

Proceedings of the 18th Annual

**DAIRY SHEEP
ASSOCIATION
OF NORTH
AMERICA
SYMPOSIUM**



**October 18 - 20, 2012
Dulles, Virginia, USA**

Proceedings of the 18th Annual

***DAIRY SHEEP ASSOCIATION OF
NORTH AMERICA SYMPOSIUM***

October 18 - 20, 2012

Holiday Inn Washington-Dulles International Airport
Dulles, Virginia, USA

Organized by:

Dairy Sheep Association of North America, 1481 San Miguel Road,
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Photographs on the Cover:

Dairy ewes, new milking parlor, and new cheese room at Shepherds
Manor Creamery, New Windsor, Maryland.
Owners and operators - Colleen and Michael Histon.

Table of Contents

Program of Events	v
Sponsors	vii
DAIRY CATTLE NUTRITION – LESSONS FOR SHEEP PRODUCERS	
Robert E. James.....	1
FEEDING DAIRY EWES BETTER FOR INCREASED PRODUCTION AND PROFIT	
Dan Morrical.....	10
OVINSHIRE FARM: PASTURE BASED FEEDING FOR OUR FLOCK	
Scott Burrington.....	18
FEEDING PROGRAM FOR IRISH CREAM SHEEP DAIRY	
Virginia and Bill Halligan.....	20
MANAGING DAIRY SHEEP NUTRITION ON AN ORGANIC FARM	
Rebecca King.....	22
KEYS TO SUCCESSFULLY RAISING LAMBS ON MILK REPLACER	
Larry Van Roekel	27
CURRENT REGULATORY REQUIREMENTS FOR OVINE SEMEN AND EMBRYOS	
Peter Merrill.....	33
CREATING ARTISANAL CHEESES: A MIX OF ART AND SCIENCE	
Sidney M. Cook	33
THE ART IN THE SCIENCE OF SHEEP CHEESE MAKING	
Dane Huebner.....	35
CREATING ARTISANAL CHEESES: A MIX OF ART AND SCIENCE	
Brenda Jensen	41
EWE (AND FLOCK) HEALTH OVERVIEW	
Eric D. Gordon	43
PROGRESSIVE WASTING DISEASES OF EWES	
Eric D. Gordon.....	57
PERFORMANCE OF KATAHDIN-LACAUNE CROSSBRED EWES	
Yves M. Berger and David L. Thomas.....	67

Table of Contents (cont.)

PARASITE CONTROL IN DAIRY SHEEP
Susan Schoenian..... 73

FARM TOUR I: EVERONA DAIRY
Pat Elliott 80

FARM TOUR II: SHEPHERDS MANOR CREAMERY
Colleen and Michael Histon..... 83

Previous recipients of the William J. Boylan Distinguished Service Award 87

Locations and Chairs of the Organizing Committees of Previous Symposia..... 88

Information from the Symposium Sponsors 89

Program of Events

Thursday, October 18, 2012

- 7:30 a.m. **Registration**, Holiday Inn Washington-Dulles, Dulles, Virginia, USA
- 8:15 a.m. **Welcome**, Laurel Kieffer, President, Dairy Sheep Association of North America, Strum, Wisconsin, USA
- 8:30 a.m. **Dairy Nutrition I: Dairy Cattle Nutrition – Possible Lessons for Dairy Sheep Producers**
Dr. Robert James, Professor of Dairy Nutrition and Management, Department of Dairy Science, Virginia Tech, Blacksburg, Virginia, USA
- 9:45 a.m. **Break: Trade Show and Networking**
- 10:15 a.m. **Dairy Nutrition II: Practical Nutrition of the Dairy Sheep Flock**
Dr. Daniel Morrical, Extension Sheep Specialist, Department of Animal Science, Iowa State University, Ames, Iowa, USA
- 11:30 a.m. **Producer Panel on Dairy Ewe Nutrition**
Moderator: Bill Halligan, Irish Cream Sheep Dairy, Bushnell, Nebraska, USA
Cindy Callahan, Bellwether Farms, Petaluma, California, USA
Virginia Halligan, Irish Cream Sheep Dairy, Bushnell, Nebraska, USA
Rebecca King, Garden Variety Cheese, Royal Oaks, California, USA
Scott Burrington, Ovinshire Farm, Fort Plain, New York, USA
Allister Veinot, Avondale Farm, Avondale, Prince Edward Island, Canada
- 12:30 p.m. **Lunch** (included)
- 1:30 p.m. **Artificial Lamb Rearing**
Larry Van Roekel, Director of Marketing, Land O'Lakes, Animal Milk Products, Shoreview, Minnesota, USA
- 2:30 p.m. **Break: Trade Show and Networking**
- 3:00 p.m. **Current Status and Procedures for the Import of Ovine Genetics**
Dr. Peter L. Merrill, Assistant Director, Animal Imports, National Center for Import and Export, USDA/APHIS/VS, Riverdale, Maryland, USA
- 3:30 p.m. **Creating Artisanal Cheeses – A Mixture of Art and Science**
Moderator: Rebecca King, Garden Variety Cheese, Royal Oaks, California, USA
Sid Cook, Carr Valley Cheese Company, La Valle, Wisconsin, USA
Dane Huebner, Grafton Village Cheese, Grafton, Vermont, USA
Brenda Jensen, Hidden Springs Creamery, Westby, Wisconsin, USA
- 5:30 p.m. **A Culinary Celebration of North American Artisanal Sheep Milk Cheeses**
Cheese and wine tasting open to all symposium attendees.

Program of Events (cont.)

Friday, October 19, 2012

- 7:30 a.m. **Registration**, Holiday Inn Washington-Dulles, Dulles, Virginia, USA
- 8:15 a.m. **Welcome**, Laurel Kieffer, President, Dairy Sheep Association of North America, Strum, Wisconsin, USA
- 8:30 a.m. **Ewe Health Overview**
Dr. Eric Gordon, Associate Professor, College of Veterinary Medicine, The Ohio State University, Columbus, Ohio, USA
- 10:00 a.m. **Break: Trade Show and Networking**
- 10:30 a.m. **Progressive Wasting Diseases in Ewes**
Dr. Eric Gordon, Associate Professor, College of Veterinary Medicine, The Ohio State University, Columbus, Ohio, USA
- 11:30 a.m. **Lactation Performance of Katahdin-Lacaune Crossbred Ewes**
Yves M. Berger, Researcher (Retired), Spooner Agricultural Research Station, University of Wisconsin-Madison, Spooner, Wisconsin, USA
- 12:00 p.m. **Lunch** (included)
- 1:00 p.m. **Parasite Control in Dairy Sheep**
Susan Schoenian, Extension Sheep and Goat Specialist, Western Maryland Research and Extension Center, University of Maryland, Keedsville, USA
- 2:15 p.m. **Break: Trade Show and Networking**
- 2:45 p.m. **State of the Market for Domestically Produced Sheep Dairy Products**
- 3:00 p.m. **Dairy Sheep Association of North America Annual Meeting**
- 7:00 p.m. **Banquet with Awards and Recognition Program**
Separate registration required

Saturday, October 20, 2012

- 8:30 a.m. **Board Buses for One Farm Tour**, Holiday Inn Washington-Dulles
Farm Tour I: Everona Dairy, Dr. Patricia and Brian Elliott, Rapidan, Virginia
Farm Tour II: Shepherds Manor Creamery, Colleen and Michael Histon, New Windsor, Maryland
- 4:00 p.m. **Buses return to Holiday Inn Washington-Dulles and Symposium Concludes**

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DAIRY CATTLE NUTRITION – LESSONS FOR SHEEP PRODUCERS

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Blacksburg, Virginia, USA

Introduction

Although there are differences between dairy sheep and dairy cattle nutrition there are a remarkable number of similarities. Unlike sheep selected for wool or meat, dairy sheep perform at a much higher level metabolically, which is similar to comparisons made between beef brood cows and the dairy cow. The publication - Principles of Sheep Dairying in North America is an excellent publication which has proved to be an excellent resource assisting me in this presentation. I note several key points which will be the foundation of this presentation.

- Dairy Sheep produce milk with high solids content.
- Milk fat is characterized by a higher prevalence of shorter chain fatty acids than observed in cow's milk.
- Their daily dietary intake is quite high @ 5-7% of body weight.

I have been a breeder of Jersey cattle and it's interesting to note that there are some similarities between Jersey's and dairy sheep. Their smaller body weight, higher milk solids (14%) and respectable daily volume of milk production demand that Jersey's consume more dietary dry matter than those of the Holstein breed. As a result it is not uncommon to observe herd daily ration intakes exceeding 5% of their body weight in high producing Jersey herds.

Successful dairy nutrition is a result of:

1. Accurate ration formulation,
2. Mixing and delivery of the ration
3. Consumption of the ration as intended by the nutritionist and the herd manager

Unfortunately there is a serious disconnect between these three items and in most cases, science is far ahead of the manager's ability to implement our knowledge of dairy cattle nutrition. This presentation will focus on each item and provide suggestions on how to successfully feed the herd.

