistern and consists of lymphocytes and plasma cells, which monitor all invading organisms and attempt to exterminate all invading pathogens.

Additionally, other non-specific defences also take part in the defensive process. These are the lactoperoxidase/H_2O_2 system, which is particularly active against streptococci and the lactoferrin, which is active against Gram-negative bacteria. The complement system does not seem to be of significant importance in the mammary gland of the ewe, while the immunoglobulins play a greater role in protection from pathogens, rather than acting directly against them.

Against all these host defence mechanisms, the invading bacteria have a range of virulent factors. These aim to a) enhance bacterial growth (e.g., formation of biofilms by staphylococci and attachment onto mammary epithelial cells), b) overcome the defence mechanisms of the host (e.g., presence of capsule by *M. haemolytica*, intracellular survival by staphylococci), or c) destroy these mechanisms (e.g., secretion of leukocidin by *M. haemolytica*).

Other factors also account for the outcome of the infection. For example, various innocuous bacterial populations in the teat duct compete with the invading pathogens and usually limit them, hence rendering them more susceptible to the host's defences. More significantly though, factors impeding the efficacy of hosts defences (as described above) at various levels and via various pathways are usually the ones determining the outcome of infection. Any factor, which would interfere with the defences of the host, may be crucial in the development of mastitis.

In these cases, the bacteria overpass the teat and invade the mammary parenchyma. The non-specific mechanisms and the cellular mechanisms are also present at that stage, but in most cases the pathogens seem to prevail. The pathogens can thus multiply and produce virulent factors, which damage the host's tissue. The lesions inflicted involve destruction of mammary tissue (epithelial cells and alveoli) and of venous thrombosis. There is marked leukocytic infiltration, extravasations and tissue destruction.

As the inflammation progresses, there is tissue degeneration and necrosis. These result in separation of the mammary parenchyma from the skin and the unaffected half. The lactiferous ducts can be plugged with clots of milk and inflammatory debris (dead cells, tissue parts etc.), a practical consequence of that being the difficult diffusion of antibiotics administered via the intramammary route.

In the final stages of the disease, there is degeneration and sloughing of alveolar epithelial cells. The whole mammary gland, depending on the extent of the lesions, can become necrotic.

Diagnosis

Diagnosis of the clinical disease is straightforward. Lameness of affected ewes can be useful to spot them within a flock. Their lambs appear to be hungry and usually they may attempt to "cross- suck" healthy ewes in the same pen. For a detailed examination, the ewe should be cast and restrained in that position; the mammary glands should be palpated; their shape, size and consistency should be checked. The teats must be examined to their whole length. The two mammary glands and the two teats should be compared to each other. A streak of secretion should be drawn to the gloved hand of the investigator for presence of changes. Any abnormal signs should be recorded.

Collection of a sample of mammary secretion (~ 10 mL), under strict aseptic conditions, is required for identification of the causative agent. An initial estimation of the causal agent can be performed by means of microscopic examination of a mammary secretion after Gram staining. Bacteriological examination should be performed on conventional media (e.g., Columbia blood agar) for aerobic incubation for up to 72 h. The majority of aetiological agents grow well in such conditions and hence, there is no need to include routinely anaerobic incubation or McConkey agar. Sample incubation improves the isolation rate, but on the other hand it can lead to overgrowth of contaminants or of innocuous teat flora and consequently to misleading results.

After isolation and identification, susceptibility testing of the causal agent is useful in order to support the treatment regime of the affected animal.

The diagnosis of subclinical mastitis is more difficult. As a golden rule, it has been proposed that simultaneous bacterial isolation and increased leukocyte counts in mammary secretion confirm presence of the disease. However, this is not always the case and therefore, a variety of conditions have also been described in the international literature.

The increase in somatic cell counts (i.e., leukocytes, SCC) in the mammary secretion characterises the inflammatory reaction. One should make a distinction between increased leukocyte counts in an infected individual versus a high SCC in the bulk tank milk of a flock. Therefore, it has been proposed that successive measurements and two thresholds are necessary to establish the infection status of a ewe's mammary glands. A mammary gland is defined as "healthy" if SCC are below 500,000 cells per mL in two successive samplings and as "infected" if SCC are over 1,000,000 cells per mL in two successive samplings. In all other cases the mammary gland is defined as "doubtful" and further tests are required. Based on the above and the average prevalence of subclinical mastitis in flocks, an SCC equal to 650,000 cells per mL in the bulk milk tank, reflects a 15% prevalence of subclinical mastitis in the flock. It is noteworthy that currently there is a scientific dispute between researchers for these figures; thresholds as low as over 250,000 cells per mL or as high as 1,000,000 cells per mL have also been proposed.

