

Proceedings of the 14th Annual
GREAT LAKES DAIRY
SHEEP SYMPOSIUM



Oct 30 – Nov 1, 2008
Maryville, Tennessee, USA



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***GREAT LAKES DAIRY SHEEP
SYMPOSIUM***

October 30 – November 1, 2008

Maryville College and RT Lodge
Maryville, Tennessee, USA

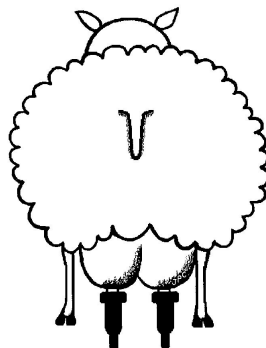
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from top to bottom:

Sheri Palko milking ewes at her Locust Grove Farm, Knoxville, Tennessee
– photo provided by Sheri Palko

Locust Grove Farm's "Cumberland" sheep milk cheese
– photo provided by Sheri Palko

Dairy ewes and lambs at Blackberry Farm, Walland, Tennessee
– photo from www.blackberryfarm.com

Blackberry Farm's "Singing Brook" sheep milk cheese
– photo provided by Kristian Holbrook

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Program of Events

Thursday, October 30, 2008

- 10:00 a.m. **Registration**, Conference Center, Maryville College, Maryville, Tennessee, USA
- 11:45 a.m. **Welcome**, Conference Center, Maryville College, Maryville, Tennessee
- 12:00 p.m. **Sheep Dairying Producer Panel**
Sheri Palko, Dairy Sheep Producer, Knoxville, Tennessee, USA
Kristian Holbrook, Dairy Sheep Producer, Walland, Tennessee, USA
Ronnie and Daphne Rogers, Dairy Sheep Producers, New Market, Tennessee, USA
- 1:00 p.m. **Economics of Conversion: Cow Dairy to Sheep Dairy**
Dr. Gary Rogers, Geno Global, Hamar, Norway and New Market, Tennessee, USA
- 2:00 p.m. **View Trade Show, Coffee Break**
- 2:30 p.m. **Sheep Cheese Marketing Panel**
Tom Clark and Allyson Zollner Brennan, Sheep Dairy Owner/Operator and Cheese Marketer, Old Chatham, New York, USA
Sheri Palko, Sheep Milk Cheesemaker, Knoxville, Tennessee, USA
Dr. Pat Elliot, Sheep Milk Cheesemaker, Rapidan, Virginia, USA
- 3:30 p.m. **Benefits of Dietary Dairy Fats**
Nina Planck, author of Real Food: What to Eat and Why, New York, New York, USA
- 4:15 p.m. **Affinage Primer**
Rob Kaufelt, Proprietor, Murray's Cheese, Greenwich Village and Grand Central Terminal, New York, New York, USA
- 5:30 p.m. **Adjourn Educational Sessions**
- 6:30 – 8:00 p.m. **Cheese Reception**, RT Lodge

Friday, October 31, 2008

- 7:00 a.m. **Board Buses for Farm Tours**, RT Lodge
Blackberry Farm – Kristian Holbrook
Locust Grove Farm – Sheri Palko
Indian Crest Sheep Farm – Ronnie and Daphne Rogers

Program of Events (cont.)

Friday, October 31, 2008

- 6:00 p.m. **Annual General Meeting – Dairy Sheep Association of North America,**
 RT Lodge
- 7:00 p.m. **Banquet,** RT Lodge, separate ticket required

Saturday, November 1, 2008, Conference Center, Maryville College

- 8:30 a.m. **Overview of Sheep Dairying in Israel**
 Dr. Gabriel Leitner, National Mastitis Laboratory, Kimron Veterinary
 Institute, Bet Dagan, Israel
- 9:30 a.m. **Impact of Handling and Thawing on Cheesemaking Properties of Frozen
Sheep Milk**
 Dr. Bill Wendorff, Department of Food Science, University of Wisconsin-
 Madison, Madison, Wisconsin, USA
- 10:30 a.m. **Update on Semen Importations**
 Dr. Dave Thomas, Department of Animal Sciences, University of Wisconsin-
 Madison, Madison, Wisconsin, USA
- 11:00 a.m. **Effect of Dry Treatment on Mastitis in Dairy Sheep**
 Carlo Spanu, Graduate Research Assistant, Department of Dairy Science,
 University of Wisconsin-Madison, Madison, Wisconsin, USA and
 University of Sassari, Sassari, Italy
- 11:45 a.m. **Visit Trade Show, Buffet Lunch**
- 1:00 p.m. **Somatic Cell Count Regulation and Antibiotic Testing of Sheep Milk**
 Dan Scruton, Vermont Agency of Agriculture, Food and Markets,
 Montpelier, Vermont, USA
- 2:00 p.m. **Immunology of Mastitis in Sheep**
 Dr. Gabriel Leitner, National Mastitis Laboratory, Kimron Veterinary
 Institute, Bet Dagan, Israel
- 3:00 p.m. **Symposium Concludes** – Thank you for attending, and have a safe trip
 home.

Speakers

Allyson Zollner Brennan, Cheese Marketer, Old Chatham Shepherding Company, Old Chatham, New York

Tom Clark, Dairy Sheep Producer and Sheep Milk Processor, Old Chatham Shepherding Company, Old Chatham, New York

Pat Elliot, Dairy Sheep Producer and Sheep Milk Processor, Everona Dairy, Rapidan, Virginia

Kristian Holbrook, Dairy Program Manager and Cheesemaker, Blackberry Farm, Walland, Tennessee

Rob Kaufelt, Proprietor, Murray's Cheese, Greenwich Village, New York, New York

Gabriel Leitner, Researcher, National Mastitis Laboratory, Kimron Veterinary Institute, Bet Dagan, Israel

Sheri Palko, Dairy Sheep Producer and Sheep Milk Processor, Locust Grove Farm, Knoxville, Tennessee

Nina Planck, author of Real Food: What to Eat and Why, New York, New York

Gary Rogers, Geno Global, Hamar, Norway and New Market, Tennessee

Ronnie and Daphne Rogers, Dairy Sheep Producers, Indian Crest Sheep Farm, New Market, Tennessee

Dan Scruton, Senior Agricultural Development Coordinator, Vermont Agency of Agriculture, Food and Markets, Montpelier, Vermont

Carlo Spanu, Graduate Research Assistant, Department of Dairy Science, University of Wisconsin-Madison, Madison, Wisconsin, USA and University of Sassari, Sassari, Italy

Dave Thomas, Professor, Department of Animal Sciences, University of Wisconsin-Madison, Madison, Wisconsin

Bill Wendorff, Professor, Department of Food Science, University of Wisconsin-Madison, Madison, Wisconsin

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Roth Kase USA, Ltd., Monroe, Wisconsin, USA; <http://www.rothkase.com/>

Silver:

Center for Sustainable Agriculture, The University of Vermont, Colchester, Vermont, USA; <http://www.uvm.edu/sustainableagriculture>

Dairy Connection, Inc., Madison, Wisconsin, USA; <http://www.dairyconnection.com/>

Wisconsin Sheep Dairy Cooperative, Strum, Wisconsin, USA; <http://www.sheepmilk.biz/>

Bronze:

Biotic Industries, Bell Buckle, Tennessee, USA; <http://www.biotic.com/>

Old Chatham Shepherding Company, Old Chatham, New York, USA; <http://www.blacksheepcheese.com/>

All 2008 sponsors are gratefully thanked for their generous support of the 14th Great Lakes Dairy Sheep Symposium and for their interest and support of the North American dairy sheep industry.

Please consider supporting these sponsors as you purchase equipment, supplies, and services for your dairy sheep farm or sheep milk processing facility.

SHEEP DAIRYING: IS IT FOR EWE?

**Sheri Palko
Locust Grove Farm, L.L.C.
Knoxville, Tennessee, USA**

The Beginning...

Drawn to agriculture/livestock from an early age, my sheep dairy began as a hobby. My background is in software engineering, but I left the traditional workforce years ago to stay home and raise our three daughters. My husband, a nuclear engineer who grew up on a Holstein dairy, was very supportive of my “brain storm” from the beginning; although I do recall the evening he looked at me with a funny grin on his face and said, “You know, honey...I grew up with six brothers and sisters on a dairy. If I had wanted to grow up and milk something, all I had to do was raise my hand.” While I still have a handful of family and friends who are certain I’ve lost my mind, my immediate family has always been there when I needed them. This business would not be in operation today if it wasn’t for each of them. From my husband doing laundry (and mixing colors with whites) and fixing meals, to my father building a new milking parlor ramp, to my older teenagers driving the younger ones and making trips to the grocery store. None of this would have been possible without their love and support.

When asked to be on the producer’s panel and do a presentation, I knew immediately who I wanted to address. I wanted to reach those people who have a true interest in sheep dairying and cheese making and attempt to give them an accurate glimpse at what is required and what is involved. Mostly, I would like to change some preconceived notions about what it takes to successfully operate this type of business. I wanted to dispel some myths that it takes hundreds of thousands of dollars to get started. I also wanted to relay to people the work that is involved as accurately as I can without being overly discouraging, or sugar coating the hard decisions. I have a lot of requests from people to “come and see” my operation because they are thinking about doing something similar. Most of these people arrive with a preconceived notion that this is something they can successfully accomplish “on the side” or “in addition to”. They own a few sheep and would like to milk them and make and sell cheese. “Oh, you mean there are regulations I have to follow?” “I have Cheviots, can’t I just milk them?” “What is mastitis?” “You mean you milk EVERY day? Well, you do take a day off once in a while, don’t you?” On the other hand, if the true passion and desire are there, those questions get answered and the burning desire to do and learn more will develop.

It’s not “just” about passion, although loving what you do will make you a better shepherd. It’s not “just” about the money, but let’s face it; we’d all like to make a decent living. It’s not “just” about the lifestyle, especially since this type of lifestyle wouldn’t appeal to a majority of the people. It’s about balancing all of those things in a proper way to fill a niche and achieve your own personal and financial goals while doing something you love.

So, when, exactly, did I loose my mind? It was a slow evolution really... I competed in competition, obedience, and herding trial dogs and needed sheep to train my dogs. I decided the

sheep needed to "earn their way", and with the market growing for "buying local", and the potential demand of valued-added farm products, my hobby turned into a small business. I loved working with the animals, wanted them to earn their way, and at the same time, a friend had a dream to make cheese from sheep's milk. In 2005 an LLC partnership was formed and we applied for a value-added grant from the state via "Pick TN Products". We were awarded that grant in Dec of 05 with the hitch that we be operational by June of '06. All of the sudden our 3 yr start-up plan became a 6 month plan - we just couldn't turn down that \$10,000 grant simply because it didn't meet our timetable. We were off and running... we had a dream... now we needed a plan.

Money...

Let's face it, starting any business costs money. The goal for us was how to get off the ground in a realistic, yet affordable way. We each brought a flock of sheep to the table, bought out half of each other's flock, and ta da, a partnership was formed. Very little money actually changed hands. He owned more sheep than I did, so I paid him the difference. We were now 50/50 partners.

Our grant allowed for 1/3 of all purchases that qualified, up to \$10,000. We were running on leased property, so we decided to put the majority of our investment into portable fixed assets, and as little as possible into non-portable things such as buildings. Working with an existing structure, I designed blueprints for a combination dairy/cheese making facility that would be housed under half of the roof of the existing barn. The building itself was built with a lot of sweat equity and called in favors to friends who knew a little about plumbing, block laying, wiring, etc. The windows were old ones out of a church being remodeled; the doors were purchased from a salvage yard. Anyone we knew who had a skill that might be useful was called upon to help, frequently in exchange for lamb meat.

For equipment, we shopped around, but knew the equipment was a long-term investment, so most of our money went into equipment. We began with a DeLaval 12-head stall cascading stanchion, a new 300 liter Nieros bulk tank, a 75 gallon hot water jacketed cheese vat, and we milked into 55 lb stainless buckets. We successfully achieved our goal of not exceeding \$60,000 total investment. Funds came from a combination of grant money, a \$40,000 FSA loan, and capital contributions from each partner.

Chores, Chores, Chores...

From the beginning, my business partner and I divided up all daily and weekly chores with two exceptions... He did all of the sales and marketing and I did all of the bookkeeping. We took turns milking and making cheese. While that sounds pretty straight forward and basic, it is also not all-inclusive. Our four basic chores of milking, making cheese, sales and marketing, and bookkeeping, quickly turned into a list of monumental undefined tasks that we realized we needed to define and share. Tasks such as, but by no means limited to... lambing, tagging, feeding and caring for lambs, mowing pastures, thawing frozen pipes, hauling grain and hay (LOTS of hay), maintaining fence lines, putting lambs and expectant mommas up at night to prevent predation, maintaining the cheese in the cave, addressing spring grass scours, keeping

the lamb pens clean, cleaning stock tanks, cutting, packaging, and weighing cheese, filling and shipping orders, keeping dairy and cheese room supplies stocked, etc., etc... Also not mentioned is scheduling (and remembering) non-farm commitments such as your daughter's swim meets and spring choral concerts. And "no"... as one of my relatives asked one Easter Sunday a few years ago... "I can't take the day off." A paper written by Mary Faulk a few years ago asked the question, "And who is going to do the laundry?" Don't laugh... that's a very valid question. To this day my very supportive husband cooks dinner most nights in the winter and spring. Not to mention that he is my number one handy-man for broken pipes, downed tree removal, and equipment repairs. Oh, and he can help pull lambs too.

Past, Present, and Future...

In June of 2006 we received all of our licenses; who knew we needed so many... a dairy license, a product license, a sampler's license, and antibiotic testing license, and soon to come, a receiving license. We made (and sold) a whopping 35 lbs of cheese that year. Not much cheese, but a ton of experience was gained in that short amount of time. We were official, and boy were we excited and enthusiastic. We started with 2 aged raw-milk hard cheeses. Because our sheep's milk was so precious to us, we purchased pasteurized jersey milk for the sole purpose of experimenting with our recipes. By the time we were licensed we had only a handful of ewes lactating enough to make milking worth our while. Every drop was like white gold, and in the 6 remaining weeks of the season, we made those drops count. And then.... We waited... and waited... Making aged cheeses is certainly not an immediate gratification process. We spent the fall learning from all the things we did right and wrong. We planned for the coming season knowing we'd make more mistakes but quite relieved that the first 6 week learning curve was out of the way. And still... we waited for the cheese to age. By the end of October we just couldn't wait any longer and tested our first batch. Quite pleased with the results, we prepared with even more enthusiasm for lambing season to begin.

Our milking season begins in the middle of January (when lambs start arriving) and continues until the middle of August. In 2007, we milked 36 ewes, had 1 case of mastitis (which would end in fatality), and culled 5 low producing ewes. I developed two new cheeses which turned out to be a huge success and would later become our best-sellers. We made cheese every 3 days, 85% of our sales were wholesale, we sold 2000 lbs of cheese, and we ended the year with 1635 lbs of cheese in the cave. (For those doing the numbers... some of our cheese was made with sheep milk from another producer in 2007.) My average adjusted daily yield for my sheep was 4.185 lbs of milk per day per ewe.

By Feb of '08, the business had grown and changed pretty rapidly. I needed to decide whether to slow the boat down, or haul out a few more paddles and guide it as it grew. On Feb 14, 2008 I bought out my business partner and things got really interesting. I already had 30+ lambs on the ground, many more on the way, and I was alone. Someone pulled the plug on my boat, and I spent the next 60 days just paddling as fast as I could. I had heard that if you move fast enough that even a boat without a plug wouldn't sink. I guess that rumor is true. I found relief in some unexpected places. My sister who is a school teacher, began assisting in cheese making and cave maintenance. She discovered quite a passion she didn't know she had and is now head cheese maker for our operation. In the meantime, a call to the UT Dept. of Agriculture

turned up a pre-vet student with a desire to work with large animals. She was a lifesaver and with her great animal intuition picked up on milking very quickly. Unfortunately she is now off to vet school, and I am finding myself writing her letters of recommendation. Hiring, training, and managing other people have been my biggest hurdles. For the privilege of working with those two irreplaceable people, I went through a lot more who just didn't work out. When you've done it all yourself for several years, you don't realize how much is in your head. I began to realize I couldn't expect other people to just "know" that the sheep needed to have their stock tanks filled. It seemed pretty basic to me, but not so obvious to others. My partner and I both knew what basic daily things needed to be done without even thinking about it. Now, all of the sudden, the entire work load was on me. If I didn't just verbalize it, but also put it in writing, it might not get done. My mind was an organizational maze for several months after the buyout. If you've ever asked your child to clean the bathroom and gone back and it wasn't done well, you know what I mean. As a parent you know you need to take the time to take that child by the hand and show them how to do it properly. As an exhausted parent who is sometimes short on patience and time, we want so much to just dig in and clean it ourselves because we can do it quicker and we know it will get done right the first time. Even though I didn't have the time, I had to force myself to slow down and be very specific and orderly with my employees. My mind knew it was the right thing to do, but at times it was just easier to do it myself. I now have two part-time cheese makers (one who actually survived our 2007 season with me as a new manager), a student who does part-time farm maintenance, and I'm looking for two milkers for the coming season. I would have predicted my biggest hurdle would have been sales and marketing, but hiring good, dependable, hard-working people has proven to be my toughest challenge.

Immediately following the buy-out, I had an in-line milking system installed, and ordered and installed a new cave unit. I didn't realize what a difference the new cave unit would make, and in hindsight it's the best investment I made this year. With the humidity and temperature no longer fighting for top control, the texture of the 2008 cheeses is far superior to the previous 2 years. In 2008 I milked 40 ewes, had one case of mastitis (which she recovered from), and culled 6 low producing ewes. Due to the buyout I only had time to take measurements twice throughout the year, so I have no flock averages for 2008 (I'm already regretting that, but...) I made one of my four, aged, raw-milk cheeses every 3 days during that time period. Only 25% of my sales were wholesale. I made 3200 lbs of cheese, and by the end of the year the cave will be empty, having sold the remainder of the 2007 inventory and all of the 2008 cheeses.

My motto by mid-2008 was to work smarter, not harder. Buying a 4-ton grain bin helped a lot with that in 2007. Beginning in the fall of 2008 I switched from small square bales of hay to large 1 ton round bales. I am already a fan of these large bales, although for Christmas I have asked for a horn for my tractor – those silly sheep have no respect for large tractor tires. With fall here, hay in the barn, and rams turned in with ewes, it is down time at the farm. But there is always something that needs daily attention. A week ago I had a ewe crash; I nursed her and drenched her for 24 hrs. She began to rally, so I made an appointment to take her to the vet for some fluids at 8am the following morning to get her over the hump. By 8am the following morning, I was on IV's due to a severe stomach virus. The ewe was dead before anyone could check on her at noon. Hard choices have to be made, and sometimes there are only so many hands to do the work.