Accurate ration formulation

Sophisticated ration formulation systems are readily available to dairy cattle nutritionists. Over the past 10 years I would characterize the following advancements as having the greatest impact on dairy cattle nutrition:

- Protein and carbohydrate digestion in the dairy cow. The net result of these advancements is to predict the impact of diet on yield of rumen microbial protein which

is a significant contributor to the supply of absorbable amino acids for milk synthesis and determinant of rumen health and intake by the cow.

- Fatty acid supplementation of diets to improve the fatty acid profile of milk
- Trace mineral nutrition.

Protein and carbohydrate digestion. Healthy ruminant feeding systems should focus on provision of nutrients which support optimally growing rumen microbial populations requisite for fiber digestion. Protein can be classified into rumen degradable (RDP) and undegradable (RUP) fractions. The RDP fraction can further categorized into protein which is broken down very rapidly to fractions which degrade over several hours in the rumen to ammonia, urea, amino acids and peptides which are utilized to support microbial growth. After passing out of the rumen and into the intestines the amino acids of the microbes can be digested and absorbed to support maintenance, growth, pregnancy and milk production. The quality of microbial protein is quite high, meaning that it is digestible and contains many of the essential amino acids. The RUP fraction consists of protein which is resistant to digestion in the rumen and passes to the intestine unchanged. Unfortunately some of this fraction is indigestible and passes from the animal undigested. The amino acid content of RUP depends on source of the protein with a variety of plant and marine sources used to provide the desired balance of amino acids to support high production. The challenge in protein or amino acid nutrition is twofold.

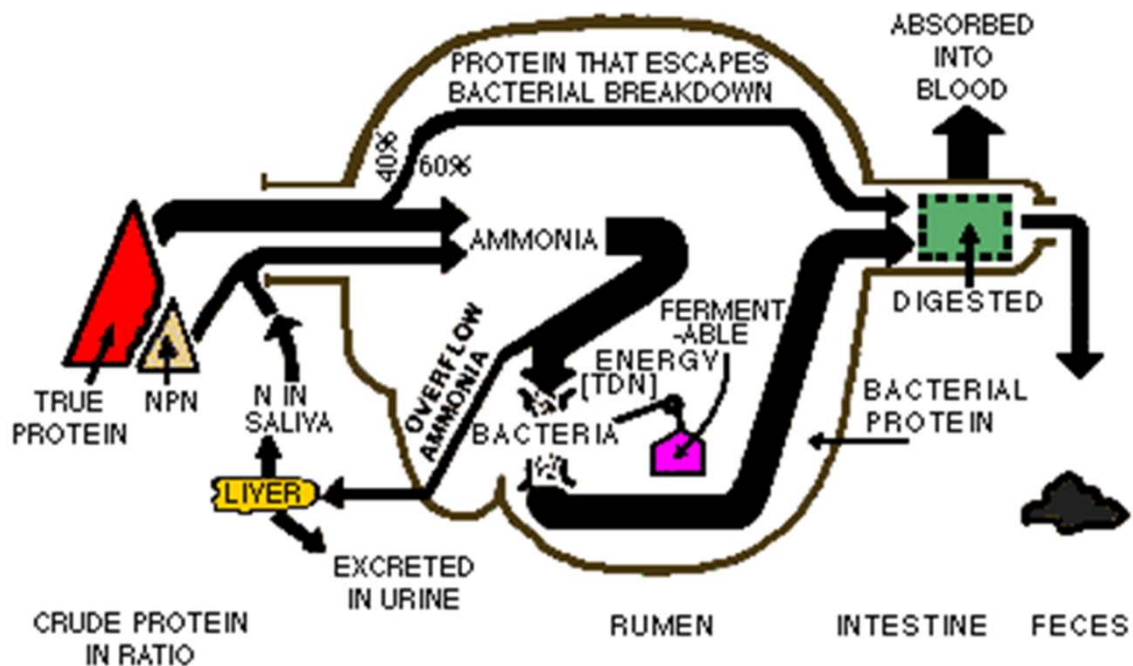


Figure 1. Illustration of protein digestion in the ruminant.

Figure 1 demonstrates the concept of protein digestion in the ruminant. First, sufficient RDP must be provided to meet the needs of the microbes in the rumen. When intake of RDP is too high or too rapid, excess crude protein in the form of ammonia can pass across the rumen wall

and into the blood, some of it is recycled back into rumen, but the excess passes out in the urine and becomes an environmental pollutant. The second challenge is to provide the “right” blend of RUP sources to provide the needed amino acids to supplement that from digested rumen microbes. It is challenging to predict amino acid content of the protein reaching the absorptive sites beyond the rumen. In addition, because amino acids escape degradation in the rumen doesn’t assure that they will be digested and absorbed postruminally. Protein requirements are specified in grams of metabolizable protein based upon age, stage of lactation, production The most recent recommendations for dairy cattle were published in 2001. Since that time considerable progress has been made in predicting microbial amino acid synthesis and predicting amino acid flow to the intestine from RUP. These models have been in ration formulation programs such as CNCPS, NDS, Nittany Cow and others. This technology has enabled dairies to reduce the quantity of crude protein recommended for lactating dairy cattle thereby saving money and reducing nitrogen escaping to the environment. Given the high level of intake in sheep it is likely that the amino acid content and digestibility of RUP will differ from that observed in the dairy cow.

Unfortunately, one cannot discuss amino acid nutrition without consideration of the carbohydrate content of the diet. Carbohydrates are separated into those existing in the cell wall (fiber, pectins) and the cell contents (sugar, starch...). Considerable effort has been expended to more fully understand both fiber and starch digestion in the ruminant. Healthy rumen microbe populations are dependent upon a **balanced** supply of fiber and nonfiber carbohydrates. Again the challenge exists in predicting the digestibility of both fiber and starch in the rumen. In general, as plants mature the fibrous portion becomes more lignified and less ruminally digestible. This implies that high producing ruminants benefit from the consumption of forages harvested in an earlier stage of maturity. Recent work by Kammes and Allen (2012) has demonstrated the impact of plant maturity in grasses and legumes on intake, diet digestibility and performance in ruminally and duodenally cannulated dairy cattle. Diets were based upon either late or early cut Orchardgrass or alfalfa silage and were formulated to contain ~ 25% forage NDF and ~30% NDF in the total ration. With the grass silage diets, the negative impact of more mature forage with higher (and less digestible) NDF content could be overcome through greater supplementation with dry corn and soybean meal. With the alfalfa diets, the NDF levels were slightly lower (22% forage NDF and 27% total NDF) and milk yield was not different between treatments. However, cows receiving early cut diets ate more and produced milk with lower fat%, resulting in lower feed efficiency. These studies demonstrate that the negative impact of forage maturity could be overcome through additional supplementation of energy and protein. However, one must remember that diets based upon early cut forages fostered higher rumen pH’s and possibly improved ruminal health and involved less cost of supplemental feeds.

More recently, greater attention is being paid to the digestibility of corn (Hoffman and Shaver). This is especially noteworthy given the increased prices of corn. We have long known that decreases in particle size increase digestibility as a greater surface area of the starch is exposed to digestive enzymes. However, recent research has noted a negative correlation between the vitreousness of corn and its digestion in the rumen. Varieties with a high degree of vitreousness contain starch which is imbedded in a prolamin matrix which makes the corn more resistant to premature germination. This may be desirable from some viewpoints, but it has negative implications for the value of corn for ruminants. This relationship is shown in Figure 2.

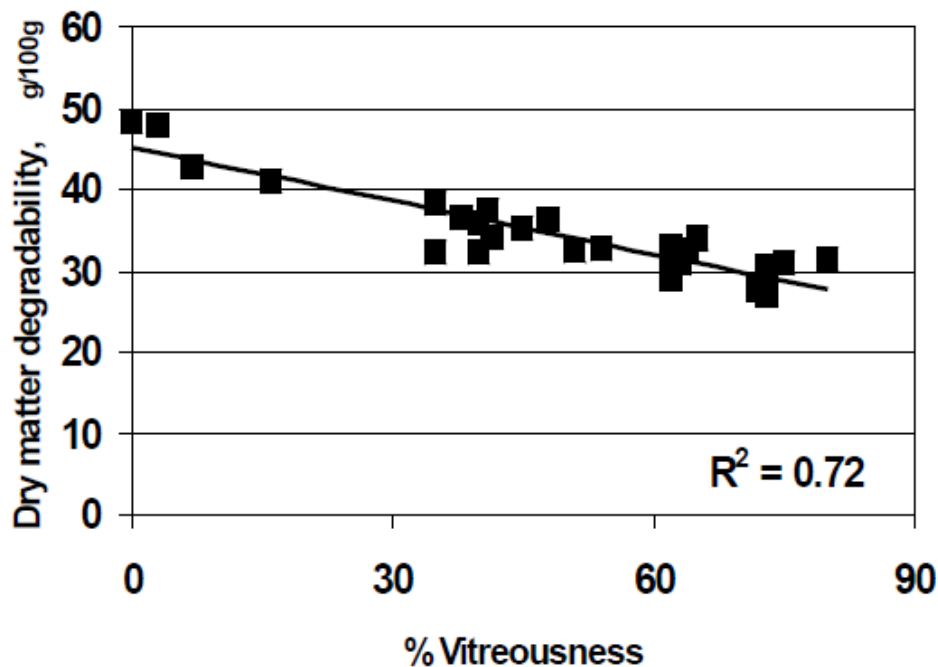


Figure 2. The relationship between kernel vitreousness and in situ DM degradability of corn. (Ngonyamo-Majee, et al., 2008)

Many feed analysis laboratories now offer in vitro tests to estimate starch digestibility. However, the correlation of in vitro tests with the digestibility in the animal have not been determined owing to different particle size of the corn and differences in diet composition when the corn has been included in rations on the farm. The impact of this characteristic on digestion of starch in sheep has not been studied. Since sheep tend to chew their feed more thoroughly than dairy cattle, the impact may not be as great.