Although infection is the major factor affecting number of SCC in milk, there are nevertheless other non-infectious factors which can also play a role. Although their contribution is not as important as that of infectious agents, one should nevertheless have them in mind, when interpreting SCC on a flock or individual animal basis. These include: parity number (generally SCC are increased in older animals), lactation stage (SCC are increased after lambing and at the end of lactation period), litter size (SCC are increased in large litters), milk yield (SCC are increased in low-yielding animals), milking frequency (SCC are increased in animals milked thrice a day), hour of day (SCC are increased in evening milking) and milk fraction (SCC are increased in the first streaks of milk).

There are now reliable methods for measurement of SCC in milk. Of these, the electronic Fossomatic counter is the one more frequently employed. Apart from that, there are the rapid or indirect methods, which can provide an accurate estimate of the number of SCC in milk. Two indirect methods, the California Mastitis Test and the Whiteside Test, can be used.

The California Mastitis Test consists of mixing equal amounts (2 mL) of milk and a test substrate commercially available, into a specially designed paddle. The mixture is swirled and the resulting clot formation is scored as follows: "-" (negative), "trace" and "1", "2" and "3" (positive, according to degree of clotting). The test is accurate enough to be used for routine monitoring of animals in a flock, and its significant advantages are the possibility of on-farm usage and the minimal cost.

The Whiteside Test consists of depositing five drops of milk on a clean slide and then mixing with one drop of a normal NaOH solution. The mixture is swirled with a microbiological loop and the resulting clot formation is scored as follows: "0" (negative), "±" (trace) and "1+", "2+", "3+" and "4+" (positive, according to degree of clotting). The test is very accurate and cheap, but requires a basic laboratory before it can be applied.

Treatment

There is only one rule for treatment of mastitis: the combination of speed and efficacy. Treatment should start immediately after detection of the first signs of the disease and should include effective antimicrobial agents. It should be pointed out that there is a significant lack of studies specifically on ovine mastitis. Therefore, a lot of knowledge has been drawn from relevant studies in cattle and adopted accordingly for sheep.

Occasionally, the development of disease is very rapid and can cause extensive damage. Even if it is not, mammary histological lesions are evident within 2 days after infection. Consequently, early instigation of treatment is important, in order to minimise mammary lesions and to lead to restoration of health. Treatment should thus be applied with the first clinical signs.

Effective antimicrobial agents should be used for treatment. Ideally and in order to preserve susceptibility of pathogens to the available drugs, treatment should be carried out with narrow spectrum drug, specifically effective against the causal agent of each particular case. However, this may not be possible given two conflicting factors: a) the necessity for early instigation of treatment and b) the time required to perform a full bacteriological examination (including bacterial isolation, identification and susceptibility testing). Therefore, treatment can start "blindly" by means of a broad-spectrum antibiotic effective against the two major causal agents of the disease, namely *S. aureus* and *M. haemolytica*. Apart from the obvious reason, i.e. cure of the affected ewe, effective treatment is also important as a means of minimising sources of infection for other animals in the flock.

Treatment should be performed by using intramammary antibiotic tubes. There are many commercially available products, which contain broad-spectrum antibiotics or a combination of narrow-spectrum ones, which are suitable for mastitis treatment. Unfortunately, few of these products are licensed specifically for ewes. Hence, one may safely use products licensed for cows. It is noteworthy that usually the recommended dosing regimes are inadequate for complete cure of the animal and thus, it is advisable to extend them for another one to two days than the manufacturer recommends.

Systemic administration of antibiotics is indicated a) when the course of the disease is very rapid and accompanied by systemic signs and one suspects bacteraemia, which cannot be treated by intramammary antibiotics alone, b) in cases of chronic, subacute mastitis, when inflammatory debris "clogs" the duct system of the mammary gland, thus impeding full diffusion of intramammary antibiotics and c) in treating cases of mammary abscesses, which cannot be effectively treated with intramammary antibiotic administration.

When infusing intramammary tubes to ewes, various mistakes can take place and may lead to treatment failure. The most common ones are the following:
a) inadequate cleansing of the teat orifice before insertion of the tube, which can lead to introduction of new bacteria into the teat - the area around the teat orifice should be thoroughly cleaned and disinfected before insertion of the antibiotic tube for intramammary administration and
b) administration of half-tube (when using tubes for cows), believing that as the mammary gland of the ewe is smaller of the cows', it would require a smaller amount of antibiotic - however, this is absolutely wrong and only leads to underdosing, with two consequences: failure of treatment and promotion of resistance development among causal bacteria.