In 2009 I will be milking 80-90 ewes and making cheese every two days. I am developing a fifth cheese, but have no plans to sell that cheese until at least 2010. My adult ewes are all already bred and will begin lambing on January 9th. There will be 37 returning milkers, 20 are yearlings who are first time lambers, and 35 are ewe lambs. I will have more than 150 lambs over the course of the season... more than 100 of those will arrive prior to the end of January... all will go on milk replacer between 3 and 4 days old. No... I don't sleep in January and February, and yes, more than half my ewes will be first time lambers... it should make for an interesting winter. With the relaxing fall season here, it's hard for some to believe that I'm already looking forward to January, especially since I'm not a cold weather person. But by the end of January when I stand back and look at all the beautiful and healthy lambs, and watch our creamy milk being made into cheese, I know every second of it will be worth the work. I love what I am doing, and I firmly believe that there are several key components to successful dairying and cheese making. Those ingredients are a supportive family, an ability to wait for long term gratification, and most of all a passion for the work. If you possess those three ingredients, the rewards are worth all of the blood, sweat, and tears.

BLACKBERRY FARM

**Kristian Holbrook
Dairy Program Manager
Walland, Tennessee, USA**

Blackberry Farm is a Relais et Chateaux hotel in the Smoky Mountains of East Tennessee. The Farm encompasses 4,200 acres which border the National Park and are mainly forested. We have approximately 60 acres devoted to pasture and that is shared with our horses.

Our goal is to have 60-100 animals milking and we hope to transition into using all organic feed and eliminate chemical wormers by 2010.

In early 2005 we purchased 10 East Friesian ewes, three rams, and 20 lambs to begin our milking flock. The animals are kept on pasture year round and only fed supplemental grain during lactation.

In 2006 we began crossing our East Friesians with some Karakuls with unusually high milk production. The results of this cross have been promising as we have seen minimally lower milk yields as compared to our purebred East Friesians. The benefits have been higher solids in the milk and lower nutritional demands in the crosses.

We currently have 80 ewes on property and will be milking the best 48 in 2009. All of the milk produced at Blackberry Farm goes into the production of our line of cheeses. These are sold retail and wholesale across the country.

Following is one of several articles that were written recently about Blackberry Farm, our dairy sheep, and our sheep milk cheese.

BLACKBERRY FARM ADDING "CHEESE" TO THE EXPERIENCE

Beth Haynes

Web article from WBIR TV-10, ABC affiliate in Knoxville, TN

<http://www.wbir.com/life/programming/local/liveatfive/story.aspx?storyid=62415&catid=8>

Updated: 8/19/2008 7:57:05 PM

As the sun rises, nature's wake-up call rings throughout Blackberry Farm's rolling hills. While guests enjoy a relaxing retreat, the workday begins. "Are you ready this morning girls?" asks Livestock Manager Vicki Milligan. "Come on. Come on," she leads sheep to the milking barn.

As its name suggests, Blackberry is very much a working farm. And, its flock of sheep is reporting for duty. "It's like clockwork. We let them out in the mornings, and they come straight into the dairy barn. They get in their slots, and then they wait for us to start milking," says Milligan. Twenty-four sheep in Blackberry's pasture play a very important role. They are part of the farm's newest endeavor, cheese-making. And, good cheese begins with their milk.

"It's higher in fat than cow's milk," explains Kristian Holbrook, Blackberry's Dairy Program Manager. "It's higher in protein than cow's milk." Holbrook is Blackberry Farm's cheese connoisseur. He loves cheese, and he loves making it at Blackberry's creamery. "Cheese isn't fancy food, it's just necessary food."

Cheese-making is a tedious art form that combines cooking, chemistry and lots of cleanup. During the summer season, Holbrook is making bleu cheese. Of course, he begins with raw sheep's milk. "This will make about 160 pounds of cheese," says Holbrook, referring to the milk in the cheese vat. Holbrook then adds starter cultures and mold. "The starter culture creates the acidity of the cheese. The blue mold is from the caves in France." The science of it is keeping the bacteria happy. "We're going to put in rennet, and this will coagulate the milk in about 25-30 minutes." The milk solution turns to curd. Holbrook says there is a trick to knowing when it is ready to be cut. "Stick your fingers in the curd, and pull up. If there is a clean break, you know it's set up enough." As Holbrook cuts, the whey rises to the top, and the cheese curd settles. "That is pretty nice looking bleu cheese curd right there." Once the whey is completely drained, the curd is salted, molded, and stored for 3 to 4 months.

In addition to bleu cheese, Holbrook has perfected 3 other seasonal blends of cheese that reflect Blackberry Farm. "I want the cheese to taste like the air does here in West Miller Cove. We want to highlight the best of what East Tennessee has to offer." And, through cheese, Blackberry Farm is accomplishing that mission. You can find this little taste of East Tennessee not only on the farm, but also in restaurants all over the country. You can also find Blackberry Farm cheese along with other homemade goods at the Farmer's Market in Maryville. And you can find out more about how Blackberry Farm makes sheep milk cheese on wbir.com

SHEEP MILK PRODUCTION IN NEW MARKET, TENNESSEE

**Ronnie and Daphne Rogers
Indian Crest Sheep Farm
New Market, Tennessee, USA**

Before April of 2007, Indian Crest Sheep Farm was known as Indian Crest Farm. We have milked Holstein cows since 1979. In the fall of 2005, we bought our first flock of 60 crossbred ewes and 1 ram. We then bred our Dorset/Dorper crosses to our East Friesian ram. Over the next year, we increased our flock to over 300 head. In January of 2007, we started selling our cows and began converting our dairy to accommodate a sheep milking operation.

In 2007 we produced 40,847 lb. of milk, and by the end of 2008 we will have produced 112,000 lb. We started out milking 100 ewes of various types, and we now have approximately 300 mature ewes plus young stock. The ewe flock consists of 15 % meat type ewes, 33 % F1 or first-cross Friesians, and the remainder 52% are Friesian and Lacaune mix. We house all of the sheep indoors at the present time with plans on pasturing at a later time. Our lambing process begins in January and ends in June.

Our farm consists of 238 acres, which we utilize for various combinations of hay, corn, pasture, and tobacco production. We have a family of 15 that help in our day-to-day operation including a husband and wife team. We have really enjoyed this new and challenging experience and prefer sheep milking overall.

ECONOMICS OF CONVERTING A COW DAIRY TO A SHEEP DAIRY

**Gary W. Rogers
Geno Global
Hamar, Norway
www.geno.no**

Background

The number of dairy farms and the number of dairy cattle in Tennessee and the surrounding states has been declining rapidly in recent years. Many factors have contributed to this situation but the most important factor is the low profitability of traditional dairy farms in the region. Dairy farms in the region have had to cope with a rapidly declining milk price (in real dollars) and rapidly increasing costs of production. Traditional dairy farms in Tennessee and the surrounding states have realized returns to family labor and management in the range of \$200 to \$400 per cow per year when averaged over the last 5 to 10 years. Dairy farms utilizing grazing very heavily have had slightly larger returns on a per cow basis. Returns to family labor and management for these grazing herds over the last 5 to 10 years have ranged from \$400 to \$700 per cow per year. These returns do not reflect debt service and/or rent so actual money available for family living expenses would be lower. With average farm size around 120 cows in Tennessee, it is easy to see why dairy producers might be looking for alternative ways to increase farms profits. A typical Tennessee dairy farm with 120 cows might be expected to have returns to family labor and management between \$25,000 and \$40,000 per year. Dairy farms with 120 cows require considerable labor and management so dairy producers have worked very hard for low returns over the past 5 to 10 years.

Dairy sheep production in Tennessee and the surrounding states offers one alternative to traditional dairy production. However, commodity marketing outlets for sheep milk limit the opportunities in this region. Specialty and niche markets for sheep milk products provide a viable opportunity for marketing sheep milk in Tennessee and the surrounding states. However, careful business plans are critical for the successful conversion of a traditional cow dairy to a sheep dairy.

Indian Crest Farm Example

Indian Crest Farm has been operated by Ronnie Rogers and family since 1979. Hired labor and family labor have all contributed in varying amounts to the labor supply for this farm during its history. Dairy cow numbers fluctuated over the years but from 2000 to 2006 the farm operated with approximately 100 mature cows. Most of the cow facilities and the major forage/silage equipment were fully depreciated by 2005 and the farm was at a point where some major changes were necessary to be able to continue as a profitable and productive operation. Several cash crops have played a role in the farming operation through the years as well.

In 2005 and 2006, the development of a potential market for sheep milk was realized because of the interest from Blackberry Farm as well as Locust Grove Farm. Based on this opportunity to market sheep milk, a thorough economic analysis was done to see if it would be

financially feasible to convert Indian Crest Farm from an operating cow dairy to a sheep dairy. Many factors led to the final decision to sell the cow herd and migrate to a functioning sheep dairy. Important factors included: (1) aged farming equipment used for silage/forage production and waste handling (which would be expensive to replace but would not be needed for a sheep dairy); (2) fully depreciated cow feeding facilities and cow housing facilities; (3) lack of desire on the part of next generation to continue dairy cattle production; (4) aging owner and other family members which would reduce labor available; (5) relatively low cost of starting a sheep dairy with existing facilities that were becoming less suitable for a cow dairy but that would work for a sheep dairy; and (6) the opportunity to produce at least as much profit from the sheep dairy.

The financial analysis of the transition was made after giving careful consideration to the opportunities to utilize the current facilities. Cost of converting cattle housing to sheep housing would be negligible. The cost of converting the existing cow milking parlor to a sheep parlor would also be negligible and this cost would be shared with funds from the Tennessee Agriculture Enhancement Program. The milking permit was straight forward since the facility was already approved as a Grade A dairy.

Financial Analysis Approach

As a dairy extension specialist I worked with many dairy farms on budgeting for decision making related to herd expansion. In addition, I helped several prospective dairy farms with decisions related to beginning a dairy production enterprise. As a tool to help with these decisions, I developed a simple spreadsheet in Excel (Microsoft Corporation) that was used for calculating or forecasting expected net returns for these new ventures. Recently I modified (and simplified) this spreadsheet to fit a prospective sheep dairy. This spreadsheet was used to evaluate the potential net returns for the conversion of Indian Crest Dairy Farm to a fully functional sheep dairy. The spreadsheet was developed to allow for easy modification of inputs and to evaluate the sensitivity of net returns to various input parameters. The spreadsheet is set up as a partial budget (variable costs and returns) and it produces estimated net returns on an annualized basis. The Excel spreadsheet is available from the author (email grogers200@yahoo.com).

As with any type of financial analysis, the use of proper inputs is critical. The accuracy of input values can have a major effect on the accuracy of the projected budgets. However, input values are not known with certainty and the spreadsheet allowed us to cover the expected range for a sheep dairy. Inputs include milk price, cull ewe price, lamb survival, lamb value, ewe cost/value, milking labor cost, number of ewes, milk yield per day per ewe, ewe weight, breeding cost per ewe, hay or forage price/cost, grain price/cost, times milked per day, lambing rate, cull rate, death rate, days milked per ewe, and days dry per ewe. Income items include milk income, lamb income and cull ewe income. Expenses include milking labor costs, feed costs, utilities cost, manure disposal costs, bedding costs, health care costs, breeding costs, replacement ewe costs and parlor/milking facility depreciation. The spreadsheet is also set up to evaluate the net revenue from cheese production from the same flock although this component of the spreadsheet is likely over simplified.

General Results

Results from modifying input values in the spreadsheet to see the impact on income minus costs clearly indicate that the most critical elements in the expected financial success of a dairy sheep operation are milk price/value, milk yield, number of ewes that can be handled and flock dynamics (including management costs and lamb sales). Flock sizes of 200 ewes or more can make a reasonable net return if milk price is very good and flock performance is acceptable. Milk yields less than 2.5 pounds per ewe per day, especially with short lactations, will not be very profitable unless lamb sales are outstanding or milk price is greater than \$1.00 per pound. Profitable flocks in Tennessee and the surrounding states will require 200 or more milking ewes, excellent milk yields, and efficient flock management to result in acceptable net returns unless some form of value is added to the milk. However, if a niche market for the milk is available or value is added to the milk, dairy sheep flocks of various sizes may be financially viable. Example results will be presented at the Symposium in an interactive manner.

SHEEP CHEESE MARKETING PRODUCER PANEL DISCUSSION

**J. Thomas Clark and Allyson Brennan
Old Chatham Shepherding Company
Old Chatham, New York, USA**

Tom Clark - Summary

The Old Chatham Shepherding Company was established in 1993 with a flock of 150 Dorset and Finn-Dorset ewes purchased from Cornell University. We have continually introduced new East Friesian genetics to the flock starting with semen from Germany, animals and embryos from New Zealand, Canada, Holland and Belgium. Later this month we are bringing in a new strain of semen from Peter Welkerling in Canada. About four years ago we started an intensive breeding selection system using software developed at Cornell University which is showing excellent results. Because of the type of products that we produce and sell, we must milk year round and we have developed a system where we produce about 100 gallons per day 365 days per year.

Our products consist of a white mold camembert style cheese which is produced from sheep's milk and cow's milk. We make this fresh cheese in several sizes and even though it is one of our original products, it is our best seller and won a blue ribbon in the American Cheese Society (ACS) competition this past summer. We make a 100% sheep's milk yogurt in four flavors. Our newest product is a 100% blue cheese, which we make in both a pasteurized and raw milk form. It is a Roquefort style blue cheese, with a little less salt than typical Roquefort cheese, and it has developed increasing demand in the market place. Our cheese sales are growing about 10% per year, and our yogurt sales are growing at a 20% rate. Our products are sold throughout the United States. Allyson will tell you how we have established ourselves in the market place.

Allyson Brennan – Beginning Marketing

Old Chatham Shepherding Company started to establish brand awareness by selling the cheese and yogurt on the farm at the self serve "Cheese Store" based on the honor system. To this day, we are our own best customer. During early development, we participated in the NYC Union Square Green Market to launch consumer discovery which lead to weekly deliveries by our own truck to retailers in New York City such as Zabar's, Fairway Markets, Grace's Marketplace, Murray's Cheese Shop and other prominent specialty shops and upscale restaurants. Our yogurt has been a staple at Tavern of the Green's Sunday Brunch since 2002.

Today, Old Chatham Shepherding Company is recognized coast to coast at retailers like Whole Foods Market, Wegmans, Earth Fare, Central Market, Dean and DeLuca, Jimbo's and many smaller notable independents.

Tom Clark – Distribution

We started distribution to customers by packaging our products in Styrofoam insulated boxes and frozen gel packs and shipping via 2-day FedEx. We continue this practice to many of our customers who prefer this method versus through distribution.

Our first opportunity to work with a large distributor began in 2000 when we partnered with United Natural Foods to distribute our yogurt throughout the Northeast. Today, UNFI distributes the yogurt coast to coast and, it is available in 8 of their warehouses. For the warehouses in the east, their truck picks up at our farm.

We have found through the years that smaller specialty distributors work best at handling our cheese products versus larger distributors where the product can be mishandled, stored at improper temperature or delivered over-ripe to the customer.

Allyson Brennan – Proven Marketing Programs

Through trial and error, we have learned that direct communication at store level is the proven key for success. This is true if you are selling direct, using a distribution center or a distributor to deliver the products. Utilizing a pre-order program works best for delicate cheeses such as the Old Chatham Shepherding Company's. By working closely with the people who are selling direct to the consumers, we are able to ensure freshness of our product, product rotation and quality inventory.

By participating in training programs, live demos and store level support, we are educating and keeping a high level of energy focused on our products leading to increased sales.

We do very little advertizing, but we are happy to participate, when asked, in newspaper articles, magazines articles and books about cheese. Recently, we have been mentioned in Wine Spectator, Acela's and Town & Country magazines as well as local newspapers. This type of free publicity keeps our name out there and helps to generate sales.

EWE WANT TO SELL WHAT?

**Sheri Palko
Locust Grove Farm, L.L.C.
Knoxville, Tennessee, USA**

New Product Assumptions: Know Your Product...

In 2006, we developed two cheeses we were proud of. In order to wisely market those cheeses, we quickly discovered a few things people were and were not looking for. Buzz words became apparent for those desiring gourmet cheese. Words that seem to really catch the attention of potential customers were adjectives like “farmstead”, “artisan”, and “raw-milk”. Hey! We had that, let’s promote it! On the other hand, gourmet cheese markets were asking about production rates and the potential for cheese “out of season”. We knew getting to full production would take several years, so we had to determine if there was a way to handle that demand without losing that particular market. We admittedly spent a lot of time worrying about it, but in the long run “doing” little, as we could only sell what we could produce. We patted ourselves on the back at the thought of selling most of what we produced, and decided that if we sold out, we would worry about meeting demand at that point. Not the best approach to take, but giving a positive spin to that particular roadblock was the only way we knew how to handle it. So we forged ahead.

We roughed out the “feel” and “look” we wanted our web page to have, and we hired an advertising firm to help design our logo, labels, and web page. The expense of hiring this firm qualified for the marketing part of our cost share grant, so our costs weren’t too outrageous. And in hindsight, it was money well spent. We were official; we had a product, a logo, and a webpage. Now on to some serious strategizing...

Throwing Mud Against The Wall...

Frankly, sales and marketing strategies were not really up to me in the first two years. These decisions were primarily up to my former business partner, and I was quite happy to keep my hands out of that particular filing cabinet. I can analyze and recount what was done, what did and did not work, but I have no experience, other than intuition and what would appeal to me as a consumer, about beginning to define sales and marketing strategies for a new company. So I will proceed by simply relaying what was done in this area during 2006 and 2007, and the results of those efforts.

My business partner chose to target the wholesale markets from the beginning, believing that the key to volume sales and low maintenance repeat business would be from sales to wholesale buyers. During that time, I developed two new cheeses. We priced our cheeses at what we determined was “just under” the current market nationwide. This was rather difficult to determine since we were the first licensed sheep dairy and aged raw-milk cheese processing facility in the southeast. We didn’t have a lot to compare to, but used what local, regional, and national information we could acquire. We decided from the beginning to offer a discount for

regular customers who bought more than a minimum amount of cheese. We began with a dollar discount amount as our initial brainstorm, and quickly converted that to a percentage discount to allow for easy transition during price changes. To qualify for our wholesale discount a vendor must order a minimum of 12 pounds of cheese, and they would receive a 22% discount. The discount percentage was calculated as “the best we could do and not lose money”. Again, not necessarily the best way to calculate it, but we were flying by the seat of our pants.