Added fat to diets. As milk production in dairy cattle has increased exponentially over the years, it has become more challenging to meet the cow's requirements for energy without having a negative impact on rumen health. It is not uncommon for dairy cattle in early lactation to produce in excess of 100 to 150 lb. of milk containing more than 15 lb. of milk solids. Diets for high producing dairy cattle would have as much as 30% of the diet as starch and sugars as sources of energy and precursors of milk lactose and milk fat. Further increases in the carbohydrates would be counterproductive to rumen health. As a result it has become more common to add limited amounts of fat as tallow, prilled fat, whole oil seeds or calcium soaps of fatty acids. These sources differ in fatty acid chain length, degree of unsaturation and availability in the rumen. Diets without added fat usually contain approximately 2 – 3% fat. Fats are commonly added to the diets of high producing cows to increase fat level to 5 – 6% of the diet DM. The impact of added fat is variable depending on fat source, physical nature of the diet, fiber content of the diet and other factors. However, when properly mixed in the diet, increased milk production is commonly observed. Feeding too much fat (>6%) or fat which is very available to rumen microbes commonly results in depressed intake and in some cases depressed milk protein.

More recently, research has investigated the addition of oilseeds and vegetable oils to increase the contents of polyunsaturated fatty acids including alpha linolenic acid (C18:3n-3) in milk. These fatty acids, termed CLA's, have been shown to have beneficial impacts on health of humans consuming animal products enriched with this fatty acid. The CLA's are found in greater amounts in the meat and milk of grazing animals and in confinement-reared cows when diets are enriched with oils such as linseed oil. Benchaar and coworkers (2012) found that dairy cattle could tolerate the addition of up to 4% linseed oil without detrimental effects on rumen function, digestion and milk yield. The impact of added polyunsaturated fats on sheep milk would be interesting given that sheep milk typically is lower in C-18 fatty acids than dairy cattle. The challenge with incorporating this practice in dairy cattle is that the consumer must be willing to pay the premium for inclusion of the ingredients in the diet.

Chelated trace minerals. A recent study by (Nemec et al, 2012) compared the effects of inorganic sulfate vs. chelated forms of copper, manganese and zinc on production, plasma and milk mineral concentrations and immune response in early lactation cows. No effect of treatment was observed for milk production, milk composition, or plasma minerals. However, cows supplemented with chelated minerals showed enhance neutrophil phagocytosis and response to a rabies vaccination.

Feeding management of the dairy herd.

Research has enabled development of models to implement effective ration formulation programs which **theoretically** enable one to develop rations to more accurately meet the nutrient needs of dairy cattle. However, the second phase in successful feeding management of the herd is mixing and delivering the ration as specified by the nutritionist. This requires knowledge of the nutrient content of the feeds in the ration through timely analysis. On well managed dairies, forages (owing to their greater nutrient variation), are analyzed at least monthly. An example of a analysis of forages commonly fed on dairies is shown in Figure 3. In addition to the major nutrients, estimates of NDF and starch digestibility, sugar and starch content, particle size, molds and yeasts are determined. In silage samples, knowledge of predominant fermentation acids is also valuable information. Although the latter measurements do not measure nutrients directly, they provide a better estimate of palatability and digestibility of the feeds.

Once the diet has been formulated, it is the person feeding the herd's responsibility to mix it and delivery it as specified. A five year research project (Stewart et al, 2011) was conducted with 8 cooperating dairies in Virginia to determine accuracy and precision of feeding management. Total mixed ration diets were sampled on a monthly basis and compared nutrient composition and intake to that specified by the nutritionist. In addition, feeding accuracy was monitored between visits through the use of feed management software in which rations entered into a computer are transferred to a weigh scale which records how closely the person feeding the herd came to amounts specified by the nutritionist. As expected there was considerable variation between farms with some being very accurate. Figure 4 shows typical loading accuracy and precision on the cooperating farms. This research indicated that even if our models of nutrient digestion and metabolism were extremely accurate, we are probably most limited by the ability to mix and deliver these rations. There are several commercially available feed management

A N A L Y S I S R E S U L T S Type: CORN SILAGE

Moisture	74.2	%	Minerals		
Dry Matter	25.8	%	Ash	3.9	% DM
Proteins			Calcium	0.29	% DM
Crude Protein	9.4	% DM	Phosphorus	0.27	% DM
Adjusted Protein	9.4	% DM	Magnesium	0.25	% DM
Soluble Protein	65.6	% CP	Potassium	1.41	% DM
Ammonia	17.3	% CP	Sulfur	0.14	% DM
ADF Protein (bound protein)	0.91	% DM	Sodium	0.010	% DM
NDF Protein	1.1	% DM	Iron	122	PPM
Rumen Degr Protein	82.8	% CP	Manganese	29	PPM
Rumen Undgr Protein (Strep. G)			Zinc	31	PPM
			Copper	8	PPM
			Selenium		
Fibers			Molybdenum		
Acid Detergent Fiber	31.3	% DM	Nitrate Ion		
Neutral Detergent Residue	50.5	% DM	Chloride Ion	0.40	% DM
Crude Fiber			DCAD (Meq/100gdm)		
Lignin	3.88	% DM			
Lignin / NDF Ratio	7.7	% NDF	Energy / Indexes		
Soluble fiber	2.1	% DM	TDN	70.3	% DM
peNDF	48.4	% DM	Net Energy Lactation	0.74	Mcal/lb
NDF Digestibility, Invitro			Net Energy Maintenance	0.75	Mcal/lb
12 hr digestibility			Net Energy Gain	0.47	Mcal/lb
24 hr digestibility	58.0	% NDF	Relative Feed Value (RFV)		
30 hr digestibility			Relative Feed Quality (RFQ)		
48 hr digestibility			Milk/ton		
Indigestible NDF, Invitro 120 HR			NFC	32.5	% DM
NDF Dig. Rate (Kd)	4.95		Enzymatic NSC		
			Qualitative		
Non-Fibers, Structure, Utilization			pH	3.78	
Digestible Dry Matter (fast)			Total VFA	15.32	% DM
Sugar	1.1	% DM	Lactic acid	5.20	% DM
Starch	19.1	% DM	--Lactic/TVFA		
--Enzyme Available			Acetic acid	8.73	% DM
--Digestibility, 2 hr			Propionic acid	1.42	% DM
--Digestibility, 7 hr	74.0	% Starch	Butyric acid		
Fatty Acids, Total			Isobutyric acid		
Crude Fat	4.8	% DM	1, 2 Propandiol	0.366	% DM
Acid hydrolysis fat			Titrateable Acidity (meq NaOH)	19.09	
CS Processing Score	65.9	% DM			
Particle size > 0.75"	4.4	% DM	Mold	1	Cfu/g
... 0.31" - 0.75"	71.5	% DM	Yeast	2000	Cfu/g
... < 0.31"	24.1	% DM			

Figure 3. Nutrient analysis of corn silage – Cumberland Valley Analytical Service.