Although, as mentioned above early "blind" treatment with a broad-spectrum antibiotic is essential, milk samples collection for bacterial isolation, identification and susceptibility testing must still be carried out. This is helpful in improving (even at a late stage) the treatment regime, as well as in gathering information regarding the prevalence and the susceptibility patterns of mastitis causal agents in a flock.

Treatment failure in mastitis is a common event. The reasons for treatment failure are as follows:
a) delayed start of treatment,
b) use of an improper and/or ineffective drug, i.e. a drug which is not suitable / effective against the causal agent(s) of a particular mastitis case,
c) under dosing, as interruption of the treatment, with the first signs of clinical improvement - improvement of clinical signs does not imply killing of all bacteria, which can lead to a reoccurrence of the disease,
d) under dosing, as administration of less than the prescribed dose (i.e., a full intramammary tube) at each treatment point,

e) use of expired products, which thus have a reduced efficacy,
f) use of products, which have been contaminated, as a result of inappropriate storage or usage conditions,
g) contamination of the mammary gland, when inserting the intramammary tube to an inadequately cleansed teat orifice - this can result in simultaneous entrance of skin bacteria that can cause mastitis.

Supportive treatment can include non-steroid anti-inflammatory agents (e.g., flunixin meglumine), in order to alleviate the clinical signs, and thus improve welfare standards of affected ewes.

Prevention
There are no specific udder health schemes devised and appraised for dairy ewes. A lot of the available suggestions are based on similar schemes applied in dairy cow herds. However, there are distinct differences between the two species and schemes may not always be applied indiscriminately.

For ewes suckling lambs, the recommendations that can be of value are as follows:

- Reduction of stocking density, if ewes are housed.
- Improvement of the general condition of the animals, in order to maintain an effective immune response.
- Splitting of large litters and feeding lambs artificially.
- Maintenance of healthy teats. In suckling ewes, *M. haemolytica* is transmitted by lambs to the ewe, and therefore one can only hope to minimise possible transfer of bacteria and to help ewes mount an efficient defence. Healthy teats are of paramount importance in these animals, because they can limit the organism and thus protect the mammary gland. Teats with lesions (e.g., chaps, fissures, viral lesions, bites etc.) should be taken care of, in order to restore their health. Weaning of lambs should also be considered, as a means to avoid transmission of the pathogen to the ewe.

Every successful mastitis management program in milking ewes must a) present a clear financial benefit for the farmer, b) be easily comprehended by the farmers and c) be incorporated into the general management program of the flock. In general, a mastitis prevention program has two main legs: a) minimising the rate of new infections and b) decrease the severity and the duration of existing infections.

Initially, realistic targets, which can be achieved and, at the same time, improve the quality of milk produced, should be set. Within these, monitoring of the flock's performance by accurate record keeping is important.

In order to minimise the rate of new infections, the following steps should be taken:

- Pre-milking animal preparation: milk stripping, udder cleaning-drying.
- Regular maintenance of milking systems: proper settings of milking machine, regular cleaning of milking systems, regular checks by qualified personnel.

- Correct milking routine: frequency of milking, use of gloves during milking, early detection of mastitis cases, separate milking of ewes with mastitis, correct application of milking unit on the udder, correct "fall" of milking unit from the udder.
- Post-milking teat disinfection: use of effective, well-preserved preparations at the correct dilution, confirmation that all teats have been dipped.
- Reduction of infection in the environment of animals.
- Maintenance of healthy teats.

In order to minimise the severity and the duration of existing infections, the following steps should be taken:

- Effective treatment of all cases of clinical or subclinical mastitis; apart from the obvious welfare and financial reasons for treating affected ewes, effective therapy also reduces the infection within a flock and decreases the risks for infecting other ewes.
- Application of "dry-ewe" treatment at the end of lactation; "dry-ewe" treatment contributes to elimination of existing infections, to prevention of new infections and to improving milk yields at the forthcoming lactation.
- Culling of ewes with long-standing mastitis, with persistent mastitis or with recurring mastitis; there are two strategies in culling of ewes with mastitis: the first involves a drastic policy of culling any ewe which fulfils the above criteria, while the second is milder and involves culling ewes which would not respond to the "dry-ewe" treatment. Either way, culling is an integral part of any prevention program as it reduces veterinary expenses, it decreases spread of pathogenic bacteria and helps the farmer to concentrate on healthy animals with proper milk production.