We had our criteria, so the real work began. A nice color, tri-fold brochure was designed and mailed to hundreds of cheese shops all over the country. My partner spent countless hours on the phone making cold calls to wholesale cheese stores, vineyards, and restaurants. When traveling to other cities, he would drop in on these establishments and attempt to promote our cheeses to the owners and buyers. On several occasions these techniques worked very well. With brochure in hand and the offer of sending free samples, the owners and buyers were frequently very open-minded to trying our cheeses. Small samples of each cheese were sent to the prospective customers who showed interest, and then follow-up calls to each of these establishments would potentially produce an order. I don't have statistics about how much mud was actually thrown against the wall since I didn't do the throwing, but I do know that to this day we have quite a few regular wholesale customers who are the direct result of this original marketing effort.

In 2007, we sold 2000 lbs of cheese and 85% of that cheese was sold at our wholesale price. We ended the year with 1635 lbs of cheese in the cave. I was pleased with the numbers for our first full year of production, but worried the potential increase in the production over the next few years would far exceed our current sales strategies.

Do Something, Even If It's Wrong...

In the winter of 2008, I decided we needed some new marketing strategies. I simply didn't have enough experience to know what those strategies should be. The business was growing faster than anticipated, and that growth called for some change. That change needed to come about in one of two ways... slow the growth, or encourage it. But one thing was obvious, we couldn't stay the same, a profitable business is never stagnant. On February 14, 2008 I bought out my business partner while chanting over and over again, “I don't want to do sales and marketing! I don't want to do sales and marketing!” On February 15 my parents called me and said, “Guess what? Looks like you're going to be doing sales and marketing.” I was so busy lambing, milking, and making cheese, that it was easy to avoid what I didn't want or know how to do. The thought of actually having to “sell” something simply overwhelmed and terrified me.

My mother has said on many occasions concerning being a parent, “There are two ways to manage: You can manage by objective, or you can manage by crisis.” Alright, I admit it; I managed by crisis for at least 6-8 weeks. It was simply too overwhelming to manage any other way. I had a ewe with a torn uterus, 50 lambs already on the ground, a lamb with pneumonia, and first timers still to lamb. I was milking twice a day, making cheese every three days, and had no employees. Who had time to sell cheese?!? I was beginning to think I had lost my mind! But when you manage by crisis, you simply keep putting out the biggest fires first. I knew the

crisis couldn't last forever; after all, I would quit milking and making cheese in August and surely have time to take a breather for a few minutes.

As some decent help began to filter through all of the “not so great” potential employees, I found myself gradually coming up for air. Lambing season was slowing down, and I began to remember why I was doing this. I had a flock of hardy, healthy ewes who I simply loved. I was a good shepherdess. I made four wonderful, marketable cheeses. Now it was time to manage by objective.

Like Your Cheese, Love Your Cheese...

I absolutely love being a shepherd. I love the animals and know each of them by sight from the front and behind. Animals are my passion, and a passion will help make you better at what you are pursuing. I was making four cheeses, and I really liked all four of them. But... did I love them? Well, I would really like to improve the texture of all my cheeses. I would like to change the rind on one cheese, and the color of another. On a third cheese I would like to see more consistency. How is all of this relevant to marketing? I have learned so much in this year of crisis, but probably the thing that stands out in my mind the most is that it's so much easier to market something you love. If you don't love what you're marketing, change it so that you do, or selling it won't come easy to you.

My first major step toward improving the quality of my cheeses was to purchase a new cave unit which would maintain a more constant humidity without sacrificing consistency in temperature. My belief and hope was that this improvement in cave conditions would achieve the texture I was wanting in all of the cheeses. Unfortunately, it would be the middle of April before I knew how well that hypothesis would play out.

In the meantime, I felt I needed an adjustment in the price of my cheeses. I thought that they were under priced, but was hesitant to make any radical changes immediately following the change in ownership. So I decided to leave my retail pricing the same for 2008, but to change my wholesale discount from a 22% to a 20% discount. That difference would be nominal to the vast majority of my wholesale customers, but would potentially help my cash flow tremendously. I also felt that it was easily justified given the drought conditions and the astronomical jump in the prices of grain and hay. I would need to send a mass email to all existing customers and then “make the time” to make follow-up calls and introduce myself since most of these customers had been dealing with my former partner.

Having a plan for dealing with existing wholesale customers, I decided to put marketing to new wholesale customers on the back burner. Instead, I decided I wanted to really spend some time developing my retail market. I attended several annual business meetings for the different local farmer's market organizations and became a member of several. I planned to hit as many local farmer's market as my time would allow, to see if I could build my local retail clientele. Have I mentioned I didn't want to do sales and marketing? I was really dreading having to take the time to stand under a tent and sell cheese. However... I had several factors in my favor. First, I was the only person selling cheese at these markets. Added to that was the

fact that my cheese was raw, and the growing demand for raw milk products was proving to be a huge plus for marketability. Second, I was local. More and more people really want to support local farmers and producers. Finally, I loved my product. My 2008 cheeses that were beginning to come out of the cave were fabulous! I made changes to my existing tri-fold brochure, and called upon several family members who are much more creative than I am to help design a booth setup for the markets. The major expenses for the farmer's markets fall into two categories: initial expenses and ongoing expenses. The initial expenses are the cost of becoming a member of the organization running the market, and equipment and advertising costs such as tables, tablecloths, coolers, a tent, a banner, and I decided on some nice monogrammed polo shirts for an added professional touch. Total cost was less than \$250. Ongoing costs consist mainly of toothpicks and actual cheese samples, and the cost and labor of packaging and labeling wedges of cheese smaller than whole wheels. I discovered that offering samples at the markets is what really sells the cheese. It's a big expense, but well worth it. I also discovered I really enjoyed talking about the sheep, the cheese, and the entire process with customers who were really interested about where their food was coming from. Who knew? I have really enjoyed selling cheese.

In 2008, I've sold 4700 pounds of cheese, and only 25% of that was at the wholesale price. Have I mentioned I love my cheese!?!

The Learning Curve...

Toward the end of 2007 we began to carry product liability insurance. This is necessary if you are going to sell to larger markets such as Costco and Whole Foods. This was a good move in my opinion. Internet sales, both wholesale and retail, have continued to increase due to the web page. We now offer ordering by fax, phone, or internet, and now accept Master Card and Visa. Frankly, we rarely get fax orders, so I am questioning the necessity of that expense. I process 5-10 charge card orders each week, so offering to take credit cards was a productive move in my opinion. At the farmer's markets I made an email/newsletter sign-up sheet available from the first market in April. Until August I didn't know what I would do with such a massive email list, but something told me that developing that list would be beneficial down the road. In August I sent my first newsletter via Constant Contact online software. Again, an investment I believe will pay off. I have more than 600 customers who now receive my newsletter and the feedback has been very positive. Through the newsletter I can not only keep the customers informed about what is currently available, but published pre-determined sales plans for enabling farmer's market customers to continue to purchase cheese during the "off season".

My wholesale pricing has been refined a little more. A new requirement this year is that if you are in East TN and you are purchasing my cheese for retail, you must sell it at the same exact price as my current retail pricing. That has prevented me from having to compete against myself, and also provides consistency over multiple retail outlets for my customers.

One last thought I'd like to comment on. The cheese a customer buys, tastes, and shares should represent only your best. It is their first impression of your product, and could be the beginning or end of a long term customer relationship. Don't be afraid to throw away any cheese

that is at all “off flavor” or has a consistency you aren’t happy with. It will pay you dividends in the long run to offer only your best.

My fall goals have been to provide more consistent follow-up with my wholesale customers and to continue to develop more wholesale markets. Upon calculation pound for pound, my wholesale sales in 2008 were actually down a few hundred pounds. During my management by crisis phase, I really neglected to follow-up with current and develop new wholesale customers. Finding that balance between wholesale and retail seems to be a challenging moving target, and with twice as much cheese to sell in the coming season, both markets will need to be well maintained. In 2009 I would like to enter several of my cheeses into some competitions. Lack of time and lack of product in 2008 simply didn’t allow for such extras. I will enter them in 2009. Have I mentioned, I love my cheeses!?!

SHEEP MILK CHEESE MARKETING

Pat Elliot
Everona Dairy
Rapidan, Virginia, USA

Production of artisanal, farmstead cheese is multifaceted. It is like balancing on a tippy three-legged stool. One leg is the sheep and their care and the production of the milk. Another leg is the production of the cheese itself. And the third leg, the most difficult leg, I think, is the marketing – one has to learn to balance a viable business on these disparate legs.

I started with a Border Collie puppy who grew up and needed work, so I began carving the first leg of that stool of farmstead cheesemaking: the sheep and their milk. Fulfilling and rewarding! Then, the second leg, the cheese, was totally different – creative, involved with cleanliness, a totally different set of skills involved – a more ornately carved leg to continue the metaphor. Then finally that third leg of marketing - what to do with the cheese! I have found that there is a lot to this leg - it's made up of little pieces put together like legos!

If the cheese goes on that FedEx truck and a check comes back in the mail, much later, it is because one has learned how to balance the farmstead operation on that three-legged stool. Each leg needs to be sturdy: the animals and the milk, the cheese making, and the marketing.

My goals are still evolving but revolve around how to support the operation so it is sustainable (meaning I can keep doing it). For me that means having the highest producing animals, the best employees, the best cheese, the best markets! It means keeping my eyes open and making changes; It means learning new things – reading, talking to people, experimenting, doubting

These are the steps I believe in and follow as a farmstead producer.

For this panel I am presuming the other two legs of the stool - sheep and their milk, and the cheesemaking - are under control. Now how to market?

The table on the next page is not in any special order – like the real world, which hits one all at once!



Deerbird

“HAACP” for Marketing	CCP (Critical Control Point)	Pearls
Where to sell: getting that first order: distributors, wholesalers, restaurants, wineries, festivals, retail – catalog, web, farmers’ markets	Call, visit, sample, etc.	Selling cut-rate may cut some of your potential; make a price differential in markets
Packaging , labels, shipping plans	Must arrive cool enough, inspector must O.K., dedicated area	Avoid plastic, Get a string cutter
Brochures, business cards, other information	Sets the tone	Will it be read? Consider cost
Publicity	Join American Cheese Society, samples at market, chef, stores, wineries, distributors, festivals	Mucho dinero
Pricing	Need a profit at end of day; sheep cheese is upscale and the best; different prices for different folks	Oh, God, I need help!
Presenting the cheese	Tell your story Promote sheep milk for all of us	Sells cheese for me
Check other sources for supplies	For quality, innovation, price	In spare time
Inspectors, regulations	Ask their advice. Thank them. Object to their boss if necessary.	Just do it!
Sell all the animal	Boys, wool, need program	“Waste not, want not”
Customers	Keep in touch with them; easier to win old ones back; newsletter, call, e-mail	Don’t put all your cheese in one basket
Try new things	Consider changes	But be skeptical
Retail takes another layer of learning	Apply, tent, signage, tables, cutting, etc	A learning experience and fun, more money
If you are unsure	Get advice from someone who knows	Remember the deerbird!
Study. Learn. Change.	Small Business publications, Harvard, FSA, etc	Real research
New stuff - organic? humane? sustainable?	These are marketing tools primarily	The deerbird again!
Attitude	Smile – learn how or get out	It sells cheese. Cheerfully refund the money. Jump the hoops. etc.
Good people to help	Check references, background, ideas, moral support	Learn to say “no” Learn to say “thanks”
Analyze results	Keep records - DHIA, production, sales, batch numbers, who bought what, make sheets, composition tests, water content	Learn to like doing this if you can.

**REAL MILK
REAL CHEESE
REAL FOOD**

Nina Planck

**Author of Real Food: What to Eat and Why and Real Food for Mother and Baby (April)
New York, New York, USA**

Take an advance peek at Nina's talk at the 14th Great Lakes Dairy Sheep Symposium. Nina will discuss what dairy sheep farmers and cheesemakers need to know - and eaters want to know - about sheep milk.

- I. Industrial Food Imitates Traditional Food
- II. Traditional Food is Superior in Flavor and Nutrition
- III. Industrial Food, not Traditional Food, Causes Disease
- IV. What is Traditional Food?
- V. What is Industrial Food?
- VI. What is Real Milk?
- VII. Components of Sheep Milk

**www.NinaPlanck.com
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CREATING MARKETABLE SHEEP MILK CHEESES AN AFFINAGE PRIMER

**Rob Kaufelt, Proprietor and Zoe Brickley, Affineur
Murray's Cheese Shop
New York City, New York, USA**

Overview

Affinage is a French term for the professional control of a complex series of bio-chemical reactions following the creation of a fresh cheese – cheese-aging. I am not a microbiologist, nor an affineur, though I have one on staff. I am a business man, and my job is the professional control of my inventory and its marketability. Understanding the science of cheese is important for making a good product. But understanding the role of affinage within a global marketplace is the key to selling it. Cheese design and affinage should be the cornerstone of your marketing plan.

Background

Murray's Cheese Shop has been an institution in the West Village of New York City since 1940. It began as a small bodega with cheese, cheap oils, and tomatoes – all catering to the Italian locals in the area at the time. I bought the place in '87 adding more specialty cheese every year until the shop had outgrown the tiny storefront -14 years later. We took the opportunity to move across the street to a bigger location. That's when I built the caves and the classroom. I wanted to take cheese to the next level, and I wanted everyone to learn, as we did, about the incredible world of cheese.

Today Murray's grosses over ten million dollars annually, growing every year. Our wholesale department, only five years old, has already attracted more than 300 of the best restaurants across the country. We have nearly 30,000 subscribers to our website, from which anyone can order cheese and have it shipped to their doorstep. Murray's has partnered with Kroger Supermarkets and has recently opened several in-store pilot locations in the Midwest. At Grand Central Terminal you can find a Murray's full service cheese counter and, by the end of the year, a cured meat store.

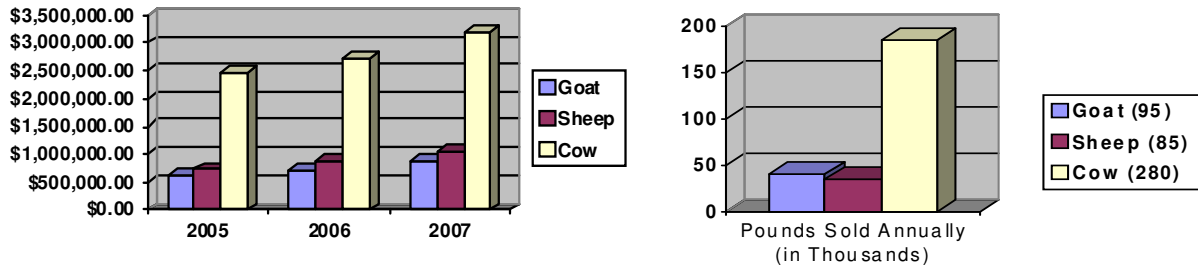
Market Research - Murray's inventory of sheep's milk cheeses:

Here's a big picture look at the annual total of items, sales, and poundage by milk type for 2007:

	SKUs	Poundage	Sales	Avg. \$ per SKU
Goat	95	40,000	\$863,500	\$21.99 / lb
Sheep	85	37,000	\$1,068,000	\$28.99 / lb
Cow	280	185,000	\$3,192,500	\$17.99 / lb

Note that the figures do not include cheeses made with mixed and Buffalo milks, so the totals are artificially low. We carry close to 500 cheeses including promotions and seasonal variation, and our sales approach \$7 million in cheese and dairy products.

- a. Let's look the proportion of sales by milk type (2005 - 2007) and weight sold (2007). Sheep milk cheeses account for only 20% of annual sales, totaling nearly a million dollars last year.



The ratio of total pounds sold and sales for milk type shows that, with sheep milk, we are bringing in higher sales per item. So sheep brought in more sales than goat, with fewer pounds sold of fewer items; they tend to be more expensive across the board. The average price for cow's milk is clearly much lower.

- b. Here's an idea of how much sheep milk cheeses we have sold in the last three calendar years, broken down by the highest grossing countries:

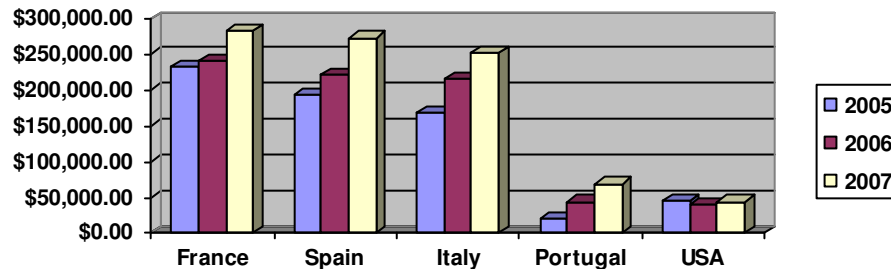


Figure 1 - Sheep Cheese Annual Sales by Country

Not only does the U.S. display the lowest sales in the sheep category, but we actually show negative growth. This should be attributed to a fixed supply from the farms we work with.

It should follow that demand for domestic cheeses has risen along with other countries', but we have been unable to find cheeses with the availability, quality and style we are looking for. Further, as popularity grows, farmers are taking on new clients and consequently reducing our over-all share in the production. Spreading inventory more thinly among clients makes for more administrative work but perhaps, increased sales security.

Our supply issue is exacerbated by the seasonal limitations on these farmstead products. The top grossing European cheeses are industrial and available year-round. Many of you, at best, only make cheese 150 days a year.

History of Milking Sheep in the U.S.

Although cheesemaking is experiencing a sort of post-industrial renaissance, dairying has been a part of our cultural heritage since our country's inception. Using European recipes and bending them to accommodate our lifestyles and markets is not a new concept.

A growing mainstream market for specialty sheep milk cheeses though, is a phenomenon that has just begun within in the last quarter century. As smaller family farms continued to fail or be consolidated within larger operations, more and more families sought an alternative approach. Sheep, as you know, offer several opportunities to add value on sight, by processing their milk, wool, and meat. But profiting primarily through sheep milk cheesemaking is still quite difficult.

The market has been largely driven by the influx of European chefs in the last 30 years and their growing celebrity status – which, along with our own Julia spawned a generation of savy gourmands, looking for specialty ingredients.