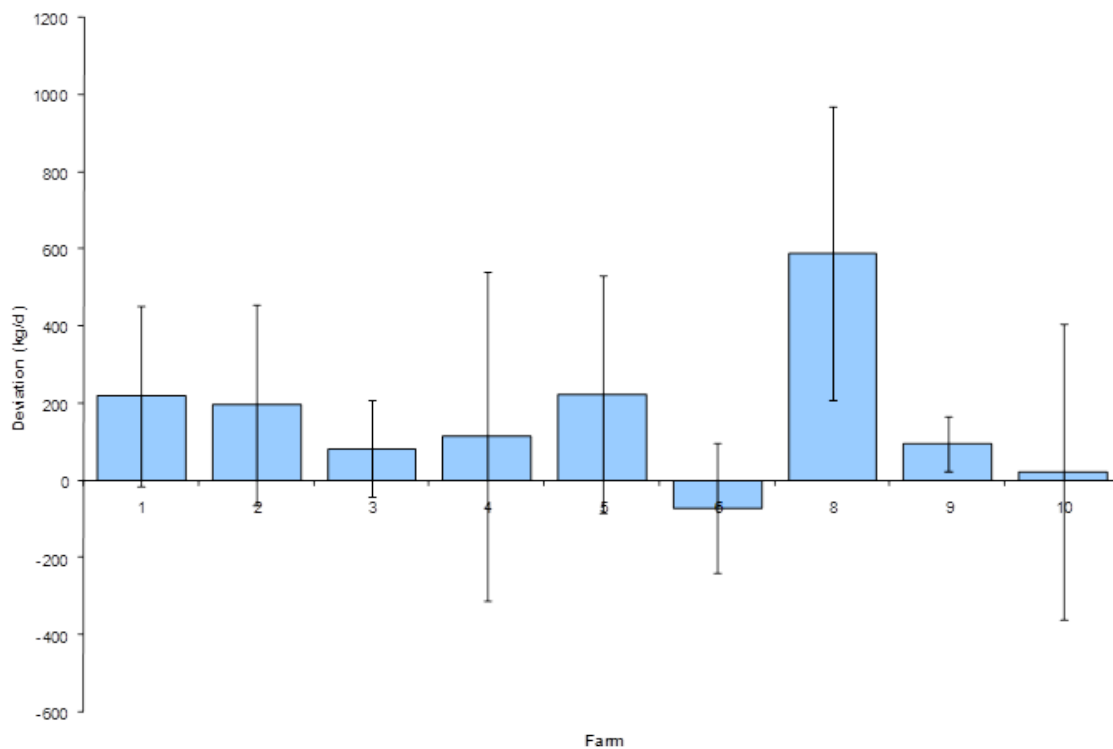


Figure 4 Typical daily ration loading error on cooperating farms in Virginia feeding management project. The wide bars indicate average over or underfeeding of ingredients while the lines indicate the standard errors which are an indication of the precision in feeding.

programs available to dairy producers used to monitor feed inventories, determine “shrink” or the losses of feed on the farm and to evaluate feeding accuracy and precision. These programs require integration of the scales on mixer wagons with the computers where the feed management software resides. Although the feed management technology used on dairy farms may not be feasible on most sheep dairies, the practice illustrates the importance of knowing what the sheep are consuming and how this compares to the specified rations and ultimately meeting nutrient requirements of the ewes.

The last component of successful feeding of the dairy herd is estimating what the animals actually consumed. Grazing dairy cattle are selective grazers; therefore it is very difficult to estimate the nutrient value of what the animals are consuming. Knowledge of intake is gained through exceptional pasture management in which weeds and less desirable species are not permitted to flourish. This is achieved through rotational grazing, fertilization and timely mowing if necessary to prevent weed species from reaching maturity and producing seed. Feeding programs for confinement-reared cattle are easier to manage. Most dairy producers have adopted TMR feeding systems in which ration ingredients are mixed in large wagon equipped with scales and augers. However, dairies are beginning to adopt robotic milking systems which enable grain feeding during milking on an individual cow basis. The challenge in feeding forages separately and concentrates or grains according to production is that animals exhibit preferences for specified feeds that may differ greatly from animal to animal. Legume hay crops present challenges because animals usually choose the more digestible and palatable leaves and leave the

stems untouched. Chopping or grinding hay crop forages is problematic because it results in the considerable loss of forage nutrients as dust. Concentrate ingredients including mineral and vitamin supplements must be premixed. Unfortunately, this last component of feed management is the “art” and frequently requires good subjective evaluation skills. Success in determining intake of individual ingredients is challenging and requires the feeder to evaluate nutrient composition of what remains in the feed bunk prior to the next feeding.

Research continues to provide valuable information which has enabled us to effectively model digestion and metabolism in the ruminant. However, models are most effective in telling us what we don’t know about ruminant nutrition when they incorrectly predict intake or performance. Successful feed management requires the manager to follow some key basic principles regardless of the species of dairy animal being fed.

1. Know the average daily intake of ration dry matter per animal in each group. This is requisite to effective ration formulation.
2. Practice timely evaluation of feeds. This is most important for hay crop forages and commodity -type feeds which may be economical sources of nutrients.
3. Group animals to enable formulation of diets which meet requirements of the majority of animals in the group.
4. Continually evaluate the “three rations” for each group. Are they the same?
 - a. The ration that is formulated
 - b. The ration that is mixed and delivered.
 - c. The ration that the animals consumed.

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FEEDING DAIRY EWES BETTER FOR INCREASED PRODUCTION AND PROFIT

**Dan Morrical
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Ames, Iowa, USA**

Introduction

Sheep nutrition and feeding is extremely critical to the success or failure of the ewe flock enterprise. As shepherds our task is to provide balanced rations that meet the ewe's nutrient requirements on the least costly basis. Feed costs account for half the cost of producing lamb, milk and wool. Therefore, cost control must always be foremost in the shepherd's mind. Sheep enterprises face a greater challenge in meeting needs of the flock because of the large within flock and between flock variation. This is best illustrated by the feeding of replacement ewe lambs versus mature ewes. Lastly, feed costs have escalated much more than the products we sell, which further increases the pressure to minimize costs while maximizing ewe production.

Nutrient Requirements

The amount of nutrients the sheep require is affected by several factors. These include ewe age and weight along with stage of production and level of production. Figure 1 outlines the stages of production, and demonstrates how nutrient requirements change through the production cycle. It is important to realize that all ewes in the flock are not at the same stage of production on any given day. This factor is affected by the length of the breeding season and production system (once a year lambing versus accelerated lambing systems). Another example is late versus early lactation ewes.

Critical phases of the production cycle include flushing/breeding as it sets the maximum drop rate for flock. Early/mid gestation is critical in that placental development occurs from day 30-90 of gestation. Placental size or weight effects nutrient transfer between the ewe and fetuses. Underdeveloped placenta results in smaller birth weights regardless of late gestation nutrition. Twenty days of severe underfeeding or 80 days of slight underfeeding will both retard placental growth. Additionally periods of stress can increase fetal loss which reduces production in terms of lambs to sell and milk. The remainder of this paper will deal with late gestation and lactation stages of production since most flocks are grazing during other production phases.

Late Gestation Nutrition

Determining how much to feed ewes in late gestation is a very difficult practice. Use of ultrasound scanning for fetal number allows for fine tuning the late gestation nutrition. The goal of late gestation nutrition program is to insure adequate nutrient intake for strong vigorous lambs of moderate birth weight. Additionally, ewes must enter lambing season in average to above average body condition to maximize milk production. Adequate birth weight of lambs is critical to insure lamb survival and a successful lambing season. Small lambs have less resistance to

cold stress and reduced pre-weaning growth. Big lambs increase the incidence of lambing problems and increases shepherd labor and lamb death loss. Fetal scanning and the separation of ewes into different feeding groups by those carrying singles, versus twins versus triplets or more helps to reduce the real big singles or small twins and triplets. Experienced technicians have accuracy's above 90% on fetal numbers so contracting an experienced scanner is the key to successful implementation of this technology.

The nutrients of greatest concern during late gestation feeding would be energy (TDN), crude protein (CP), minerals, specifically iodine and selenium, and vitamins, E. The TDN level required is affected by the number of fetuses and cold stress. Winter lambing, short fleeced ewes generally cannot consume enough forage alone to meet their energy requirements, thus requiring the feeding of concentrates (corn, etcetera).

Fetal growth accelerates rapidly during late gestation. Furthermore, energy required is much higher for the two weeks pre-lambing versus six weeks pre-lambing. A means of controlling costs is to step up grain feeding as lambing approaches. Ewes carrying singles require less grain and do not need to receive grain as early as those carrying multiples. Late gestation rations should begin 5-6 weeks pre-lambing for ewes carrying triplets and their fetuses. Those with twins can be delayed to 3-4 weeks pre-lambing whereas those with singles can be held off until two weeks pre-lambing. This is only possible when facilities allows for sub-dividing the flock in multiple management groups.

The absolute level of grain to feed is highly dependent upon the nutrient density of the forage being fed. Table 3 demonstrates the huge variation in nutrient density of hays. Nutrient analysis costs \$10-\$20 per sample and is money well spent. Balancing diets based on average or book values for hay is a risk progressive shepherd's should not take especially in highly productive flocks. Furthermore, one cannot accurately determine the nutrient density of hays with visual appraisal. Tables 2 and 3 provide example rations for all phases of production with a wide array of forage sources. To minimize the risk of acidosis from excess grain feeding, ewes receiving over 1.5 pounds of concentrate per day should receive it in split feedings. Additionally, if hay does not need protein or mineral supplementation than whole corn can be fed whole.

Selenium, iodine and vitamin E are critical micro-nutrients for lamb survival and a smooth lambing season. Selenium can be added to the ration of sheep at .3 PPM or .3 mg/kg of feed. The maximum allowable selenium intake from supplemental sources can not exceed .69 mg per head per day. This is a very small amount and extreme care is required in calculating how much to add. More importantly selenium at 2 PPM can be toxic. Selenium status of ewes is dependent upon both the selenium concentration in the mineral and intake of the mineral, along with the selenium level in the feedstuffs. Flocks with a history of selenium problems in newborn lambs should consider force-feeding selenium via the grain mix. This insures all ewes consume adequate amounts on a more uniform basis. If selenium is force fed, there should not be a free choice selenium source available. Table 4 shows the level of intake required for various selenium concentrations in the mineral or trace mineral salt. Selenium crosses the placenta so newborn lambs selenium status is totally dependent upon the selenium of their dams late gestation intake.