Concluding remarks

Mastitis is an important disease of sheep, financially-crippling and with serious welfare implications. It is a multi-factorial disease and as such, it has many facets and requires various approaches for its control. Although much data has been generated in recent years, there are still aspects of the disease which require further study. The most important of these, is the assessment of preventive measures, based on the recent findings about the epidemiology and the pathogenesis of the disease.

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NOTES

SARDINIAN CHEESE PRODUCTION AND REVIEW OF SHEEP MILK RESEARCH

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We want to share our trip to Sardinia with you....

In April, we attended the 5th International Symposium on the Challenge to Sheep and Goat Milk Sectors, in Alghero, Italy. The first two days included oral presentations on current research topics interspersed with poster presentations. The research topics represented a huge breath of knowledge and investigation occurring abroad. Some interesting topics related to dairy sheep were covered:

Detection of species alteration in milk and dairy products; F. Addeo et al., Italy
One goal is the development of a screening strategy to detect bovine milk in the milk of other species. There is a quick test available for the detection of bovine Immunoglobulin G in other milk. An emerging challenge is the detection of caprine in ovine or bovine in water buffalo milk (mozzarella), for which they are designing an immunoglobulin screening method.

Investigating the fatty acid composition in sheep milk; A. Carta et al., Italy and France
While there is an effect of diet on milk fatty acid composition, this group found chromosomal regions that influenced the types of fatty acids found in sheep milk, especially those associated with conjugated linoleic acid (CLA).

Volatile fingerprint of Piacentuni cheese produced with different tools and type of saffron; S. Caprino et al., Italy
The SMart Nose, the first artificial nose based on mass spectrometry was used to investigate differences in aromatic profile of a traditional Sicilian cheese. This cheese is traditionally made with sheep milk and saffron. The SMart Nose was able to distinguish a difference in the aromatic profile between cheese made using either a wooden or plastic mold and between cheeses made with either local or commercially available saffron. This tool may have potential use in determining the authenticity of "Protected Designation of Origin" (PDO) registered cheeses.

The final day of the conference included a cheese plant and farm tour. The island of Sardinia (approximately the size of Vermont) has over 15,000 shepherds (1.5 million people total) and 3 million dairy sheep. The number of cows, pigs and goats is only 286,000. The island makes two PDO cheeses, Pecorino Romano (90 % of this Italian cheese is made on the island), and Fiore Sardo.

Our first stop was the third largest cheese plant on the island, one of 75 processing plants that make Pecorino Romano. The 800 shepherds ship milk from December until August. During the three months of peak production, the plant receives 100,000 L milk/day. The cheese is aged for 5 months in salt and then ripened for 3 months. As the photos indicate, salt is major component of this cheese and makes up 5 % of the final product. After ripening, all wheels are subjected to "quality control", where they are scanned for any internal cracks. The 10 % of the wheels with such imperfections are sold as 2nd grade and likely used for shredded cheese. Over 90% of the Pecorino Romano made in Italy is exported to the United States.

Our next stop was a farmstead operation which makes Fiore Sardo or "Flower of Sardinia". This raw milk cheese is made using fresh, lamb rennet. There is no starter culture added to the milk, only rennet from 1-month old lambs, after two weeks of drying. This farm milked about 200 ewes and the rennet supply was a growing concern for the cheese maker. The cheese required one intestine for every 150 liters of milk, amounting to 4 intestines every day (or 4 intestines per 600 L milk per day). The cheese is smoked by an open fire for 18 days, before an aging process of 3 months plus 2 weeks. Aging actually occurred in a village in the valley, as climatic conditions in the mountains were too hot and moist.

The main breed is the Sarda, a smaller framed ewe averaging about 100 to 110 lbs. The general production values are:

- 8 month lactation
- 650 lb. milk per ewe per lactation
- $ 0.36 / lb. milk
- $ 5 to $10 / lb. cheese

The Universita degle Studi di Sassari works closely with the regional research station, Istituto Zootecnico e Caseario Per La Sardenga. This station milks 2,000 dairy ewes and 100 does, and is the research site for the university faculty and graduate students whose work focuses on sheep. The site includes two milking parlors, metabolic cages and 330 ha of pasture (2/3 of which is under irrigation). As the photos indicate, dairy sheep production in Sardinia is mixed between unimproved, hillside pastures and cultivated, lowland pastures. This research station grew some of the crops at the Spooner Stations, such as Italian ryegrass, and others, such as Burr medic and Sulla, a tropical perennial legume species.

NOTES


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