Two of the first farms to serve the new market successfully are near us on the East Coast: Major Farm of VT and Old Chatham of NY. Their cheeses are the top selling of the American bunch for Murray's. Old Chatham is bringing in more than \$20,000 and Major \$8,000 – though we could sell at least triple the amount we are allotted. Number two happens to be a newer dairy, a farm we just started working with this year. Ancient Heritage Dairy in Scion, OR supplied us with \$15,000 of a small format, lightly aged cheese called Adelle. They manage to keep it available all year round. Lovetree Farms of WI should be noted as a pioneering presence in terms of sheep cheese quality and farmstead ideals. Mary's cheese is sold primarily through local markets in Wisconsin and Minnesota.

The graph clearly shows that growth is due for our U.S. market. The more successful U.S. cheeses we carry, sheep or otherwise, have been able to capitalize upon an existing European cheese's market and a growing interest in locally sourced food. To do this, you must understand the global market.

Let's get specific about sales:

Here are the top ten selling sheep cheeses by gross sales for the YTD preceding September 2008: (* denotes Wine Spectator's list of '100 Great Cheeses', 2008)

In these cases, price point is inversely related to the scale of production, with the exception of Persille de Malzieu – it is a smaller production Roquefort made just outside the designated AOC area. The designation restricts supply and drives value. Also, Herve Mons cheeses are indicated. He is a well known French affineur and was the consultant for our caves' design.

Cheese Name	Country	Interior/Rind	Sales	Retail Price / lb
*Manchego, 1yr.	Spain	Flaky / Waxed	\$129,318	\$15.99
Pyrenees Brebis, Mons	France	Semi-firm / Natural	\$111,290	\$22.99
*Ossau-Iraty, Mons	France	Firm / Natural	\$70,099	\$28.99
*Manchego, 3mo.	Spain	Flaky / Waxed	\$59,441	\$13.99
Roquefort, Vieux Berger	France	Blue / No Rind	\$49,500	\$32.99
Pecorino Tartufello	Italy	Truffled / No Rind	\$40,489	\$27.99
*Persille de Malzieu, Mons	France	Blue / No Rind	\$35,600	\$24.99
Pecorino Romano, Fulvi	Italy	Flaky / Waxed	\$33,958	\$12.99
*Pecorino Foglie di Noce	Italy	Flaky / Natural	\$33,396	\$30.99
La Serena	Spain	Soft / Natural	\$32,658	\$21.99

Also of note: Manchego and Pyrenees Brebis are 2nd and 4th respectively in overall sales among all cheeses behind Parmigiano (\$380,000+ including 3 different quality types and a pre-grated format) and Buffalo Mozzarella (\$122,000). Ossau Iraty is seventh overall.

What are the trends here? What does the market for Sheep look like?

Most of these cheeses are harder tomes meant for aging. The reason for this lies in the history and geography of their parent countries. Generally, sheep were milked in arid climates with sub-prime grazing or difficult terrain. People milked sheep because they couldn't milk cows. They made hard cheeses to last them through the long months when the sheep weren't milking.

This begs the question – if milking cows and selling their cheese is more economical – why are you milking sheep? Are you restricted by climate and vegetation? An expert has estimated that a herd size of 300 animals or more is necessary to develop a profitable ovine dairy. That is if you can sell all that cheese.

Your cheese needs to be REALLY good if you want your business to grow and service metropolitan markets, which are markedly different than rural ones. Talk to experts. Find a way to get honest feedback and constantly work to shape your recipe, affinage design and technique to accommodate for this market difference. So far, there are ten or less sheep cheeses, made and distributed in the U.S. that can hold their own against a European selection in this regard. This is not to say that there are only 10 good cheeses – surely there are many more.

However, of more than 11,000 entries in the American Cheese Society competition in 2008, only 6 farmstead aged sheep tomes were entered in that category.

Overserved Markets:

Think twice before making a bloomy-rind cheese. This is the easiest cheese to make and the easiest inventory to turn around, but it is an over-served market and actually one of the more difficult types to perfect with sheep's milk. That's why there are very few examples of this style from Europe, and the ones we can find tend to have been invented for modern markets or made from mixed milks. The high fat content in the milk can make proper curd drainage difficult, trapping residual whey. This causes inappropriate acid development that often leads to overly liquid externally ripened types.

Furthermore, the magical things that happen with aged sheep cheeses, that set them apart from goat and cow styles, only begins to occur after months of affinage. The key is breaking down those abundant, and uniquely delicious fat globules in step with proteolysis. This way, inevitable bitterness from lypolysis is a just a phase in your drier cheese, as opposed to the death of your high-moisture bloomy.

Though you could make a cow type cheese, like a 60 lb. keg of traditional bandaged cheddar, this might not be the most practical choice. Choose a sheep specific original model for your affinage plan. This makes your product easier to recognize and comprehend for the customer.

Avoid mimicking a vague, archetypical, inexpensive table cheese if you have to charge more for it. (Like 'Pecorino Romano')

You could make a Manchego, but lots of folks are trying that, and the expectation there is for a cheap table cheese. Again, with a bigger production this might be a good idea, but for the price point you need, get nichier. Your milk is better and more difficult to get than cows milk, so make sure your cheese reflects that. Do some more market research. Eat lots of cheese.

Underserved Markets:

Try the good old natural rind tomme. The French Pyreenees style is the most classic, and highest grossing example. We're always looking for more of those. To create this rind, wash with a 3% salt solution for one week to one month. Then let bacteria and mold set in. There will be several stages of growth, which can be patted down, and eventually brushed as they begin to form a crust. By the time your 60 days is up for your pastured raw milk cheese, the rind should look even and fully formed. Allow at least 8 months for flavors to fully develop.

Or do a Portugese-style Amanteigado. Amanteigado is the generic term for a small, puddingy, wash rind sheep cheese made with thistle rennet. They are phenomenal when done right, and to my knowledge, nobody has tried that yet. Similarly, A Spanish torta like the La Serena could be popular.

We could use more natural rind blue cheeses in general, let alone sheep milk ones. Roquefort and its likenesses are among our top grossing blue cheeses overall.

Affinage – Then and Now

Affinage, or the finishing process of cheesemaking, is generally mentioned in reference to a cheese's appearance and style. Although it does describe the period in which a cheese's rind appears, the initial cheesemaking recipe is really where a cheese's style is set forth.

Affinage came about as a profession that served cheesemakers. Because husbandry, farm maintenance, milking, and cheesemaking are more than enough to fill a day, others began specializing in the last few steps: gathering cheeses from remote rural locations, caring for them in a specialized facility or cave, and distributing/representing them to urban markets.

Some believe that for the United States to continue moving forward with our artisan/farmstead movement, we will need to devise regional consolidation and affinage networks. The Cellars of Jasper Hill Farm in Greensboro, Vermont marks one the first domestic example of such an initiative.

Historically, affinage and the evolution of cheese styles had everything to do with necessity, happenstance, and cultural inclination. So cheeses were shaped to fit a civilization's needs largely through trial, error, and accident. The fact that the simultaneous cultivation and suppression of different microbes drives diversity within cheese makes the history of the stuff a shining example of Darwinism.

Now, we can use the discoveries of Darwin, Pasteur and all the other dead guys to evolve a new delicious cheese in record time. But it can still take years. So... use the tools they gave us!

Be scrupulous about sanitation, and monitor your milk quality in terms of somatic and bacteria cell counts.

Be gentle with your milk. Agitation ruptures fat cells, causing them to break down prematurely and contribute of dirty flavors and aromas during aging. We notice this – often, especially with sheep milk, which is prone to lanolin flavors anyway.

Monitor your variables with instruments designed to do so. This includes moisture content, time, temperature, salt, and pH. Especially pH. Monitor pH in the vat, on the table, and everywhere in between. Calculate your rate of acidification. Know your targets.

Actual scientists agree that the behavior of the colloidal phosphate calcium 'glue' in cheese is THE major determinate of texture development, and is largely affected by pH fluctuations throughout the make process.

The inability to control pH effectively is the leading cause of technical flaws like graininess, runniness, and unbalanced sharpness.

Usually a flakey or fluffy interior has a lower internal pH, while a smooth or elastic paste has a higher one and is less acidic.

Use commercial starters, at least until all of your other variables are in check. We have not, in recent years, accepted any cheeses that to our knowledge are using home-cultured / yogurt starters.

If everything is set up correctly in the make process, and a style-appropriate recipe is used, then affinage becomes as easy as knocking that first domino.

Cheese by Type

The last page of this presentation includes an Affinage family tree by rind type. Work with someone who specializes in the type you are making to learn specific affinage techniques.

Generally, cheeses are either primarily internally ripened, or surface ripened, though this is more a spectrum than a dualism. Moisture content and pH are the major factors in how much transformative power a natural rind has over the texture and flavor development of an aging cheese (high moisture = lots). Specific ripening cultures and varying cheesemaking techniques serve to further characterize the many cheese types within each listed ripening category.

Surface ripened cheese, either by bacteria (*b.linens* / **washed rind**) or mold (penicillin *c.* / **bloomy rind**) or fungi (*p. geotrichum* / brainy, off-white bloom) are high in moisture and ripen within a few weeks. Their shape is intended to control the surface area ratio of rind to paste. This is the reason traditional bries are flat – enzymes from the rind must transform the texture curdy paste all the way through, before fat breakdown and rancidity overwhelm the palate.

Temperature and humidity of the cave and internal pH and moisture levels are integral to controlling the surface ripening process. An overly warm or humid cave or an overly acid/moist paste, can lead to a liquefaction of the exterior, before the center ever softens. This is on par to burning the outside of a steak and leaving the center raw.

Internally ripened cheeses are lower moisture and generally ripen through anaerobic fermentation. This is to say that the microflora are able to secrete enzymes and transform texture and flavor without oxygen, albeit more slowly than surface ripening microbes on a high moisture cheese. Sometimes internal and external ripening forces act in tandem – the outer edges of a semi-firm cheese may visibly soften beneath a natural rind while the interior develops flavor with relative independence.

Even if a mold covered, washed, or leaf wrapped cheese is primarily internally ripened the overall appearance of the cheese, and its ability to slowly dry and exchange gasses through the permeable rind, creates value. And any kind of **natural rind** should contribute some earthy aroma and flavor.

Powdery yellow and rusty red swaths (not to be confused with *b.linens* or dead bloom) are an unusual, positive achievement on a natural rind. *Mucor*, or grey ‘cat fur’, can mar the appearance of a bloomy, but may comprise the majority of some natural rinds.

Waxed or cryo-vac cheeses are unable to release moisture and are expected by customers to be inexpensive, commodity types. Innovative poly-coating allows a cheese to 'breathe' and is easier to achieve than a functional or inert natural rind, but it fails to add perceived value. Many restaurant clients will refuse a coated or waxed cheese on that basis before they even have a taste. With that said, cryo is a great way to extend the shelf life of a fresh cheese.

Another option is to **bandage** a cheese meant for several months of internal ripening by wrapping it in linen and rubbing it with lard to seal.

The market for **flavored** cheeses, both internal and external additions, is much narrower in a metropolitan market than in rural farmer's markets where they can be quite popular.

Many **Alpine** style cheeses, like Gruyere, are washed to develop b.linens in their youth, but the lower moisture content prevents softening. As the cheeses age, the cultured rind becomes a brown-orange crust that protects the cheese.

Other aged cheeses, especially in the grana (parm) style are **brushed clean** or washed of mold from their onset, resulting in a bald or naked appearance. A pumpkin thick rind of dehydrated cheese encases the wheel and prevents excessive moisture loss.

Blues are tricky because they are internally and also aerobically ripened cheeses. So after blue mold spores (p. roquefortii or p. glaucum) are added to the milk, and the milk made into cheese, oxygen is introduced by spiking the cheese with sterilized needles. An intentional open texture in most blue cheeses helps them to develop parsley shaped pockets of mold in addition to the needled veining. Some blues are aged in foil, and don't develop a rind to speak of.

***Mite: Tiny arachnids, similar to dust mites, that tend to colonize aged, natural rind cheese. A ring of dust around the base of an aging cheese is a telltale sign of mite. If kept in check they can contribute an unusual and interested floral character to the aroma of a cheese. If left to their own devices they can cause extensive cratering, discoloration, and in bandaged cheeses with open texture - internal bluing.

Generally, regular weekly brushing with a soft bristle brush will keep mite populations under control, while keeping inhabited rinds from becoming mottled or unevenly cragged.

Cave Design

The affinage of a sheep milk cheese, and the techniques employed, should be no different than other milk types. The cheesemaking process is where adjustments need to be made for differences in milk composition.

When designing a cave space, keep these values in mind:

Natural materials – including wooden boards and unfinished concrete or, if you're lucky, exposed stacked stone cellar walls. These surfaces are porous, so they absorb and release moisture helping to retain a constant level of high humidity.

Humidity control: You should be able to adjust your humidity, and get it above 90% if necessary. Generally, this is only possible with ultra-sonic technology, which makes a light fog. Avoid high pressure spray systems – They leak and rain.

Low velocity refrigeration or cold coil cooling: A conventional walk-in fridge is harsh, windy, and too cold. Excessive air movement will dry the *surface* of the cheese only, causing cracking and uneven aging. The goal is to dry cheeses at an even rate from the outside to the center.

Fresh air in-take or exhaust: The opening and closing of the cave door might provide enough fresh air, but an exhaust system that pulls heavier gasses off of the cave floor is beneficial. Many, particularly surface ripening, microflora can only do their jobs efficiently with a good supply of oxygen for the respiratory process.

A **vaulted ceiling** is conducive to proper airflow and is less likely to drip from condensation. Untreated concrete also resists droplet formation and dripping. Sealed concrete, plastic walk-in siding and stainless or plastic aging racks are more likely to be dripping wet in a properly humidified cave. They are also 'sanitary surfaces' and thus resistant to the establishment of a microbial cave personality. A sanitary cave can never truly be 'seasoned' or contribute that 'je ne sais quois' to your finished cheese...

Visit many different cave set-ups before you build. Find someone making your cheese type, and educate yourself about aging techniques. If possible, travel to see small European producers.

Conclusions

You can make a great farmstead cheese from healthy, pastured animals and sell it fresh or finish it in 40 lb. cryo-vac blocks, but you won't get more than \$6 per pound wholesale for it. If you have a thousand sheep, this affinage-free business plan may be feasible. However, let's assume that you have a few hundred sheep or less. To make ends meet, you will have to charge upwards of \$10 per pound. To create the perception of value necessary for sale to retailers:

*Choose a definitive style that fits within a larger, international framework. Name it explicitly. Make sure your cheese roughly matches in texture (pH), appearance and flavor profile.

*Aim for a specific price-point that competes with your specific model (could even be another successful U.S. cheese with an under-served market) when you pitch to a potential client.

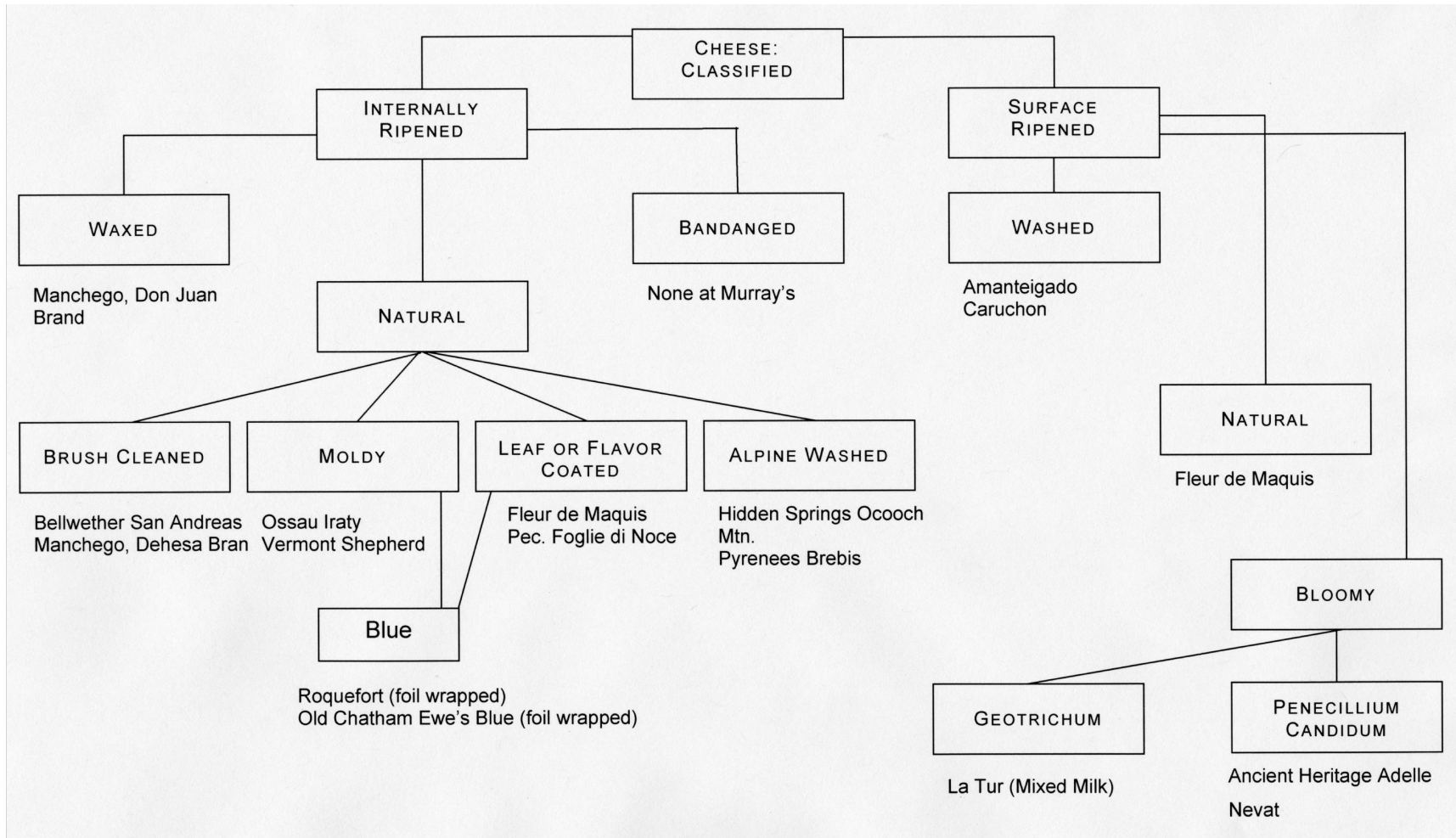
* Your cheese should be perfected and in good supply before you pitch. Don't send samples that are under-aged, noticeably flawed or highly limited in availability. Use

professional packing materials, lots of ice, and as much production and pricing information as possible if sending through the mail. First impressions really do matter.