Vitamin E, unlike selenium is not toxic. Vitamin E does not cross the placenta so a newborn lamb's only source of E is ewe's milk or injections. The concentration of Vitamin E in ewe's milk or colostrum is directly correlated with the Vitamin E intake of the ewe prior to lambing. Vitamin E levels are extremely variable in feedstuffs because it denatures with storage and is also denatured in the rumen with high grain feeding. The new NRC has drastically increase requirements for E. Unfortunately, high E supplementation research results do not show uniform, consistent results. Researchers have postulated this is related to the environmental stress during lambing. This creates a dilemma in that one must predict weather conditions to determine if additional E would be beneficial. Vitamin E is very cheap and therefore feeding a minimum of 100 iu per fetus or lamb nursed per ewe per day is a preventative step that is money wisely invested.

Iodine is the last micronutrient that is most commonly deficient. The closer a flock is to an ocean the less likely iodine is deficient. The most common iodine deficiency is goiter, however other symptoms include reduced resistance to disease, still births and hypothermia. The new NRC also increased iodine requirements depending on stage of production. Lactation is the highest at .8 ppm. Most mineral supplements are short on iodine for ewes at this level. The simplest method of overcoming iodine issues is to provide free choice iodized salt. Precautions need to be taken as to insure ewes are still consuming adequate levels base mineral. Producers need to read the mineral tags feeding directions and monitor mineral intake by the flock. Sheep cannot read the feed tags and have no nutritional wisdom. Ewes which are over consuming mineral are craving salt or the mineral is composed to much intake enhancers like corn byproducts. The simplest means of controlling over consumption is to provide a week's worth of mineral and free choice iodized salt or plain salt. Ewes can be without mineral for a day or two without any impact on their productivity.

Nutrition Disorders During Late Gestation

Ketosis or twin lamb disease is the most often discussed nutritional disorder that occurs during late gestation. The cause of ketosis is inadequate energy intake by the ewe resulting in fat catabolism (fat breakdown to feed the rapidly growing fetuses). Ewes which are most prone to ketosis would be those that are timid eaters or smaller ewes that do not consume their fare share of grain. Overly fat ewes also tend to be more susceptible to ketosis. I believe this is due to reduced intake capacity from internal fat and increased fat resources for breakdown. Granny ewes or ewes with poor mouths are also likely candidates for ketosis. Prevention is best accomplished by monitoring condition scores and keeping ewes from becoming obese. Thin ewes can be sorted off and fed separately so that they can be fed better and insuring that they are consuming their fare share. It is important that thin ewes are sorted out early enough to allow sufficient time (60d) for getting them to the correct condition score by lambing.

Vaginal prolapses are another problem that occurs more frequently in obese ewes. Ewe lambs carrying multiple fetuses are also more prone to vaginal prolapses. The main problem with vaginal prolapses is lack of space. Limiting hay intake and preventing obese ewes are two critical steps to reducing or eliminating vaginal prolapses. An example of limiting hay intake would be to feed ewe lambs a 50:50 hay concentrate ration versus an 80:20 ration, respectively. Producers who use round bales of hay or cornstalks have a bigger challenge relative to forage

intake. Hay consumption from large packages can be controlled by limiting access to big packages for a set length of time each day. Precautions with restricted access include allowing plenty of feeding space around bales so all ewes have easy access. Otherwise, pushing and shoving will prevent timid or smaller ewes from their daily consumption. Processing the hay may also provide a means of reducing fill problems. The practicality of this practice is dependent upon hay price and equipment availability to handle processed hay.

Milk fever is different in sheep as compared to dairy cattle in that ewes develop symptoms prelambling. It has been my experience that the most likely candidates for milk fever are those carrying triplets. Classic symptoms of milk fever would be recumbent ewes that may or may not have their rear legs stretched out behind them. As one increases milk production via East Friesian crosses or increases flock prolificacy, milk fever incidence may also increase. The differential diagnosis between ketosis and milk fever would be the effected ewe's response to calcium therapy. Ewes fed on rations with alfalfa as the primary roughage ingredient should have adequate calcium intake. Diets composed of corn silage or grass hay due to lower calcium levels have greater risk of producing milk fever.

Lactation Nutrition

Lactation is the phase of production with the highest nutrient demand as shown in Figure 1. The amount of nutrients required is dependent upon the number of lambs nursed or a ewes genetics for machine milking.. Because of the huge differences in requirements the most important time to split the flock into production groups is during lactation. Lactation requirements are split into early and late in Table 1. Ewes peak in milk production around 21 days of lactation and should sustain high milk production levels through 6-8 weeks of lactation. Nutrient requirements in table 1 are based off of projected milk yield when individual ewes are producing 2, 4 or 6 pounds of milk per day.

Protein and energy are both critical nutrients for milk production. If either nutrient is fed below the requirement, milk yields will be reduced 10% or more depending upon the magnitude of the short fall. I would suggest that almost all nursing ewes lose weight during lactation, many over 35 pounds. This occurs because energy intake is well below requirements and ewes must mobilize body stores to sustain milk production. Milk ewes do not produce as much milk and therefore weight loss is less likely. Weight loss during lactation is the critical reason that late gestation nutrition must be adequate to insure ewes are in average or better body condition at lambing. Traditionally, fat mobilization during lactation was considered as a means of controlling feed costs. However, excess weight loss is not without its costs. Ewes losing less than .5 condition score during a 60-day lactation will not suffer in terms of milk yield. Since one condition score equates to an 11% change in body weight, a 200 pound ewe could only lose 11 pounds ($200 \times 5.5\%$). This value would equate too less than .2 pounds of weight loss per day. It would not be uncommon for many ewes to lose two to three times this amount.

Weight loss during lactation also impacts protein requirements. The more weight ewes lose the higher their protein need. This situation is due to the ewe's ability to effectively mobilize body fat but having minimal ability to mobilize body protein for milk synthesis. It is also important to realize that fat conversion to milk is about 60% under protein and energy deficient

rations whereas with adequate protein fed, fat conversion to milk is 80%. To demonstrate this relationship between protein requirements and weight loss, a ewe losing .5 pounds per day requires a lactation ration containing 21% crude protein. However, if the energy intake is increased to prevent weight loss, this ewe would require only 11.5% crude protein in their ration. The reason for this is the extra energy intake results in increase microbial protein yield.

Lactation Nutrition Mistakes

One of the most common mistakes inexperienced shepherds make is over feeding grain to the ewes in the lambing jug. This situation most frequently occurs when we try to accelerate the milk output in ewes that do not have enough to feed their lambs. This over feeding can create problems with acidosis and lead to less milk production rather than more. Newborn lambs probably do not consume more than 10% of their bodyweight in the first day or two of life, so it is not critical that ewes be pushed in while in the jug.

The next mistake that needs to be avoided is over feeding the ewes in the week to ten days before weaning. It is critical that shepherds modify the pre-weaning diet of ewes to reduce mastitis problems. This is easily accomplished by cutting off the grain feeding for the last 10 days before weaning along with feeding low quality hay. This management input is trying to limit the ewe's protein and energy intake as both nutrients are required for milk production. Feeding straw for the last 2-3 days before weaning further shuts down milk production. After weaning ewes should be maintained on low quality feed for 3-7 days to assist ewes in drying up. Lastly, if ewes are fed by number nursed, it is important to move ewes to the next lower ration if they lose a lamb or lambs.

Practical Feeding

Feed costs are very high. Testing hays and controlling waste are two critical inputs for competitive milk production. Managing the flock to maximize drop rate is also critical as ewes giving birth to multiples will yield 10% more milk on the stanchion. This is like free milk and breeding season management is critical to the success of dairy sheep operations. Ewe condition score changes during lactation is a key to making ration adjustments. Ewes losing weight need more energy and or protein and maybe both. This may require feeding a more nutrient dense diet, since ewes may not be able eat any more feed. Lastly feed waste is extremely inefficient, it is expensive bedding along with expensive to dispose of relative to its fertilizer value. Controlling hay waste is the biggest challenge to feeding ewes when using long stem hay.

Summary

A wise county extension director told me once that when it comes to feeding livestock "one cannot feed a profit nor can one starve a profit". The important factors for profitable sheep production are controlling feed costs and increasing output. Either is pretty easy to do by itself doing both at the same time takes effort and planning.

Table 1. Nutrient Requirements of Sheep (mature ewes and rams and yearlings maintenance and lactation)

Class/Age/Other	Body Weight ^a Kg	Birth Weight or Milk Yield ^b kg	Body Weight Gain ^c g/d	Daily Dry Matter Intake		Energy Requirements ^f		Protein Requirements			MP g/d	DIP g/d	Mineral Requirements ^h		Vitamin Requirements ⁱ	
				Kg	% BW	TDN kg/d	ME Mcal/d	CP @ 20% UIP g/d	CP @ 40% UIP g/d	CP @ 60% UIP g/d			Ca g/d	P g/d	A RE/d	E IU/d
Matures Ewes																
Maintenance only																
	60		0	1.05	1.75	0.56	2.01	79	76	72	53	72	2.2	1.8	1,884	318
	80		0	1.30	1.63	0.69	2.49	98	94	90	66	90	2.6	2.2	2,512	424
	100		0	1.54	1.54	0.82	2.94	116	111	106	78	106	3.0	2.7	3,140	530
Breeding																
	60		26	1.15	1.92	0.61	2.21	93	89	85	62	80	2.6	2.1	1,884	318
	80		32	1.43	1.79	0.76	2.74	115	110	105	77	99	3.1	2.7	2,512	424
	100		38	1.69	1.69	0.90	3.24	137	130	125	92	117	3.6	3.2	3,140	530
Early gestation (Twin lambs; BW = 3.4 to 6.6 kg)																
	60	4.2	40	1.51	2.52	0.80	2.89	129	124	118	87	104	5.9	4.2	1,884	318
	80	4.9	50	1.84	2.30	0.98	3.52	157	150	143	105	127	7.0	5.1	2,512	424
	100	5.5	59	2.15	2.15	1.14	4.10	182	174	167	123	148	7.9	5.9	3,140	530
Late gestation (Twin lambs; BW = 3.4 to 6.6 kg)																
	60	4.2	161	1.65	2.75	1.09	3.94	173	165	158	116	142	8.1	4.8	2,730	336
	80	4.9	200	1.99	2.48	1.32	4.75	208	198	189	139	171	9.4	5.8	3,640	448
	100	5.5	236	2.87	2.87	1.52	5.48	258	246	236	173	198	11.3	7.7	4,550	560
Late gestation (Three or more lambs; BW = 2.9 to 5.7 kg)																
	60	3.6	210	1.57	2.61	1.25	4.50	192	183	175	129	162	9.5	5.2	2,730	336
	80	4.2	260	2.26	2.82	1.50	5.40	241	230	220	162	195	11.6	6.9	3,640	448
	100	4.7	307	2.59	2.59	1.72	6.20	276	263	252	185	223	13.0	7.9	4,550	560
Early lactation (Parlour production only; milk yield = 2.37 to 3.97 kg/d)																
	60	2.60	-52	2.14	3.57	1.70	6.14	432	413	395	291	221	11.4	9.4	3,210	336
	80	3.00	-60	3.04	3.80	2.01	7.26	522	498	476	351	262	13.8	12.0	4,280	448
	100	3.35	-67	3.46	3.46	2.29	8.27	589	562	538	396	298	15.5	13.5	5,350	560
Mid-lactation (Parlour production only; milk yield = 1.59 to 2.66 kg/d)																
	60	1.74	0	2.11	3.52	1.40	5.05	340	325	311	229	182	8.7	7.5	3,210	336
	80	2.01	0	3.14	3.93	1.67	6.00	421	401	384	283	216	10.8	10.0	4,280	448
	100	2.25	0	3.60	3.60	1.91	6.88	477	456	436	321	248	12.1	11.4	5,350	560

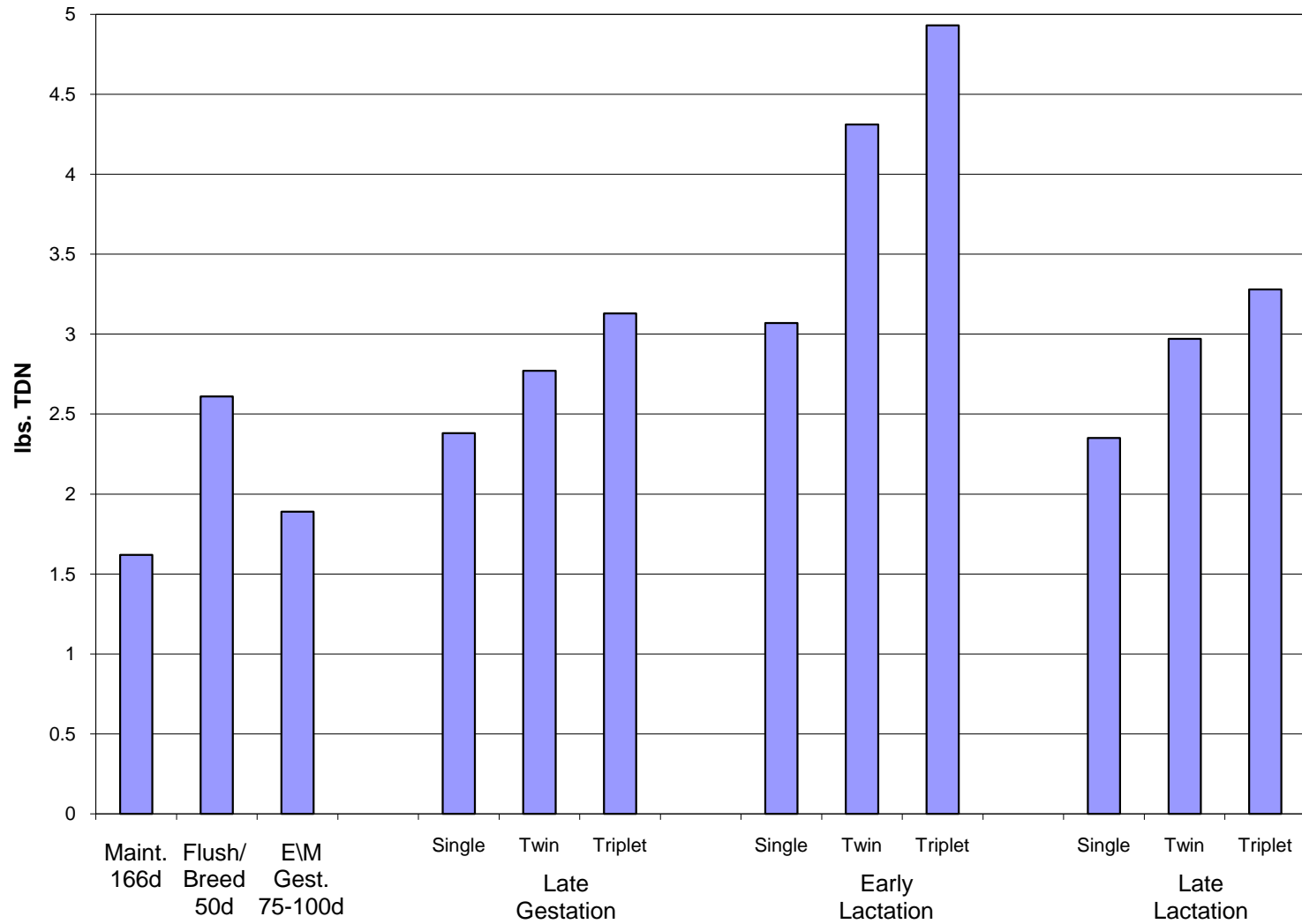


Figure 1. Total digestible nutrient (TDN) required by 175 pound ewes through their annual production cycle.

Table 3. Variation in forage quality from 1994 state wide Iowa forage survey.

<u>Hay type</u>	<u>Crude Protein</u>			<u>TDN</u>		
	<u>Average</u>	<u>Low</u>	<u>High</u>	<u>Average</u>	<u>Low</u>	<u>High</u>
Grass, 1 st cut	11.6	6.1	20.7	55.7	46.6	75.2
Grass, 2 nd cut	15.2	12.1	19.7	61.8	57.2	69.7
Alf/grass, 1 st cut	13.9	8.0	22.3	56.1	41.0	75.1
Alf/grass, 2 st cut	16.8	10.2	22.3	59.6	47.3	69.7
Alf/grass, 3 st cut	18.3	10.9	22.3	62.4	49.1	72.5

Nutrient values are based on NIRS technique.

Table 4. Trace mineral salt or mineral intake required for .69 mg selenium intake ^a.

<u>Selenium concentration in Mineral</u>	<u>Intake, oz/head/day</u>
10 PPM or .001	2.4
30 PPM or .003%	.8
50 PPM or .005%	.5
70 PPM or .007%	.33
90 PPM or .009%	.25

^a Maximum allowable by FDA.

OVINSHIRE FARM: PASTURE BASED FEEDING FOR OUR FLOCK

**Scott Burrington
Ovinshire Farm
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Ovinshire Farm maintains a farm flock of approximately 600 dairy sheep (East Friesian/Lacaune and other crossbreeds) and growing. All of our animals spend the majority of the year out on pasture for the bulk of their diet. We own 146 acres of which 100 is grazing land. The property is long and narrow and has a vertical rise of 200 to 300 feet over 1.5 miles of its length so it is a bit of an issue planning animal movement. All of our fields consist of native unimproved grasses and clover.

We have been extremely fortunate in having a local farm that raises and trains Border Collies take up to 150 dry animals for “Summer pasture” from May to November. This has been a tremendous help with keeping us in feed.