*The integrity (flavor, texture, appearance) must meet or exceed that of the incumbent cheese you have named as your model.

It must be clear to the consumer that you have created a familiar cheese that is BETTER than the 'authentic' version because it is farmstead, locally made, more rustic, artisan or traditional.

Affineur's Concept Map



THE ISRAELI DAIRY SHEEP INDUSTRY

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The Israeli sheep industry consists of 2400 growers in the 3 population sectors: Bedouin ~ 200,000 head, Arab ~ 100,000 head, and Jewish ~ 133,000 head. Most of the Bedouin animals are raised traditionally on the open desert with a short lambing season and short milking period with most of the milk used by the family. Lambs stay with the dams, females are used as flock replacements while the males are fattened and sold for meat. In the Arab sectors, most herds are kept indoors or in a pasture near home, milk is utilized by the family or used for traditional yogurt and soft cheese. Male lambs are fattened and sold for meat. However, in the Arab sectors there are also large dairy herds similar to the Jewish sectors. In the Jewish sector, there are two types of management. The first includes ~360 farms with 100,000 animals, raising highly intensive indoor and/or pasture animals for meat production. The second includes ~140 farms with 33,000 animals, raising highly intensive indoor dairy sheep.

The area's main breed is the fat-tailed Awassi sheep. This breed has been raised in the area for thousands of years and is well adapted to the rough environmental conditions. However, these native animals are small with low milk production, late maturation, and low prolificacy. In the last 80 years, this breed underwent very intensive selection and has probably developed into the best dairy sheep worldwide. Rams can reach a weight of 120 kg while ewes reach 70 - 80 kg and produce 450 - 600 kg milk. However, the major drawback of the breed is late maturation (~12 month) and small litters (1.2 lamb/lambing). The Awassi has been exported to many countries over the last 30 years.

Due to the late maturation and the small litters of the Awassi, the East Friesian was imported from Germany in the 1960's and was crossbred with Awassi to produce the Israeli Assaf. This new breed is ~5/8 Awassi and ~3/8 East Friesian, producing similar amounts of milk, but maturing earlier (~7 month) and producing larger litters (1.7 lamb/lambing). This breed was also exported to other countries. In the last 15 years, there has been a new breeding program to increase prolificacy in both the Awassi and Assaf breeds by introgressing the B allele of the *FecB* locus from the Booroola Merino breed into each of these dairy breeds. After ~ 10 generations of backcrossing of Awassi or Assaf and maintaining the BB alleles, prolificacy has increased to 1.92 in Awassi and 2.55 in Assaf. However, maturation age of the Awassi remained and milk production is still lower than the original breed. The new crossbreeds are named Afec-Awassi and Afec-Assaf.

Awassi is the main breed in the Bedouin sector while Assaf is the main breed in the dairy farms. In the meat farms, there are others breeds such as Merino, Carole, Dorpers, and many crossbreeds.

The Israeli dairy farms (within the organized sectors) produce ~9.9 million liters/year. Most farms are highly intensive, with large operations of > 1000 sheep and the smaller ones

with 300-500 animals. Due to the seasonal breeding, most animals are lambing from September to May, although by hormone synchronization there are some flocks that lamb all year round. The goal is to reach 3 lambing/ewe in the 2 years after first lambing. Animals are naturally bred or artificially inseminated. At parturition, all lambs (in most herds) are removed from the dam and raised in nurseries using milk replacer for 21 - 28 days followed by grain and hay. Female lambs are used for replacements while males are fattened and sold for meat at the age of 4 - 6 months weighing 55 - 65 kg. All farms use milking machines, ~50% of which have new computerized herd and milk management systems. Sheep are milked twice daily for 3 - 7 months. Milk is collected and sold to large dairies for cheese production. Feeding is mostly indoors and highly mechanized, similar to intensive dairy cow farms.

There is a growing number of sheep and goat "boutique dairies" in recent years. These operations combine milk and other dairy products and in many cases also restaurants as well as small boutiques for a variety of agricultural products such as wine, olives and olive oil, honey etc. The dairies, including sheep, are under government regulation and control. Every farm and each animal are recorded, milk production is licensed, i.e., each operation has a quota; milk price is calculated by the organization and supervised by the Dairy Board. Farmers are paid according to milk volume and quality, according to °SH, bacteria and somatic cell counts. The Sheep Growers Association with the Ministry of Agriculture regulate cheese and meat importations within the limits of the National Trade Organization (NTO) and other international trade agreements. Mandatory vaccination is controlled by the Israeli Veterinary Services and Animal Health, mastitis is monitored by The Israel Dairy Board and Kimron Veterinary Institute and clinical veterinarians on call.

IMPACT OF HANDLING AND THAWING ON CHEESEMAKING PROPERTIES OF FROZEN SHEEP MILK

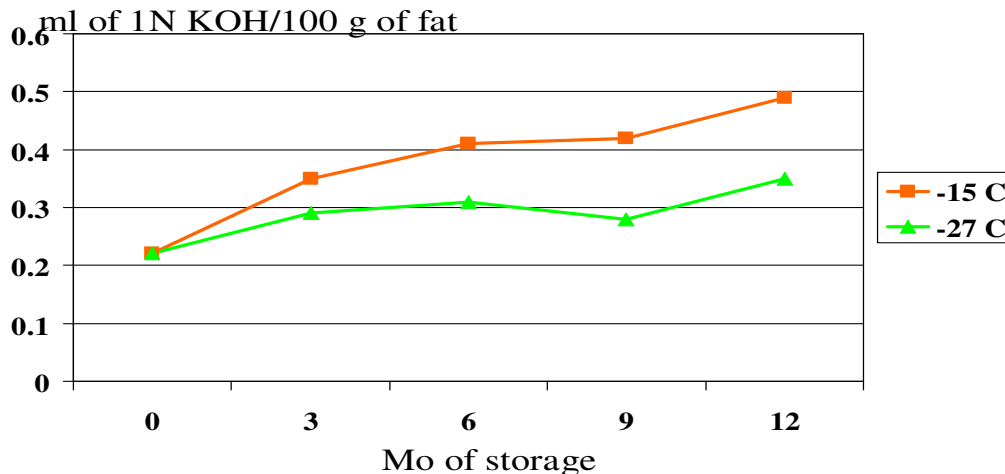
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Introduction

With seasonal production and low levels of milk production per ewe, raw milk typically is frozen at the farm until sufficient quantities of milk are accrued for further processing. Previous researchers (Bastian, 1994; Wendorff, 2001; Young, 1985; Zhang et al., 2006) have reported that frozen sheep milk can successfully be used to produce quality yogurt or cheese.

In the first several years of sheep milk production in Wisconsin, commercial cheese plants experienced some problems with milk quality and stability with frozen raw milk supplied by the dairy sheep cooperative. Some of our research studies concentrated on the projected shelf life of the frozen raw sheep milk and factors impacting raw milk quality during frozen storage. In our early research trials (Wendorff, 1998), one set of pails was frozen and stored in a home freezer at -15° C while the other set of pails was frozen and stored in a commercial freezer at -27° C. One pail from each freezer was removed after 3, 6, 9, and 12 months of storage and thawed in a cooler at 4° C. When thawed, samples were analyzed for acid degree value (ADV), intact protein, total bacteria and coliform bacteria. ADV for milk stored at -15° C were significantly higher than for those samples stored at -27° C (Figure 1).

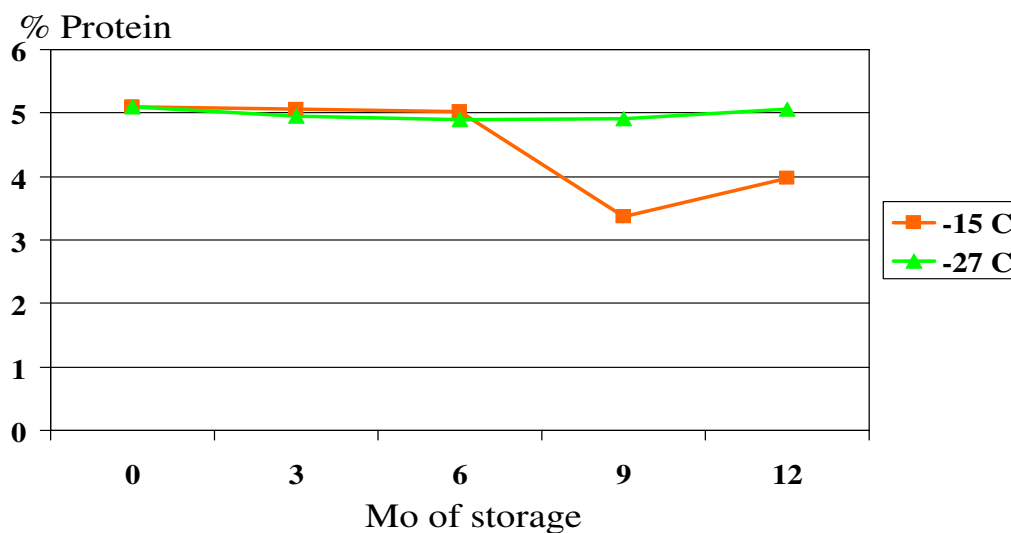
Figure 1. Acid degree value (ADV) of frozen raw milk



In spite of the increases in ADV with storage, samples did not exhibit a rancid flavor within the 12 months of storage. Several researchers (Antifantakis et al, 1980; Needs, 1992) have reported an increase in free fatty acids with frozen storage of sheep milk.

After 6 months of frozen storage at -15°C , thawed milk samples exhibited protein destabilization with flocculated protein settling at the base of containers (Wendorff, 2001). After 9 months of storage, over 20% of the protein was lost in the sediment (Figure 2).

Figure 2. Intact Protein in Frozen Milk



Samples stored at -27°C exhibited good protein stability throughout the 12 months of storage. Previous researchers have reported good protein stability in frozen sheep milk if stored below -20°C (Antifantakis et al, 1980; Young, 1985; Bastian, 1994). To preserve high quality sheep milk in frozen storage, we would recommend that milk should be rapidly frozen and stored at temperatures of -20°C or lower for no more than 6 to 12 months (Wendorff, 2001; Zhang et al., 2006).

With transport of frozen raw sheep milk to processing plants, cheesemakers have complained of poor cheesemaking properties in some lots of frozen sheep milk that had been transported in the frozen state during the summer months. Some questions have arisen concerning the potential temperature abuse of the frozen milk during transit with the possibility of partial thawing and refreezing of the milk. To evaluate the impact of that type of abuse, the first phase of this research study was set up to evaluate the impact of that abuse on cheesemaking properties of the transported sheep milk.

Extensive studies have been reported on the freezing and storage of frozen sheep milk, but little has been reported on the best procedure for thawing of frozen sheep milk for production

of cultured products. Previous researchers primarily used a slow thaw procedure in refrigerated storage for thawing frozen sheep milk. Commercial processors would like to use a quicker method for thawing frozen sheep milk for more efficient processing. The objective of the second phase of this study was to determine the influence of thawing procedure on the cheesemaking qualities of frozen sheep milk.

Materials and Methods

Sheep Milk

Mid-lactation sheep milk was obtained from the University of Wisconsin Agricultural Research Station at Spooner, Wisconsin. The milk was immediately cooled to 4° C and transported to the laboratory in Madison. Gross composition of the milk is shown in Table 1.

Table 1. Composition of frozen sheep milk used for manufacture of semi-soft cheese.

Total solids, %	17.04
Milk fat, %	6.65
Total protein, %	5.00
True protein, %	4.73
Casein, %	3.89
Casein/true protein, %	82.23
Casein:fat ratio	.58

Abusive Handling Trial

In spring of 2007, ten 40 lb. bags of fresh, refrigerated sheep milk was received from the Spooner Research Station and placed in a commercial freezer at -29° C (-20° F). The frozen sheep milk was stored for 6 weeks at that temperature. At six weeks, one bag of milk was removed from the freezer and placed in the adjoining cooler at 4.4° C (40° F) for 24 hr. After 24 hr., the bag was again placed in the freezer and refroze. This treatment was to simulate the potential loss of temperature in a refrigerated trailer for short duration before the temperature was brought back in line with freezing temperatures. This bag of milk had thawed about 2 inches in depth around the edges and sides of the bag by the end of 24 hr. of the abusive temperature.

A second bag of frozen milk was removed from the freezer and placed at the ambient lab temperature of 24.4° C (76° F) for 4 hr. The milk was then placed back in the freezer and refrozen. This treatment was to represent the potential abuse of being placed on a loading dock during transit and not being transferred directly to proper freezing temperatures from the delivery truck. This bag had about 1 inch of liquid milk around the edges and sides of the bag before being refrozen. The two abused bags of milk plus the properly frozen control sample were stored at -29° C (-20° F) for an additional two months.

After 3.5 months of frozen storage, the three bags of frozen milk were placed in a 3.3° C (38° F) cooler for two days to thaw completely. About 50 ml of each milk sample was placed in centrifuge bottles and spun down in a centrifuge at 1750 rpm for 3 minutes to remove any precipitated material from the milk. Total protein from each of the supernates was analyzed for true protein by the Kjeldahl procedure (AOAC, 2000). One Kg quantities of each milk were put into 1500 ml beakers and placed in a 31° C (88° F) water bath. A semi-soft type sheep milk cheese was produced by the method outlined below. Analyses were performed in duplicate and cheeses were formed in 3.9 in X 3.6 in X 3 in plastic cheese moulds. Cheese moistures were determined by Standard Methods procedure (Marshall, 1992). Cheesemaking trials were run in duplicate while milk and cheese analyses were run in triplicate.

Thawing Trial

The raw sheep milk from the Spooner Research Station (Table 1) was packaged in 3.8 liter Ziploc freezer bags and rapidly frozen in a commercial freezer at -27° C. Samples were stored at -27° C for 2 months prior to conducting the thawing studies.

For the thawing studies, samples were thawed under one of the following conditions: 1) slow thaw at 4° C (40° F) for 24 hr, 2) sample was thawed in a water bath at 32° C (90° F), 3) sample was thawed in a water bath at 54.5° C (130° F), and 4) sample was rapidly thawed in a microwave under the defrost cycle. Samples of each thawed milk were analyzed for soluble calcium using the procedures of Park (2000) and Ozcan-Yilsay et al. (2007).

Cheesemaking Procedure

Duplicate lots of each thawed raw milk (1 Kg) were placed in 1.5 liter beakers and placed in a 32° C water bath for the cheesemaking trial. When the milk temperature reached 31° C, 0.0387 g. of Danisco Choozit MA 4001 LYO 25 DCU culture (Dairy Connection, Madison, WI) was added to each beaker and stirred to get even distribution in the milk. The milk was cultured for 40 min. Then 0.30 ml of single strength veal rennet (Cargill, Waukesha, WI), diluted 1:10 with distilled water, was added to each beaker and briefly stirred. The milk was then allowed to coagulate until the proper firmness of the gel was obtained. Cutting time was determined by an experienced cheesemaker looking for a “clean break” when cut with a spatula. The curd was cut into ~0.75 cm cubes using a small spatula. The temperature of the water bath was then raised to 39° C and the curd was allowed to heal for 10 min. The curd in each beaker was then stirred for 20 min while the cooking temperature of 39° C was reached. Whey was drained from each beaker and the curd was placed in 3.9" x 3.6" x 3" fresh cheese moulds (Dairy Connection, Madison, WI). The hooped cheeses were covered and allowed to drain at 21° C for 20 hr. The cheeses were then weighed to determine cheese yield. Samples of each cheese were analyzed for moisture content.

Cheese Analysis

All compositional analyses were carried out on the milk and cheeses in triplicate. Raw milk was analyzed for total solids (Green and Park, 1980), fat by Mojonier, Procedure 989.05 (AOAC, 2000), protein (total percentage N × 6.35) by Kjeldahl, Procedure 991.20 (AOAC,

2000) and casein, Procedure 998.50 (AOAC, 2000). Cheeses were analyzed for moisture by vacuum oven (Vanderwarn, 1989). Theoretical and actual cheese yields were determined as outlined by Wendorff (2005).

Statistical Analysis

Results were analyzed using one-way ANOVA and Tukey's difference test on Minitab statistical software (Release 13.32; Minitab, Inc., State College, PA). The level of significance was determined at $P < 0.05$.

Results and Discussion

Abusive Handling

True protein analyses of the thawed milk samples showed no significant differences between the abused milk samples and the control sample. True protein concentrations ranged from 4.63 to 4.72%. The abusive treatments apparently did not destabilize the casein in the frozen milk sufficiently to precipitate the casein during the 2 months of frozen storage after the temperature abuse and refreezing process.

Results of the cheesemaking trials are shown in Table 2. Initial pH of milks, coagulation rate, cut times and whey pHs were similar for all 3 sources of milk.

Table 2. Influence of abusive storage treatments on composition and yield of semi-soft sheep milk cheese.

	Control ¹	24R ¹	4A ¹
Cheese yield ² , %	20.62 ^a	20.48 ^{a,b}	20.19 ^b
Cheese moisture, %	43.98 ^a	42.29 ^{a,b}	40.94 ^b

¹ Control = maintained in frozen state at -29° C, 24R = 24 hr abuse at 4° C and refroze, 4A = 4 hr abuse at 24.4° C and refroze.

² Cheese yield measured after hooping for 16 hr and before brining.

^{a,b} Means within the same row without a common superscript differ ($P < 0.05$).

Cheese yield was significantly reduced with the 4 hr abuse at ambient temperatures and refreeze treatment. That abused milk also produced cheese with lower moisture content. The 24 hr abused sample at refrigeration temperatures and refreeze treatment was not significantly different than the control milk after 3.5 months of frozen storage. There was no significant difference in moisture-free cheese solids recovered from all three sources of milk. From the results of the cheesemaking trials, it appears that the milk left out in ambient temperatures for 4 hr and refroze lost some water binding capacity in the milk proteins. The treatment was not severe enough to destabilize casein and precipitate it in the thawed milk, but was severe enough to impair some of the functionality of the proteins. Upon refreezing, the larger ice crystals were similar to those of milk slow frozen in home freezers of our earlier frozen milk studies

(Wendorff, 2001). Those larger ice crystals will then destabilize the casein in the frozen milk during extended storage. In our earlier studies, milk frozen at -12° C (10°F) showed casein destabilization after 3 - 6 month of frozen storage. One question that remains is would the abusive treatments have a greater impact with a longer frozen storage period after the refreezing of the abused milk? After 2 months of storage after refreezing, the 24 hr abused milk at refrigeration conditions was not significantly different than the unabused control. With longer storage of the refrozen milk, would there be additional destabilization to cause a significant loss in cheese yield and protein functionality?