Our milk flock can range in number from 175 to over 300, and we graze the fields closest to the barn utilizing approximately 30 acres. The best way to describe the system is intensive rotational grazing as we use all portable electric netting to set paddocks, in fact we have no permanent fencing on our farm. Each day the determination is made for the size and location of the paddock and the amount of time the flock will spend on that paddock; from 12 to 24 hours depending on feed density. We never push our milk flock to clean up a paddock before being moved to a new location. I find that when the sheep graze a paddock they will obviously eat the most desirable grasses and legumes first and then move on to the less desirable. At this point we try to clip pastures to maintain even growth and keep weeds in check. Some years we do better than others depending on the price of fuel and that elusive commodity, time. We run on a relatively fixed 14 day rest period for the paddocks which gives the desirable plants time to re-grow, not to optimum height but to an acceptable height. During a wet year, life is good and the paddocks come back very quickly so everything is lush and plentiful. A dry year is a challenge as we tend to run the sheep over larger areas for shorter durations, and the recovery is not what we would like.

During the summer months we make sure there is shade available for the sheep to take cover during the hot afternoons. When the temperature goes over 90, we bring the sheep into the barn at 1:00 pm to rest under fans and eat dry hay. We make dry hay available to the milk flock in the barn before and after milking so they have a little more fiber in the diet giving us a small boost in milk fat. In the parlor, the ewes consume 2 pounds of an 18% pellet per day giving us the ability to have consistency in the daily intake of nutrition as the grass is not consistent.

Our lambs get exposed to grass as soon as possible post weaning and their fence is expanded as needed allowing them access to the barn for grain feeding and to take care of maintenance issues (worming, vaccinating, feet, etc.).

We need to get better with our pasture maintenance as invasive plants seem to keep taking more ground. One of our milk flock fields is terribly inundated with spotted knapweed and

another with horse nettle (wild tomato). Both of these spread both above and below ground and according to local extension agents would require 2 to 3 years of intensive spraying and plowing to possibly bring them under control. Other problem weeds are thistle and a small patch of henbane (toxic) we are managing by hand. My wife is wonderful as she will work all day as a large animal vet and come home and offer to sit on a tractor to deck mow fields that have the greatest need and it is very much appreciated.

I will state that we are doing an acceptable job, not an exceptional job, with the pasture and there is so much more work to be done to fully utilize the fields and make them more productive. Future plans for Ovinshire Farm include lime application, perimeter fencing and plowing and re-seeding a field or two that are severely rutted from tractor traffic.

FEEDING PROGRAM FOR IRISH CREAM SHEEP DAIRY

**Virginia and Bill Halligan
Irish Cream Sheep Dairy
Bushnell, Nebraska, USA**

We use a total mix ration (TMR) concept for feeding our ewes. The feed is ground and mixed just before feeding at a fence line feeder. The method gives us the most flexibility to adjust feed ingredients to maximize production and reduce feed cost by using the most cost efficient feeds available.

We can milk up to 600 ewes and house them in 6 pens. They are fence line fed with a capacity of 100 ewes to eat at one time. A hoop barn is centered on 2 pens for winter protection and summer shade.

The feed is stored in 7 hopper bottom bins that auger into the feeder wagon. The bins are used for corn, soybean meal, and mineral supplement. A cement slab with small bunkers is used to sort the bales of alfalfa, silage, straw or corn stalks before being added to the feed wagon. We like to have the silage stored in plastic bags to maintain the quality for the entire year.

The feed wagon is a Supreme Vertical auger feed wagon that grinds all of our bales as we mix the ration to be fed. We use a Bobcat loader to fill the wagon and pull it with a 100 hp tractor.

The biggest problem with this TMR concept is the startup cost. The following are estimated used prices to purchase the equipment.

- \$20,000 Feed Wagon
- \$20,000 Tractor
- \$15,000 Loader
- \$10,000 Grain Bins
- \$ 5,000 Cement Slab

It takes 2 loads a day to feed the 600 milking ewes and about 1 hour to feed each load. This same system is used to feed the dry ewes and mix feed for the lambs on feed.

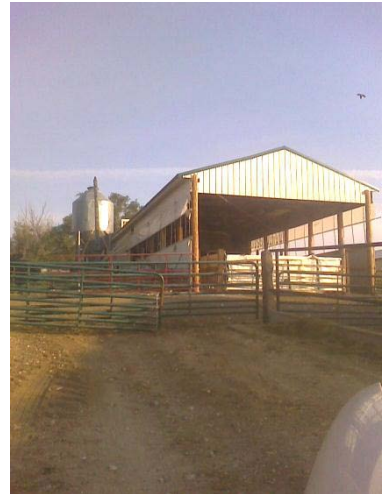
This system works only when the number of sheep is large enough to pay the front end capital investment.



Wagon Loader



Silage Bag



Parlor Feed Bin



Hay Storage



Fenceline Feeding



Corn Grinder



Bulk Bins

MANAGING DAIRY SHEEP NUTRITION ON AN ORGANIC FARM

Rebecca King
Garden Variety Cheese/Monkeyflower Ranch
Royal Oaks, California, USA

Farm Overview

Monkeyflower Ranch is a 40 acre sheep farm located on the Central Coast of California. We have been raising a flock of 100 dairy ewes on the property since 2008, following organic farming practices.* The milk from our flock goes entirely to farmstead production of aged, raw-milk cheeses under the brand name Garden Variety Cheese. Starting in 2011, we are also producing small quantities of sheep milk yogurt. The majority of our products are sold locally through farmers markets and a direct-to-consumer marketing program, with the remainder going to stores and restaurants in the San Francisco Bay Area.

Our ewes begin lambing in December and January and we dry off the flock in late summer. This year we had a group of late lambers that were milked until the end of September, and our first round of lambs are due at the beginning of December 2012. We have a Mediterranean climate in Royal Oaks, California with relatively mild weather year-round. The rainy season is generally November through May, with little or no precipitation the rest of the year. We have frosts and freezing temperatures in the winter but rarely below 30°F. The grazing season is January to May unless pasture is irrigated regularly. We have tried to correlate the lambing season with the grazing season to ensure the intake of high quality forage during milking. This should mean less purchased feed overall and the contribution of the nutrition and milk-flavoring elements of pasture during lactation. No synthetic wormers are used on our flock other than a monthly regimen of concentrated garlic juice, so we also rely on rotational grazing as an important tool in health management under an organic system.

We have been milking and breeding dairy sheep at Monkeyflower Ranch since 2008 and have seen gradual increases in our milk production. I believe this has been a result of a combination of improved stock from culling and selective breeding as well as improved nutrition. The flock average for 2012 has been well over 700 lbs per ewe, not adjusting for the age of the animal. A sample analysis of our milk components from late in lactaion can be viewed in Table 1.

Table 1. Milk Analysis for Bulk Milk August 16, 2012

Fat %	Protein %	Lactose	SNF	MUN	SCC	DIM average
8.69	6.33	4.84	12.19	27.0	142	168

Feeding Program

As described above, we practice rotational grazing during winter and spring. In fall of 2008, our pasture was seeded with a mix of Ambassador Orchardgrass, Tetraploid Perennial Ryegrass, Bison Ryegrass, Renegade Red Clover, Tetraploid Annual Ryegrass, Strawberry Clover, and Ladino Clover. We also see a variety of other grasses, forbs and legumes that have volunteered in the fields. Because of damage due to a severe infestation of ground squirrels and gophers this year we will be reseeding the pasture again this fall with a similar mix. We irrigate our pasture during the early part of the dry summer (and sometimes dry winter), but we pay a water district \$170 per acre foot in addition to the electricity bill for pumping up a hill. This is a strong disincentive for sustaining the pasture longer into the season.

When the sheep are grazing they are also given about 2 lbs. of alfalfa hay per day. During the dry summer and fall when there is no pasture they are fed free choice alfalfa hay. At the end of lactation and early part of pregnancy we will often substitute a lower quality grass hay for the alfalfa hay.

In addition to the pasture and/or hay, the ewes are fed a ration of spent brewer's grain. This is organic barley that is a waste product from a local brewery. Because they have extracted most of the sugars from the mash for the beer-making process the resulting grain is comparatively high in protein. We have not had our particular brewer's grain analyzed but the Feed Composition Guide (R.D. Preston, *Beef Magazine*, July, 2002) gives the following values for wet brewer's grain:

Table 2. Feed Composition of Wet Brewer's Grain

Dry Matter	Total Digestible Nutrients	Digestible Energy	Crude Protein	Bypass Protein	Acid Detergent Fiber
23%	85%	1.7 Mcal/lb	26%	52%	21%

Because the brewer's grain is high in protein and low in sugar, we add an organic whole corn to the ration. The intention is to provide extra energy to help in the digestion of the high protein diet of brewer's grain and leguminous pasture. The ration during milking is 4 lbs. of brewer's grain and 1 lbs. whole corn. This is divided into two feedings which the ewes receive in the milking parlor.