Based on these current trials on temperature abuse of frozen sheep milk, it appears that some temperature abuse and refreezing of frozen sheep milk during transit may have a significant impact on the cheesemaking potential of that milk. The potential abuse at temperatures below 4° C (38° F) is not as significant as abuse at ambient conditions during transit.

Based on these results, we would have the following recommendations when using frozen sheep milk for cheesemaking. For transit of frozen milk during warm weather conditions, we would recommend using that frozen milk within 2 - 3 months of receipt of that milk. If that frozen milk can be monitored during shipment and temperatures of -18° C (0° C) can be maintained, quality of that milk should not be compromised. If that frozen milk has any potential for partial thawing and refreezing, we would recommend treating that milk as if it were slow-frozen and limit storage of the frozen milk to no more than 2 months after receipt before using it for cheese manufacture.

Thawing Trial

When milk is frozen and stored at -27° C, over 96% of the water is in the frozen state, and the solids in the unfrozen portion is over 75% (Morr, 1975). This solids concentration approaches that of a partially dried product. During the freezing process, proteins are partially dehydrated and the soluble calcium is decreased as it shifts to colloidal inorganic calcium (Lin et al, 1994). During the thawing of frozen milk, the proteins will become rehydrated again and some of the colloidal calcium will shift back to soluble calcium. The soluble calcium contents of the thawed milks are shown in Table 3.

Table 3. Influence of thawing procedure on soluble calcium content and coagulation time of frozen sheep milk.

Thawing procedure	Soluble calcium (mg of Ca/100 ml of milk)	Coagulation time ¹ (min)
24 h @ 3.8° C	32.50 ^a	9 ^a
32° C water bath	29.55 ^b	10 ^b
54.5° C water bath	31.95 ^{a,b}	10 ^b
Microwave defrost	27.11 ^b	12 ^c

¹ Coagulation time is the time of rennet addition to the time of cutting the curd.

^{a,b} Means within the same column without a common superscript differ ($P < 0.05$).

The slow thawed milk at 4° C was significantly higher in soluble calcium than the milk thawed at 32° C or thawed in the microwave. The soluble calcium content of milk thawed at 54.5° C was not significantly different than that in milk slow thawed at 4° C. The quicker thawing procedures did not allow the soluble calcium content to equilibrate to the level that was attained by the slow thawing procedure. Shufflebarger (1995) reported that it takes approximately 8 hr at 4° C for the soluble calcium content to equilibrate when reconstituting nonfat dry milk.

Soluble calcium aids in the aggregation of the rennet-altered casein micelles in the rennet coagulation of milk in the cheesemaking process (Morr, 1975). The time from rennet addition to cutting of the curd was 9 min for the slow thawed milk, 10 min for the 54.5° C and 32° C thawed milk, and 12 min for the microwave thawed milk (Table 3). These results were in agreement with Lin et al. (1994) that reported a soft curd texture due to reduced coalescence of casein from decreased soluble salts from frozen milk. The breaking stress of curds gradually increased with increased soluble calcium.

Based on the approximate analyses of the thawed sheep milk, the theoretical cheese yield for the milk was projected to be 17.39% (Wendorff, 2005). The yields of curd at hooping and cheese yields after pressing are given in Table 4.

Table 4. Influence of thawing procedure on yield of semi-soft cheese produced from frozen sheep milk.

Thawing procedure	Yield of curd, % (1 h)	Cheese yield, % (24 h)
24 h @ 3.8° C	20.50 ^b	16.85
32° C water bath	20.67 ^b	16.75
54.5° C water bath	21.24 ^a	16.70
Microwave defrost	20.59 ^b	16.67

^{a,b} Means within the same column without a common superscript differ ($P < 0.05$).

Initial yield of curd at hooping for milk thawed at 54.5° C was significantly higher than the other thawed milks. However, after draining and pressing, cheese yields from all thawed milks were not significantly different. Actual cheese yields were 96-97% of the theoretical cheese yield. Cheese moisture content of the cheese from 54.5° C thawed milk was significantly higher than the other cheeses (Table 5). This was probably due to denaturation of some of the whey proteins with the higher thawing temperature and retention of moisture by those denatured whey proteins in the cheese.

Slow vs. rapid-thawing of frozen milk

In previous studies, slow thawing of milk has been recommended for several reasons. Timms (1988) reported higher protein values and lower somatic cell counts (SCC) in slow thawed frozen

cow milk as compared to the frozen milk. Canadian researchers (Gebre-Egziabher et al., 1982) reported that destruction of microbial cells was significantly greater when milk was thawed slowly at 4° C versus rapid thawing at 45° C. Lin et al. (1994) state that higher levels of soluble calcium from slow thawed milk apparently increases the expulsion of whey from milk gels. This would be especially advantageous in sheep milk which produces a denser curd that has a slower diffusion of moisture from the curd.

Table 5. Influence of thawing procedure on moisture of semi-soft cheese produced from frozen sheep milk.

Thawing procedure	Cheese moisture (%)
24 h @ 3.8° C	42.21 ^b
32° C water bath	43.61 ^b
54.5° C water bath	46.21 ^a
Microwave defrost	43.65 ^b

^{a,b} Means within the same column without a common superscript differ ($P < 0.05$).

In frozen meats, higher product losses may be experienced with faster rates of thawing (Vail et al., 1943). When thawing was slower, the time for reabsorption of extracellular water by the meat proteins was greater and drip loss was minimized (Gonzalez-Sanguinetti et al., 1985). In order to allow maximum absorption of extracellular water, thawing rate at the surface of the meat must be >50 minutes.

On the other hand, Addeo et al. (1992) reported that rapid thawing with microwaves overcame problems of fat separation during slow thawing of frozen buffalo milk. Cheese prepared from rapidly-thawed frozen buffalo milk had organoleptic properties similar to that of cheese prepared from fresh milk. French researchers (Hote-Baudart and Coppens, 1962) evaluated thawing of quick-frozen milk at 40° C, 18° C, and 6° C and found no significant differences in cream volume or viscosity. However, they did report that rapid thawing had the least harmful effect on physical and colloidal properties of whole or skim milk.

Conclusion

Results of this study did not conclusively identify one thawing procedure that was optimum for maximum cheesemaking potential of frozen sheep milk. The slow thawing procedure at 4° C did provide the greatest concentration of soluble calcium in the milk for the most efficient coagulation of the milk and most effective syneresis of whey during the cheesemaking process. However, it did not yield any significant increase in cheese yield over the other thawing procedures. The 54.5° C thawing procedure yielded a comparable cheese yield to the slow thawing procedure but retained significantly more moisture in the final cheese. This was most likely due to partial denaturation of whey proteins in the thawing treatment and greater moisture retention by the denatured proteins. Accordingly, we would not recommend thawing frozen sheep milk in a vat pasteurizer or at process temperatures above 50° C.

If a cheesemaker wants to thaw frozen sheep milk quicker than the slow thaw procedure at 4° C, we would recommend thawing the milk at 32° C. At that temperature, the coagulation and syneresis rates were only slightly decreased and the final cheese yield and moisture were not significantly different from the slow thaw procedure. Since the cheese yield and cheese moisture were not significantly different for the 32° C and the microwave thawed milk from that of slow thawed milk, we assume that the rehydration of the casein and equilibration of soluble calcium were sufficient for good cheesemaking potential from the frozen milk. In previous studies (Wendorff, 1996), we found that casein rehydration in nonfat dry milk reconstituted at 32° C for 2 hr was sufficient so that the casein functioned the same as that of fresh milk. This temperature is also very functional since it is close to the same temperature that would be used for manufacture of raw milk hard cheeses. However, in most cases we would recommend pasteurization of the thawed sheep milk prior to cheesemaking to eliminate potential pathogens and to inactivate the native lipases to control rancidity in the final cheese.

Acknowledgements

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UPDATE ON IMPORTATION OF RAM SEMEN INTO THE U.S.

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Background

The U.S. population of dairy sheep is small, probably less than 20,000 ewes, and the relationship among animals is higher than desired. Far larger populations of dairy sheep reside in Europe than in any other region of the world. Regular access to European dairy sheep genetics would decrease the inbreeding level of U.S. populations. In addition, many European countries have successful national genetic improvement programs for their dairy sheep populations that result in continued genetic improvement for economically important traits. Access to these genetically improved populations would allow U.S. producers to increase the performance of their flocks at a faster rate than the currently used ad hoc within-flock selection schemes. The import of sheep, semen, and embryos is controlled by Veterinary Services, National Center for Import/Export, Animal and Plant Health Inspection Service, USDA (subsequently referred to as APHIS) located in Riverdale, Maryland.

Import Procedures

In order to import sheep, semen, or embryos, an import permit must be obtained from APHIS by submitting VS Form 17-129 (a copy of the form and instructions can be found at the end of this paper and are available online at: http://www.aphis.usda.gov/import_export/forms.shtml).

However, before an import permit will be issued, APHIS must have an import protocol in place that has been approved by both APHIS and the exporting country for live animals, semen, or embryos. Before submitting an application for an import permit (VS Form 17-129), contact APHIS to see if an approved protocol exists.

If APHIS has an import protocol for the exporting country, request a copy and send it to your exporter to make sure that they can meet all of the APHIS requirements. If APHIS does not have an approved import protocol for the exporting country, you or your potential exporter must request a national animal health official of the exporting country to contact APHIS to initiate the development of an import protocol. The current person to contact at APHIS for approved protocols and the development of new protocols is:

Dr. James P. Davis, Senior Staff Veterinarian
USDA, APHIS, VS, AHP, NCIE
Unit 39, 4700 River Road
Riverdale, MD 20737
301-734-0694, 301-734-6402 (fax)
james.p.davis@aphis.usda.gov

Requirements of an importing flock in the U.S. may differ, depending upon the country of origin of the live animals, semen, or embryos. As a minimum, importing flocks will be required to have a premise identification number in the mandatory National Scrapie Eradication Program and may be required to be enrolled in the voluntary Scrapie Flock Certification Program (http://www.aphis.usda.gov/animal_health/animal_diseases/scrapie/).

The following table presents the countries that currently have approved protocols with APHIS for the importation of live breeding sheep, ram semen, or sheep embryos. Since disease status of a country can change, persons wishing to import sheep genetic material should still contact APHIS prior to submitting an application for an import permit in order to determine if the potential exporting country is still approved for export to the U.S.

Countries with approved protocols for importation of live breeding sheep, ram semen, or sheep embryos into the United States

Country	Approved protocol for importation of:		
	Live breeding sheep	Ram semen	Sheep embryos
Australia	Yes	Yes	Yes
Canada	No	Yes	No
New Zealand	Yes	Yes	Yes
United Kingdom	No	Yes	No

The approved protocol for the importation of frozen ram semen into the U.S. from the U.K. is at the end of this paper. This will provide an idea of the health requirements that must be met in order to import sheep genetic material into the U.S.

No animals, animal semen, animal embryos, birds, poultry, or hatching eggs may be imported unless a completed application has been received (9 CFR 92 and CFR 93).

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0579-0040. The time required to complete this information collection is estimated to average .17 hours per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

FORM APPROVED OMB NO. 0579-0040

U.S. DEPARTMENT OF AGRICULTURE ANIMAL AND PLANT HEALTH INSPECTION SERVICE VETERINARY SERVICES APPLICATION FOR IMPORT OR IN TRANSIT PERMIT <i>(Animals, Animal Semen, Animal Embryos, Birds, Poultry, or Hatching Eggs)</i>		1. NAME AND ADDRESS OF SHIPPER IN COUNTRY OF ORIGIN	
INSTRUCTION TO IMPORTER: Complete and submit one copy to the Veterinary Services, APHIS, U.S. Department of Agriculture, 4700 River Road, Riverdale, MD 20737. Prepare a separate application for each shipment.		3. PORT OF EMBARKATION <i>(From Canada show only for ocean vessel or airplane shipments)</i>	
2. NAME AND ADDRESS OF IMPORTER <i>(Include Zip Code)</i>		4. COUNTRY FROM WHICH SHIPPED	
TELEPHONE NUMBER <i>(Include Area Code)</i>		5. MODE OF TRANSPORTATION <i>(Name of Airline or Vessel, flight no.)</i>	
6. ANIMALS, ANIMAL SEMEN, ANIMAL EMBRYOS, BIRDS, POULTRY, OR HATCHING EGGS			
NO.	BREED	SPECIES	DESCRIPTION <i>(Sex, Age, Registered Name and No., Tattoo, Tag No., Other Markings)</i>
6E. PURPOSE OF IMPORTATION			
7. ROUTE OF TRAVEL INCLUDING ALL CARRIER STOPS ENROUTE <i>(From Canada show route of travel only for ocean vessel or airplane shipment)</i>			
8. PROPOSED SHIPPING DATE <i>(From Canada show only for ocean vessel or airplane shipment)</i>		9. PROPOSED ARRIVAL DATE	10. UNITED STATES PORT OF ENTRY
11. NAME AND MAILING ADDRESS OF PERSON TO WHOM DELIVERY WILL BE MADE <i>(After quarantine, when required) (Include Zip Code)</i>		12. WHERE DELIVERY WILL BE MADE IN U.S. <i>(After quarantine, when required)</i> <i>(Location of place)</i>	
TELEPHONE NUMBER <i>(Include Area Code)</i>			
13. REMARKS			
14. SIGNATURE OF IMPORTER			16. DATE SIGNED

VS FORM 17-129 (MAY 96)

INSTRUCTIONS ON COMPLETING VETERINARY SERVICES (VS) FORM 17-129

1. VS Form 17-129 is an official document, however, copies may be made for future use.

2. Please complete the entire application. The application must be legibly written or typed. Do not abbreviate.
3. Submit one application for each permit required.
4. There is a \$94.00 user fee charge for applications submitted. Payment is required before we can issue a permit. Payment can be made by check or money order made out to USDA, APHIS, bank cards (VISA or Mastercard), or through established credit with the Agency. See below for information on establishing a user fee credit account.
5. Box 1, 3, 4, and 5 - This information is important and must be completed.
6. Box 2 - Name and address of shipper or agent - please include name and telephone number.
7. Box 6-
 - (A) Number of animals. If shipment is semen or embryos, indicate the number of doses, ampules, or straws.
 - (B) Breed of animal(s) - please be exact - no abbreviations.
 - (C) Species of animal(s) - please be exact.
 - (D) Description of animal(s) - list according to species, and use additional sheet of paper if necessary.
 - (E) Purpose of Importation - indicate if shipment is an importation or transit.

Transit - Transit stop is for crew change and refueling only. Unloading of animals is not permitted. Animal(s) are subject to supervision by VS port personnel. VS port personnel must be given 1 week notice of exact time and date of arrival. Animals are to be treated as one load.

Import - Imported animal(s) intended for entry into the United States. Refer to protocol for length of quarantine, if quarantine is necessary. Importers of equine being imported for special events should also refer to protocols as necessary.

8. Box 7 — Be as specific as possible. Do not abbreviate.
9. Boxes 8 and 9 - Exact dates are needed. The permit issued will only be valid for 14 days from the proposed shipping date.
10. Box 10 - The first port of entry in the United States, in most cases of transit shipments which will stop at more than one port in the United States, please list all ports.
11. Box 11 - Be exact - include the name and number of person which contact can be made if the need arises.
12. Box 12 - 15 - As indicated.

Mailing VS Form 17-129

Faxed copies are accepted as long as you follow-up the fax with a hard copy. After completing VS Form 17-129 mail to:

Animal and Plant Health Inspection Service
 Veterinary Services
 Import Animals Branch
 4700 River Road, Unit 39
 Riverdale, MD 20737-1231

Telephone (301) 734-8170
 Facsimile (301) 734-6402

If using regular mail, please allow 7 to 14 days for us to receive the application and 7 to 14 days for you to receive your permit.

ORIGINAL PERMIT MUST ACCOMPANY THE ANIMALS, SEMEN, OR EMBRYOS DURING SHIPMENT. To expedite this process, you may enclose with your application, a prepaid airway bill, with your name and address as sender and recipient. **USDA CANNOT APPEAR ON THE RETURN AIRWAY BILL ANYWHERE.** If USDA appears on the return airway bill we will not use it. We are no longer filling out airway bills for applicants. You may send more than one pre-paid airway bill, for future use, we will keep it on file.

Establishing a User Fee Credit Account with APHIS

An account can be established by requesting an application from the following:

USDA, APHIS, ART		User Fee Helpline
P.O. Box 3334	-or-	1-877-777-2128
Minneapolis, MN 55403		or (612)370-2291

A form can also be downloaded from the following web site:
<http://www.aphis.usda.gov/library/forms>, select: "APHIS 192 ".

Approved USDA/APHIS Protocol for Importation of Frozen Ram Semen from the United Kingdom, August 1, 2008



DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS
THE SCOTTISH EXECUTIVE ENVIRONMENT AND RURAL AFFAIRS
DEPARTMENT
NATIONAL ASSEMBLY FOR WALES
DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT, NORTHERN
IRELAND

No:

EXPORT OF OVINE AND CAPRINE SEMEN TO THE UNITED STATES OF AMERICA

HEALTH CERTIFICATE

EXPORTING COUNTRY: UNITED KINGDOM

FOR COMPLETION BY: OFFICIAL VETERINRIAN

I. Information concerning the donor animal(s)

Breed	Registered name	Registration number

II. Information concerning the semen

- a) Date(s) of collection:
- b) Number of ampoules/straws and volume of each:.....
- c) Permanent identification marks on ampoules/straws indicating the date(s) of collection and breed and registered name and number of the donor animal(s) or this information

may be provided in code form with an explanation of this code:

.....
.....

d) Method and degree of dilution (with statement of preservatives and antibiotics used):

.....
.....

e) Serial number of seal on the shipping container:

.....

III. Origin of the semen

a) Name and address of the Semen Collection Centre:

.....

b) Name and address of the owner of the donor animal(s):

.....

IV. Destination of the semen

a) Name and address of exporter:

.....

b) Name and address of consignee:

.....

c) Means of transportation and all available details of shipment:

.....

d) Import permit number(s):

V. Health Information

I, the undersigned official veterinarian, hereby certify that:

- 1) the semen described in this certificate was collected in the United Kingdom, which at the time of collection, was considered by the USDA, as listed in 9 CFR Part 94 and other official publications, to be free of foot-and-mouth disease (FMD) and rinderpest;
- 2) the donor animals were part of the national herd/flock of the United Kingdom for a minimum period of time, as follows:

2.1 IN THE CASE OF DONOR ANIMALS IMPORTED FROM COUNTRIES
RECOGNISED BY THE USDA TO BE FREE FROM FOOT AND MOUTH DISEASE
AND RINDERPEST

the donor animals have been free from any import quarantine restrictions and able to move freely within United Kingdom's national herd/flock for a minimum period of 60 days prior to the collection of semen for export to the United States of America;

2.2 IN CASE OF DONOR ANIMALS LEGALLY IMPORTED FROM COUNTRIES
NOT RECOGNISED BY THE USDA TO BE FREE FROM FOOT AND MOUTH
DISEASE AND RINDERPEST

the donor animals have been free from any import quarantine restrictions and have been able to move freely within United Kingdom's national herd/flock for a minimum period of 90 days prior to the collection of semen for export to the United States of America;

- 3) the semen was derived from donor animals which were established as residents of an approved Semen Collection Centre, herein after referred to as 'SCC', in accordance with Council Directive 91/68/EEC;
- 4) in so far as can be determined, during the 12 months prior to the collection of semen for export to the United States of America, there has been no evidence to indicate that the donors have been affected with tuberculosis, brucellosis, Maedi-visna, ovine pulmonary adenomatosis, paratuberculosis or scrapie;
- 5) in so far as can be determined, during the 60 days prior to the collection of semen for export to the United States of America, the donors were not corralled, pastured or held with other animals of lesser animal health status or under any animal health restrictions which would make them ineligible as donors of semen for export to the United States of America;
- 6) the donors were inspected on the date of semen collection and found to be free of clinical signs of infectious diseases transmissible in semen;
- 7) concerning scrapie:

7.1 the donor animals

7.1.1 are permanently identified, to enable traceback to their herd/flock of origin;

7.1.2 have been kept since birth in herds/flocks in which no case of scrapie had been confirmed during their residency;

7.1.3 neither showed clinical signs of scrapie at the time of semen collection nor developed scrapie between the time of semen collection and the export of semen to the United States;

7.1.4 the dam of the semen donor is not, nor was not, affected with scrapie;

7.2 In the United Kingdom:

7.2.1 scrapie is a compulsorily notifiable disease; and

7.2.2 an effective surveillance and monitoring system for scrapie is in place; and

7.2.3 affected sheep and goats are slaughtered and completely destroyed; and

7.2.4 the feeding of sheep and goats with meat-and-bone meal or greaves derived from ruminants has been banned and the ban effectively enforced in the whole region;

7.3 a written declaration has been received from the exporter/exporter's agent stating that arrangements have been made for the semen to be transferred to females in a flock that is listed in the Scrapie National Database as part of the Scrapie Program in the United States;

7.4. for semen collected prior to 17 December 2007:

in so far as can be determined after due enquiry, the donor animals have not been in a herd/flock nor had direct contact with animals that have been in a herd/flock where scrapie has occurred within 5 years prior to the date of collection of the semen for export to the United States of America;

8) Testing

8.1 Concerning Brucella, Maedi-Visna disease and tuberculosis

on, being within 30 days prior to the first collection and again on, being not less than 30 days and not more than 120 days after the last collection of semen for export, blood samples were taken from the donor rams and sent to an official Laboratory where they were submitted to the following tests with negative results:

8.1.1 Brucella

a) *Brucella abortus/melitensis*: the rose-bengal test or card test, or the complement fixation test, or the buffered antigen test, in accordance with the OIE Manual of Diagnostic Tests and Vaccines;

b) *Brucella ovis* (in the case of sheep): ELISA which uses the *B. ovis* REO 198 HS antigen, or the complement fixation test;

8.1.2 Maedi-Visna disease:

the agar gel immunodiffusion test (AGID), or ELISA;

8.1.3 Tuberculosis

*a) the intradermal tuberculin test: the intradermal injection of 0.1 mL bovine purified protein derivative (PPD) tuberculin (1 mg/mL PPD) into either side of the caudal fold or other appropriate sites, with reading by visual observation and palpation 72 hours (plus or minus 6 hours) following injection. A negative test result is the lack of a response that can be seen or palpated.

OR

*b) a tuberculin test using the OIE recommended test (cervical test) described in the OIE Manual of Standards for Diagnostic Tests and Vaccines.

NOTE: there must be an interval of at least 60 days between the pre- and post-collection tests.

8.2 Concerning bluetongue virus (BTV)

the semen was obtained from donor animals which comply with at least one of the following conditions:

*8.2.1 they have been kept outside a BTV restricted zone for a period of at least 60 days before commencement of, and during, collection of the semen;

*8.2.2 they have been protected from attack from Culicoides likely to be competent BTV vectors for a period of at least 60 days before commencement of, and during, collection of the semen;

*8.2.3 they have been subjected to a serological test according to the OIE Terrestrial Manual to detect antibodies to the BTV group, with negative results, at least every 60 days during the collection period and between 21 and 60 days following the final collection for this consignment;

*8.2.4 they have been subjected, with negative results, to an agent identification test for BTV according to the OIE Terrestrial Manual carried out on blood samples collected at commencement and final collection, and during the period of semen collection for this consignment:

* at least every seven days, in the case of a virus isolation test,

* at least every 28 days, in the case of a polymerase chain reaction (PCR) test.

9) Semen processing and shipping

9.1 the semen was collected and processed under the supervision of the Veterinarian in charge of the SCC and was placed in individual ampoules/straws which were permanently identified with:

- EITHER** *i. the dates of collection;
- AND** *ii. the breed and the registered name and number of the donor animals;
- OR** *iii. a code representing the information in i. and ii. whose meaning has been clearly explained at II c);

9.2 the shipping container was either new or cleaned and disinfected prior to use, and only fresh liquid nitrogen has been used to charge the container;

9.3 after processing the ampoules/straws were stored under the supervision of the SCC veterinarian under hygienic conditions in a flask which had been emptied, cleansed and disinfected since it was last used, and in the case of frozen semen the flask contained virgin liquid nitrogen. The semen identified at II c) has been stored in a designated storage area only with semen eligible for export to the United States of America, and it was placed in a shipping container and sealed with an official seal with the following identification code on the seal:

.....
.....

***Delete as appropriate**

Stamp

SignedRCVS

**Name in
block letters
Official Veterinarian**

Date

EFFECT OF DRY TREATMENT ON MASTITIS IN DAIRY SHEEP

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Introduction

Mastitis is an inflammation of the mammary gland (Schalm et al., 1971; Blood et al., 1979) and is one of the most costly diseases for dairy producers. The economic impact of mastitis in dairy ewes is related to costs of treatment, culling of ewes, decrease in milk production, changes in milk composition and reduced lamb performance (Torres-Hernandez and Hohenboken, 1979; Watson and Buswell, 1984; McCarthy et al., 1988; Fthenakis and Jones, 1990; Keisler et al., 1992; Burriel, 1997; Saratsis et al., 1998; Bergonier and Berthelot, 2003; Leitner et al., 2004; Moroni et al., 2007).

The SCC of milk is widely used to detect subclinical mastitis in dairy cows, and it is considered to be an effective tool in monitoring subclinical mastitis and diagnosing intramammary infections in dairy sheep as well (Gonzalo et al., 1994; Gonzáles-Rodríguez et al., 1995; Pengov, 2001).

Mastitis of dairy ewes is usually subclinical and of bacterial origin. Coagulase-negative staphylococci (CNS) are the most common pathogens responsible of subclinical mastitis of dairy ewes (Fthenakis, 1994; Burriel, 1997; Lafi et al., 1998; Ariznabarreta et al., 2002; Gonzalo et al., 2002; Bergonier et al., 2003; Hariharan et al., 2004). Subclinical infections are associated with increased somatic cell count (Pengov, 2001; Ariznabarreta et al., 2002).

Antibiotic dry off therapy (DT) is largely used for mastitis control in lactating dairy cows, but little is known about its efficacy in dairy sheep (Hueston et al., 1989; Ahmad et al., 1992; Croft et al., 2000; Chaffer et al., 2003; Gonzalo et al., 2004). The effectiveness of dry therapy in prevention and reduction in prevalence of ovine mastitis was demonstrated (Hueston et al., 1989; Gonzalo et al., 2004).

The objective of this study is to determine the effect of intramammary antibiotic DT on prevalence of intramammary infection in the subsequent lactation.

Materials and methods

The study was carried out at the University of Wisconsin-Madison dairy sheep research facility at Spooner, Wisconsin. In 2007, the flock consisted of 331 milking ewes (245 multiparous ewes and 86 primiparous ewes). Lambing began in mid January and ewes were milked until late fall (September-October). The mean lactation length was 166 and 209 days for primiparous and multiparous ewes, respectively. Ewes ranged in age from 18 months to 8 years of age (1st to 7th parity).

Allocation to groups & administration of treatments

At the end of the lactation season, eligible milking ewes (n = 245) were blocked on the basis of the final test-day SCC, and randomly allocated to two treatment groups. The SCC blocks were ewes with the last monthly SCC greater than 400,000/ml (High SCC) or ewes with last monthly SCC less than 400,000/ml (Low SCC). During the final milking session, ewes were randomly assigned within SCC block to receive either an intramammary infusion of 300 mg cephapirin benzathine (DT) or no dry treatment (NT). Teat ends were scrubbed with cotton soaked in 70% isopropyl alcohol, and an entire intramammary tube was administered in each half udder. After administration of DT, teats were dipped using a germicidal teat dip (1% iodine solution).

Sampling & Data Collection

The dry period varied from 100 - 150 days, and lambing occurred in late January through March 2008. Before the first parlor milking, farm personnel collected a single half udder milk sample from each ewe. The samples were frozen and shipped each week to the UW Milk Quality Laboratory for bacteriological examination. After 14 - 21 days post lambing, study personnel visited the farm to collect two half udder milk samples (follow-up samples). All milk samples were collected according to National Mastitis Council (NMC) procedures (NMC, 1999). One sample was used for bacteriology and the other one to assess the half-udder SCC using a portable somatic cell counter (DCC; DeLaval International AB, Tumba, Sweden).

Bacteriology

Microbiological procedures were conducted according to NMC guidelines (NMC, 1999). Individual half udder milk samples were spread over the surface of blood agar (Bacto-Agar; Difco Laboratory, Detroit, MI) and MacConkey (Difco) agar plates. Samples were also screened for *Mycoplasma* species using comingled milk samples plated on mycoplasma media (UC-Davis). Bacteriological interpretation and identification was based on the NMC recommendation for bovine milk cultures (Laboratory handbook on bovine mastitis, 1999).

Definitions

Intramammary infection (IMI) was defined as growth (≥ 300 cfu/ml) of identical colonies. Negative culture (NG) was defined as absence of growth. No significant growth (NSG) was defined as growth of < 3 identical colonies (< 300 cfu/ml). Mixed culture was defined as significant growth of two different types of colonies with ≥ 3 identical colonies. Contamination was defined as significant growth of ≥ 3 colony types. A ewe was considered to have an IMI if at least one half udder had an IMI infection, and was considered uninfected if both half udders were NG or NSG. In the assessment of IMI, ewes with only one half udder sample available (due to missing or contaminated samples) were excluded, unless the available sample was considered to have an IMI.

The IMI data were used to characterize ewes to 4 statuses (chronic, cure, new infection and uninfected). Chronic status was defined as the presence of an IMI in at least one half udder per ewe at both lambing and follow-up. A cure was defined as a ewe with at least one half udder with IMI at lambing but no IMI at follow-up. A new infection status was defined if a ewe was uninfected at lambing, and had at least one half udder IMI at follow-up. Uninfected was defined as a ewe with no IMI at lambing and follow-up.

Preliminary statistical analysis

A test of homogeneity (χ^2 statistic) was performed to determine if the ewes were randomly allocated to treatment groups. Comparability of ewes that completed the study was compared in a similar fashion.

The prevalence of IMI at lambing and follow-up was assessed at ewe level. A χ^2 statistic was used to determine the association between intramammary infection status and treatment. The test of association was performed at the two sampling times (lambing and follow-up) on a subset of the data, including infection due to gram positive in ewes blocked in the high SCC group (SCC \geq 400,000/ml).

The SCC was transformed in \log_{10} SCC and its mean compared by group of pathogens isolated. The groups were defined as: uninfected, major pathogens (*Staphylococcus aureus*, enterobacteriaceae and Streptococcus spp.), minor pathogens (coagulase negative staphylococci, Corynebacterium spp. and Bacillus spp.), other and yeast.

Preliminary results

Treatment allocation and study population

The number of animals in the SCC groups, assigned to treatments, and present at lambing and for follow-up samples are summarized in Table 1. As expected based on the stratified random sampling plan, there was no association ($P = 0.78$) between assignment to treatment groups (DT, NT) and SCC levels (High, Low). Likewise, there was no association between assignment to treatment group and retention in the study ($P = 0.37$ and $P = 0.38$ at lambing and at follow-up, respectively).

Bacteriology

Uninfected samples accounted for 70.0% and 85.5% of the total at lambing and follow-up, respectively. The prevalence of contaminated samples at lambing (6.3%) was higher than at follow-up (0.7%). A summary of the pathogens isolated is reported in Table 2. The most prevalent pathogens were CNS (lambing (10.1%); follow-up (6.6%)). *Staphylococcus xylosus* was the most prevalent species (Table 3).

Yeasts were detected at lambing (3.2%) and at follow-up (3.7%) and all the cases were isolated from half udders assigned to the dry cow antibiotic treatment group. The prevalence of *Corynebacterium* spp. and *Bacillus* spp. was greater at lambing (4.3%) than at follow-up (1.2%).

Intramammary infection

At lambing IMI status was associated with the treatment ($P = 0.04$). The rate of IMI in the not treated group was 80% greater than in the treated group - ewes in the not treated group were 3.4 times more likely to be infected than ewes in the treated group ($P = 0.04$). At follow-up, no association was found between IMI status and treatment ($P = 0.6$) (Table 4).

The Log₁₀ SCC was significantly different ($P < .001$) among pathogens. Greater SCC was observed for minor pathogens (5.8) and differed among uninfected, yeast and other. As expected, the least count (4.57) was found in the uninfected group (Table 5).

Discussion

In agreement with previous studies, CNS were the most prevalent pathogens (Fthenakis, 1994; Burriel, 1997; Lafi et al., 1998; Ariznabarreta et al., 2002; Gonzalo et al., 2002; Bergonier and Berthelot, 2003; Hariharan et al., 2004). The greater prevalence of contaminated samples from lambing to follow-up may be explained by the fact that the samples were not collected by the same personnel. Of the 30 yeasts isolated, all cases were isolated from half udder assigned to the treatment group. Little is known about mycotic mastitis in small ruminants, but an association between incorrect administration (such as contaminated drugs and syringes) of antibiotic at drying-off was suggested (Las Heras et al., 2000).

Greater SCC was observed in IMI caused by minor pathogens. This study supports other author's findings (Pengov, 2001) that CNS in dairy ewes cannot be considered as minor pathogens, since they elicit high SCC.

Dry treatment was effective for ewes which were classified as High SCC and were infected with gram positive bacteria. The IMI in the non treated group was 80% higher than in the treated group, and the non treated group was 3.4 times more likely to have IMI compared with the treated group ($P = 0.04$). This finding is reasonable because the antibiotic used (Cephapirin benzathine) exhibits its activity against gram positive bacteria. No association was found at follow-up, probably due to the high self cure that occurred between lambing and follow-up.

Conclusion

The high prevalence of yeast infections demonstrates the importance of proper antibiotic administration procedures. To avoid potential yeast infections, dry therapy should be performed under strict hygienic conditions, using sterile products and equipment and following proper sanitation.

Results of different studies agree with the effectiveness of dry off therapy for prevention and treatment of mastitis (Hueston et al., 1989; Gonzalo et al., 2004; Chaffer et al., 2003). In this study the dry treatment was effective in reducing the IMI when used in ewes with high SCC and against gram positive bacteria. Before the dry treatment is recommended on a regular basis, other factors, such as cost benefit ratio, target pathogens (i.e. CNS), implementation of hygienic milking and management strategies must be considered. The results in this study suggest that dry therapy is recommended on the basis of the bacteriology.

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Table 1. Number of animals in the SCC groups, assigned to treatments, and present at lambing and for follow-up samples.

	DryTherapy ^a		No Treatment		Total
	High ^b SCC	Low ^c SCC	High SCC	Low SCC	
Assigned	30	95	27	93	245
Lambing	30	80	24	85	219
Follow-up	29	79	23	83	214

^a300 mg cephalixin benzathine

^b ≥ 400,000 cells/ml

^c < 400,000 cells/ml

Table 2. Isolates from half udder milk samples at lambing and at follow-up.

Isolates	Lambing		Follow-up	
	n	%	n	%
No growth or NSG	311	70.0	365	85.5
CNS	45	10.1	28	6.6
<i>Corynebacterium</i> spp.				
+ <i>Bacillus</i> spp.	19	4.3	5	1.2
Yeast	14	3.2	16	3.7
Other	12	2.7	4	0.9
<i>Enterobacteriaceae</i>	8	1.8	2	0.5
<i>Streptococcus</i> spp.	6	1.4	3	0.7
<i>Staphylococcus aureus</i>	1	0.2	1	0.2
Contaminated	28	6.3	3	0.7
Total	444	100	427	100

Table 3. Prevalence of CNS intramammary infection by species at lambing and follow-up.

Species	Lambing		Follow-up	
	n	%	n	%
Unidentified	29	64.4	15	64.3
<i>S. xylosus</i>	6	13.3	4	10.7
<i>S. chromogenes</i>	3	6.7	-	-
<i>S. auricularis</i>	2	4.4	1	3.6
<i>S. simulans</i>	1	2.2	4	10.7
<i>S. epidermidis</i>	3	6.7	2	3.6
<i>Micrococcus spp.</i>	1	2.2	1	3.6
<i>S. cohnii</i>	1	2.2	1	3.6
<i>S. lentus</i>	1	2.2	-	-
<i>S. capitis</i>	1	2.2	-	-
<i>S. hominis</i>	1	2.2	-	-
Total	45	100.00	28	100.00

Table 4. Summary of intramammary infection status in ewes with SCC > 400,000.

	Lambing		Follow-up	
	Uninfected ^a	Infected ^b	Uninfected	Infected
Not treated	7 (14.6%)	14 (29.2%)	13 (26.0%)	8 (16.0%)
Treated	17 (35.8%)	10 (20.8%)	20 (40.0%)	9 (18.0%)
Total	24 (50.0%)	24 (50.0%)	33 (66.0%)	17 (34.0%)

^a defined as: both half udders were NG or NSG

^b defined as: at least one half udder had an IMI infection

Table 5. Log SCC by group of pathogens at follow-up.

	n obs	mean	SD	SE
Major	6	5.64 ^{a b}	0.94	0.38
Minor	32	5.79 ^a	0.73	0.13
Other	4	4.72 ^{c d}	0.58	0.29
Uninfected	365	4.57 ^d	0.41	0.22
Yeast	16	5.30 ^{b c}	0.35	0.09

Means that have the same letter are not significantly different

SOMATIC CELL COUNT REGULATION AND ANTIBIOTIC TESTING OF SHEEP MILK

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The presentation will consist of an overview on the current issues and procedures in the “Grade A” Pasteurized Milk Ordinance (PMO). The PMO is the document governing interstate shipment of Grade A milk and is overseen by a cooperative effort between industry, state government and federal government through the National Conference on Interstate Milk Shipments (NCIMS). Dan is on the Other Species Committee, a technical advisory group that makes recommendations on any proposal that affects dairy animals other than cattle.

There have been two major studies ongoing in the sheep dairy arena. The first is a study to determine the most appropriate somatic cell counting method for sheep milk. The second is to determine appropriate drug testing kits for sheep milk.

Dr. Katherine Petersson, University of Rhode Island, has conducted a study during 2007-2008, on somatic cell count in dairy sheep milk. The study consisted of monthly samples of milk from 50 ewes which were taken over the entire lactation cycle. The samples were provided by Tom Clark, Owner of Old Chatham Sheep Dairy.

The study compared somatic cell count results using three different staining techniques; Levowitz-Weber Methylene Blue Stain, Pyronin Y Methyl Green Stain and the electronic Fossomatic counter.

Dr. Petersson's preliminary conclusion is that since the Pyronin Y Methyl Green Stain and the Fossomatic counter are both based on DNA stains, these two stains are more appropriate and more accurate for use with dairy sheep milk. Sheep have an apocrine secretory system which produces cytoplasmic particles. Non-nucleated cytoplasmic particles are not countable cells and can be easily distinguished from nucleated cells using a DNA stain. The Levowitz-Weber Stain is not a DNA stain. Her intention is to finalize the data and to complete a manuscript by late December 2008 and to submit it for publication.

The second on-going effort is headed by the New York Department of Agriculture and Markets and is being coordinated by Chris Hylkema. They have attained approval of the protocol and started doing the first round of tests that will verify the test kit's accuracy with spiked samples. The next study will involve samples from treated animals to validate that the test worked on treated animals. They hope to have the next round of testing completed before the NCIMS meeting in Spring of 2009.

IMMUNITY AND THE MAMMARY GLAND DEFENSE SYSTEM

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The mammary gland manufactures and secretes milk for nursing the newborn and at the same time provides passive immunity, both systemic (colostrum) and intestinal for the first stage of life until the self-immune system matures. The passive immunity in the intestine is of crucial importance because from day one, the intestine of the newborn is populated with pathogens, and the milk secretory immunoglobulins are highly targeted to the pathogens of the mother's environment.

The number of bacteria attempting to penetrate the udder is unknown, and the teat end is constantly populated with different bacteria of the sheep's environment. However, milk secreted under normal healthy mammary conditions (most mammary glands, most of the time) is sterile with no contaminating microorganisms. These conditions are successfully achieved mainly due to anatomical, physiological and chemical conditions prevailing in the teat. Bacteria penetrating the teat canal come across cells from the immune system. If the encounter is with polymorphonuclear cells (PMN) or macrophages, the event can end successfully: removal or killing of the intruder with no sign of infection, but more importantly, without establishment of immune memory. When the intruder is recognized by macrophage or dendritic cells, it can be presented to B and/or T cells via the supra-mammary lymph node which will lead to systemic response and/or to sporadic B (possibly B1) and T (possibly $\gamma\delta$) which will lead to a local response (Fig 1).

Evidence shows that both responses occur. In chronically *S. aureus* intramammary infected cows, specific IgG₁ and IgG₂ antibodies to the bacteria were found in sera from 83% of the infected cows, while no specific antibodies were detected in the uninfected cows (Leitner et al., 2000). Moreover, the specific IgG₁ class was found in all quarters and with the same titer regardless of whether the quarter was infected by bacteria or not, suggesting that cows were exposed to that bacterium via the infection of the mammary gland (quarter). Furthermore, if the mammary gland is a mucosal site, one would expect IgA antibodies in sera and/or milk from all quarters, whether infected or not. This was not the case in *S. aureus*-infected cows, where specific antibodies of the IgA class were only found in the infected quarters. Those results suggest that in contrast to other mucosal inductive sites, involvement of the systemic immunity leads to the production of IgG₁ and IgG₂ antibodies. IgA class is part of the integrated mucosal immune system targeted to protect body surfaces from attachment of pathogens and toxins, thus decreasing the probability of disease development. In contrast, in the mammary gland protection from attachment is meaningless while increased IgG antibodies in the milk can have the benefit of increased phagocytosis and killing by PMN and macrophages.

Local response is also recorded. In the study mentioned (Leitner et al., 2000), specific IgA class antibodies were found only in the chronically *S. aureus*-infected cows and only in the infected quarters, suggesting local mucosal response without the involvement of the systemic

immunity. However, the type of cells that presented the antigen and the responding B cells still need to be defined. Leitner et al. (2003) described dendritic-like cells in the interalveolar connective tissues of mammary glands that were positive to CD18/11⁺; CD21⁺ and CD5⁻ and small clusters of 2-5 B cells that were positive to CD18/11⁺; CD21⁺ and CD5⁺. Yet, the mechanisms in the mammary gland of antigens processing, antigens presenting locally or systemically via the supra mammary lymph node and the type of leukocytes involved are still unknown and call for further investigation.

The major income from dairy animals is derived from their milk production; therefore, factors that reduce milk quantity and quality can cause overwhelming economic losses to the farmers. In the case of dairy sheep, all of the milk is processed into fermented products and cheese, therefore any reduction in the content of dry matter, mainly casein, will have a detrimental influence on the industrial value of the milk. In recent years industrial countries have implemented payment schemes for sheep's milk based on protein content and SCC, similar to those used for bovine milk (Gonzalo et al., 1994). Consequently, factors influencing milk quality that were ignored before are now proving to be more crucial to the farmers than ever before.

In sheep, clinically infected glands are often not treated, which leads in most cases to irreversible loss of gland function and degeneration of the infected gland. Consequently, either the animal is culled or the infected gland is not milked for the rest of the affected animal's productive life. Thus, although clinical mastitis causes direct economic loss to farmers, in most cases it does not affect the quality of the bulk milk. In contrast, milk from sub-clinically infected udders is milked into the collection tank. At present, subclinical mastitis in dairy cows is ignored because the increase in SCC is modest (about 300 - 500 × 10³ cells/mL in the infected quarter) and the effect of dilution with the milk from uninfected quarters ensures that it does not appreciably affect the SCC of the whole bulk milk (Djabri et al., 2002). However, sheep have only two mammary glands and, therefore, the dilution effect is decreased. Moreover, it has been found that the damage to the gland tissue and the flow of cells from the blood into the milk is accelerated, which results in a significant decrease in milk quantity and a secondary loss of curd and cheese yield (Leitner et al., 2004a, 2004b).

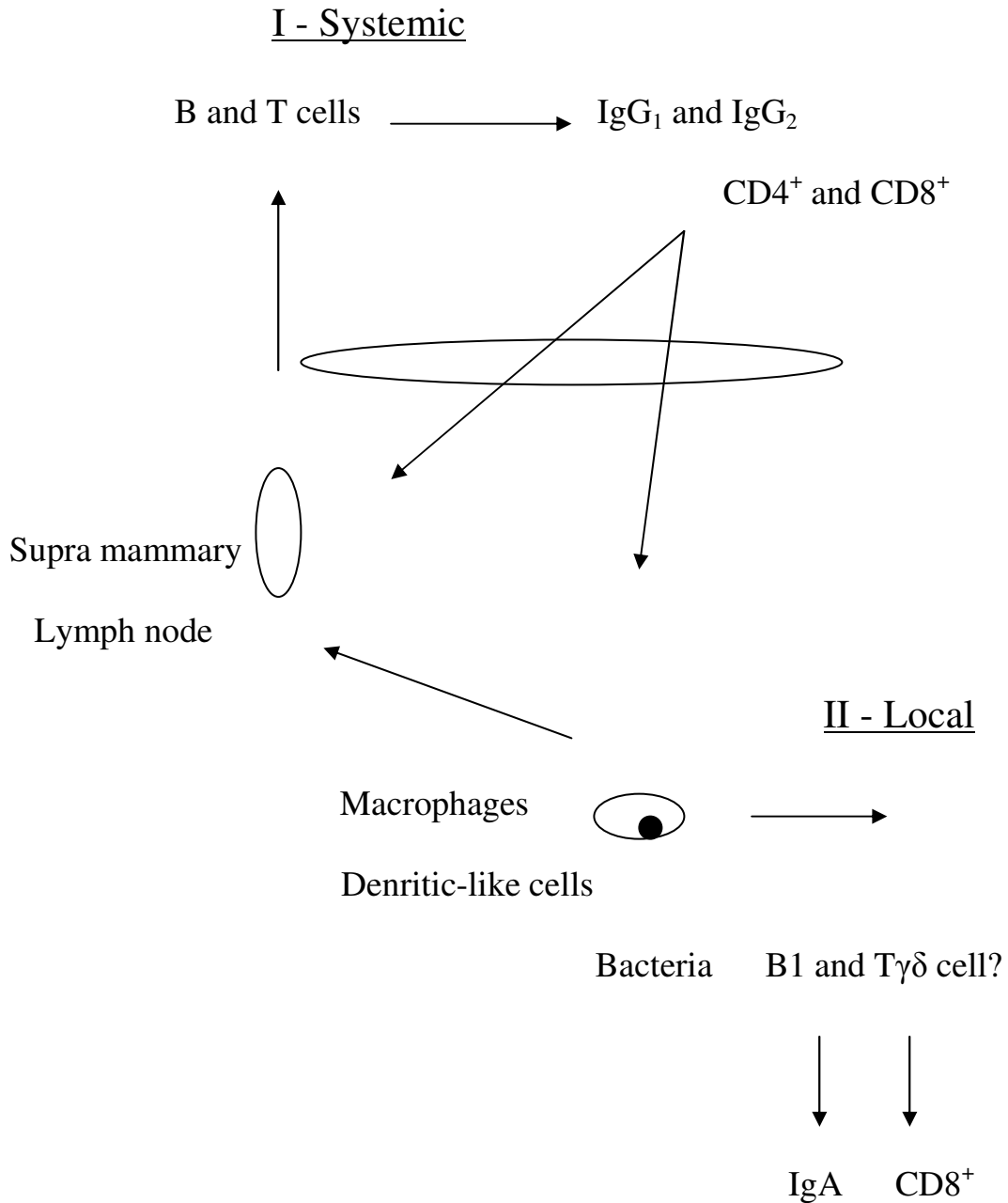
The major types of bacteria involved in subclinical mastitis are various coagulase-negative staphylococci which are found on the skin of the udder and its surroundings. Moreover, most of the sub-clinically infected glands cannot be diagnosed visually, therefore their condition can be proven only by bacterial testing, supplemented by indirect tests, such as SCC, the California mastitis test (CMT), or N-acetyl-β-D-glucosaminidase (*NAGase*) activity (Leitner et al, 2004a).

Previous studies of dairy sheep and goats (Gonzalez-Rodriguez et al., 1995; Mavrogenis et al., 1999; White and Hinckley, 1999; Luengo et al., 2004; Leitner et al., 2004a,c; Lagriffoul et al., 2006) demonstrated that intramammary infection in its subclinical form is the single most important influence on milk quality and quantity, although other factors such as stage of lactation, lactation number, time of day, lentivirus infection, and management (Menzies and Ramanoon, 2001) could be of relevance.

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Figure 1. Scenario of the specific immune response to intruders into a mammary gland. Bacteria taken by macrophages and/or dendritic cells could present systemically (I) via the supra mammary lymph node and/or locally (II) to B cells (possibly B1) and/or T cells (possibly $\gamma\delta$). Systemic response will result in the production of IgG₁ and IgG₂ in the sera and IgG₁ in milk of all mammary quarters and possibly specific CD4⁺ and CD8⁺ T cells. While local response will result in the production of IgA and possibly specific CD8⁺ only at the infected gland (inductive site).



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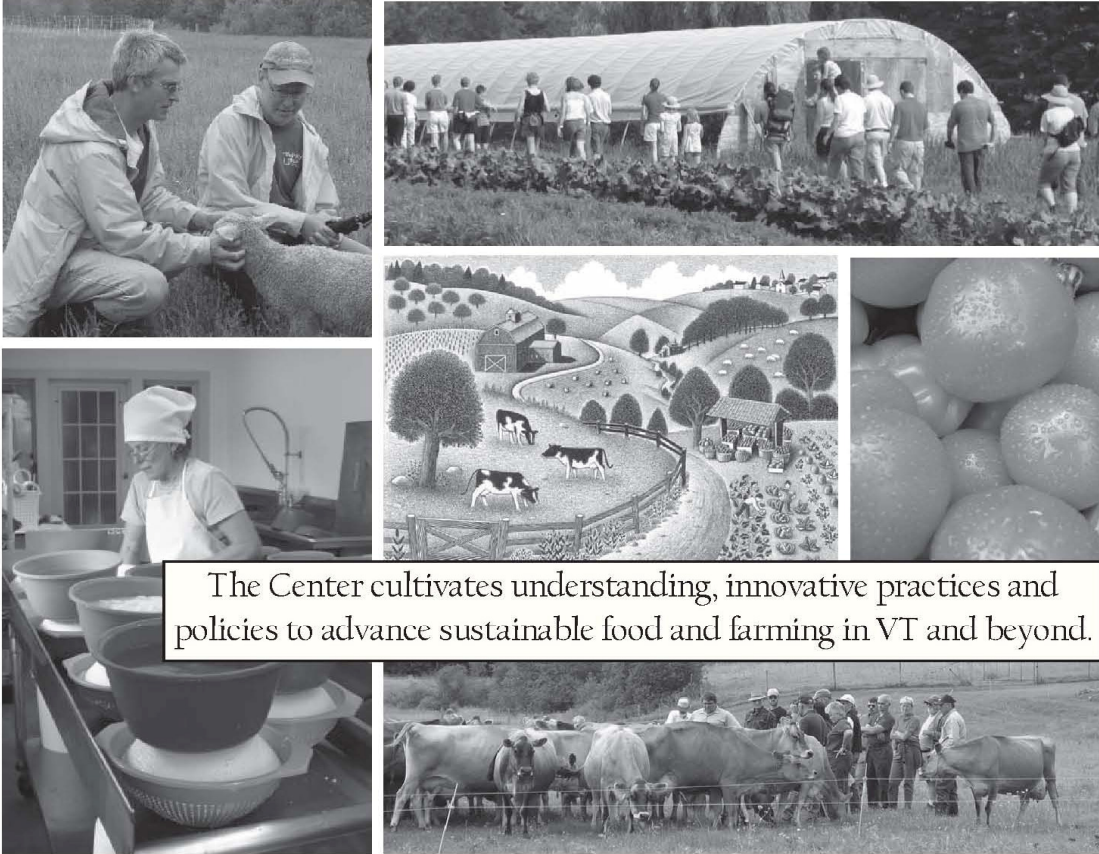
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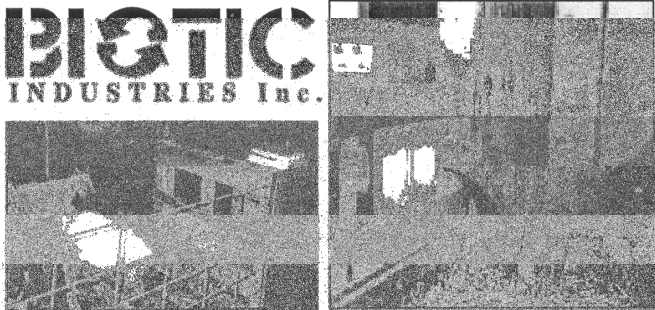


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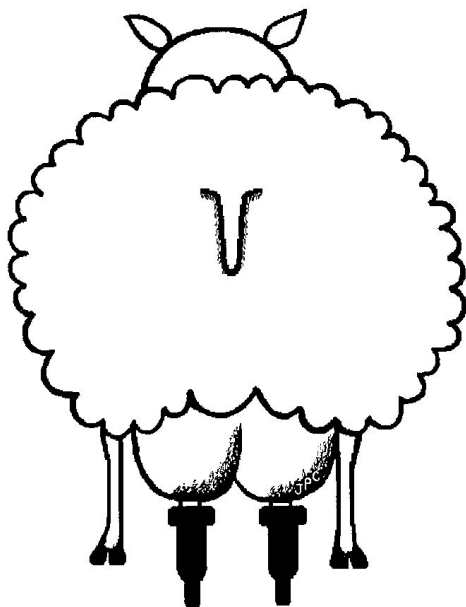
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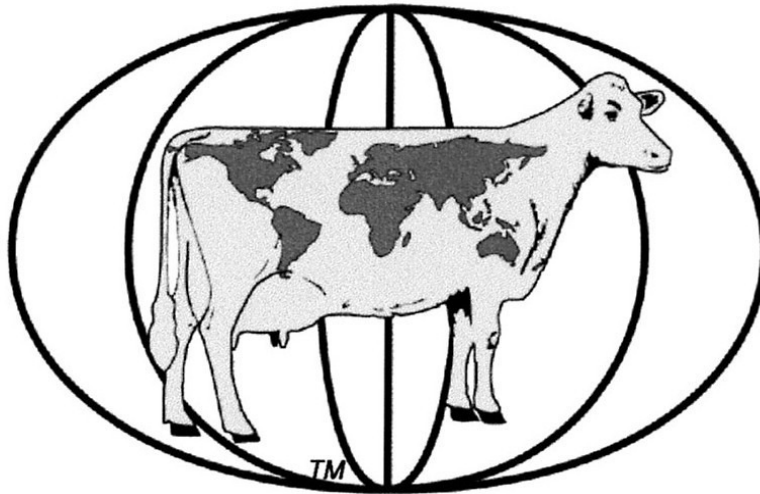
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