Our source of brewer's grain is free, but not always constant. The brewery does not operate everyday but rather Tuesday through Friday, with double batches often made in the middle of the week. Depending on the ambient temperature, the spent grain keeps between two and four days before becoming moldy and unusable. They also produce less beer and grain in the winter than in the summer. So, we substitute an organic dairy grain pellet from Modesto Milling for the spent grain and corn ration on the days we run out of the brewer's grain.

Calculating Rations and Pasture Intake

Our feeding regiment at Monkeyflower Ranch is largely based around the condition of the ewes at specific points in the season, the available feed sources and the ewe's own choice. I

strongly believe that, if given the option, the animals will make choices in their feed intake that corresponds to what is most nutritious and digestible. This is one reason we offer hay to the ewes even when they are on pasture. We also monitor the body condition of the ewes in the milking parlor and adjust their feed to keep them in optional condition.

I have made extensive use of the reference charts for sheep nutrient requirements and feed composition in the Nutrition chapter of the SID Sheep Production Handbook (American Sheep Industry Association, Inc. 2002 Edition, Vol. 7). By knowing what the requirements are of your ewes and the relative nutritional value of the feed sources you have available, you can make relatively simple calculations to determine the appropriate quantity of each feed source to offer. I would highly recommend this book as a tool for any sheep producer.

Even when you are relying on pasture for a large portion of your feed source, you can still make relatively simple calculations to determine your ewe's nutrient intake. As part of the organic certification process, producers must develop an Organic System Plan and keep detailed records of all of their management practices. Beginning in 2011, more stringent pasture requirements were established by the National Organic Standards Board and producers were required to document the calculated percentage of feed intake their animals received from pasture during the grazing season. To facilitate this calculation, CCOF created a worksheet for producers to record their feed regimen. A sample of this worksheet can be seen below.

The dry matter demand of the animals must be estimated, either through a percentage of body weight or a reference source. For my calculations, I have relied on recommendations from the National Academy of Sciences (*Nutrient Requirements of Sheep*, 6th Revised Edition, 1985). CCOF also provides a reference chart for calculating the average dry matter of various feeds. The first page is shown below as an example.

** Monkeyflower Ranch was certified organic from May 2010 to June 2012 by California Certified Organic Farmers (CCOF). In June 2012 we discontinued our organic certification. This was due to the high price and lack of availability of organic alfalfa hay, and to severe pasture damage from ground squirrels (which we were unable to manage under organic practices). At that point we purchased some conventionally grown alfalfa hay and used rodenticide bait stations on our pasture. In all other aspects, we continue to manage our farm and herd according to organic production standards.*



CCOF Dry Matter Intake (DMI) Calculation Worksheet for Ruminant Livestock

This worksheet can be found at www.ccof.org/pasturerule.php

Instructions: Use this form to document Dry Matter Intake for organic ruminants during the grazing season.

Complete a new worksheet each time the feed ration changes for a group of animals. Use a separate worksheet for each type and class of animal. Average the DMI from pasture for each type and class of animal using the CCOF Grazing Season Average DMI Worksheet to find the final average DMI from pasture for the grazing season. Submit these worksheets to your CCOF inspector each year. You may use other forms or worksheets so long as they provide sufficient information to allow for verification.

Operation Name:		Date and Year:	
Ration Name/Type/ID:		Species & Breed of Animal:	
Time period this ration is fed (during grazing season ONLY) <input type="checkbox"/> Spring <input type="checkbox"/> Summer <input type="checkbox"/> Fall <input type="checkbox"/> Winter <input type="checkbox"/> Dates: # of days:		Class of Animal: <input type="checkbox"/> Calf <input type="checkbox"/> Heifer <input type="checkbox"/> Low String <input type="checkbox"/> High String <input type="checkbox"/> Dry <input type="checkbox"/> Slaughter <input type="checkbox"/> Other:	
Approx # of animals in group:	Dry Matter Demand (in lbs):	Source of DMD calculation: <input type="checkbox"/> % of body weight <input type="checkbox"/> Lbs per day of milk <input type="checkbox"/> Other reference	

If you are using this worksheet in Excel or Adobe, formulas are provided in the yellow cells to perform the calculations for you

Feed type (list all other than pasture)	Average # of lbs fed per animal	x	Dry Matter content of feed source as %	=	DMI Fed in Lbs						
<i>Example: Hay</i>	<i>Example: 22</i>	x	<i>Example: 85</i>	=	<i>18.7</i>						
		x		=							
		x		=							
		x		=							
		x		=							
		x		=							
		x		=							
		x		=							
		x		=							
Total DMI Fed from non-pasture (sum of DMI lbs of each type) =											
	-		=		÷		=		x 100	=	
Dry Matter Demand (lbs)	Total Dry Matter Fed		DMI from pasture		Dry Matter Demand		DMI from Pasture				% DMI from Pasture

You must provide accurate dry matter content values for each feed source. Due to high variability in moisture contents, especially for fresh & ensiled feeds, it is important to use the actual dry matter content values for your operation. If you perform testing of your feed, please use the dry matter content shown by testing. You must demonstrate to your inspector the source and accuracy of each dry matter content provided. Justification for values that vary significantly from reference values will be required.

Each type and class of ruminant animal must consume an average of at least 30% of the dry matter demand from pasture during the grazing season. Requirements for DMI calculation apply only to times within the grazing season, defined as "the period of time when pasture is available for grazing", and may or may not be continuous, but must be at least 120 days per year.



Average Dry Matter Percentages for Various Livestock Feeds

Available at www.ccof.org/pasturerule.php

Information provided as reference for organic ruminant by CCOF to help calculate Dry Matter Intake. All feed for organic livestock must be certified organic, and must be listed in the Organic System Plan and approved by CCOF.

Feed Type	Average Dry Matter %	High End	Low End	Source of Data
Alfalfa (cubes, dehy)	90.2	91.3	90.0	UC Cooperative Extension 2009
Alfalfa (cubes, sun-dried)	91.6			UC Cooperative Extension 2009
Alfalfa (green chop - fall)	42.9	56.7	21.1	UC Cooperative Extension 2009
Alfalfa (green chop -> summer)	27.1			UC Cooperative Extension 2009
Alfalfa (hay)	90.2	94.3	84.1	UC Cooperative Extension 2009
Alfalfa (silage)	29.7	40.1	24.8	UC Cooperative Extension 2009
Alfalfa Cubes	91			Beef Magazine 2009
Alfalfa Cubes	90.1	92.3	89.6	Dairy One
Alfalfa Dehydrated 17% CP	92			Beef Magazine 2009
Alfalfa Fresh	24			Beef Magazine 2009
Alfalfa Hay Early Bloom	90			Beef Magazine 2009
Alfalfa Hay Full Bloom	88			Beef Magazine 2009
Alfalfa Hay Mature	88			Beef Magazine 2009
Alfalfa Hay Midbloom	89			Beef Magazine 2009
Alfalfa Leaf Meal	89			Beef Magazine 2009
Alfalfa Pellets	91.0	92.5	89.3	Dairy One
Alfalfa Seed Screenings	91			Beef Magazine 2009
Alfalfa Silage	30			Beef Magazine 2009
Alfalfa Silage Wilted	39			Beef Magazine 2009
Alfalfa Stems	89			Beef Magazine 2009
Alfalfa/Grass (hay)	84.9	85.6	83.7	UC Cooperative Extension 2009
Almond Hulls	89			Beef Magazine 2009
Almond Hulls	87.7	96.1	85.0	UC Cooperative Extension 2009
Almond Meal	90.9			UC Cooperative Extension 2009
Almond skins (ensiled)	29.8			UC Cooperative Extension 2009
Almond skins (fresh)	47.9			UC Cooperative Extension 2009
Apple (pulp, wet)	16.5			UC Cooperative Extension 2009
Apple Pomace Dried	89			Beef Magazine 2009
Apple Pomace Wet	20			Beef Magazine 2009
Artichoke Tops (Jerusalem)	27			Beef Magazine 2009
Avocado Seed Meal	91			Beef Magazine 2009
Bahiagrass Hay	90			Beef Magazine 2009
Bakery Product Dried	90			Beef Magazine 2009
Bakery Waste	91.9			UC Cooperative Extension 2009
Barley (grain)	90.4	91.0	89.3	UC Cooperative Extension 2009
Barley Feed Pearl Byproduct	90			Beef Magazine 2009
Barley Grain	89			Beef Magazine 2009
Barley Grain 2-row	87			Beef Magazine 2009
Barley Grain 6-row	87			Beef Magazine 2009

Data from UC Cooperative Extension, Dairy One and Beef Magazine

Page 1 of 10

KEYS TO SUCCESSFULLY RAISING LAMBS ON MILK REPLACER

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Abstract. Successfully raising lambs on milk replacer is dependent on the implementation of a total management system. There is significant data to support this systems approach with dairy calves. The author’s objective is to share this dairy calf data and whenever possible to share data that also supports the importance of these management systems in the milk fed lamb. The critical components of this management system are as follows;

- Navel dipping
- Colostrum feeding and managementⁱ
- Choosing the right milk replacer
- Choosing the right milk feeding system that best fits the farm’s situation
- Water & a dry feed introduction
- Weaning management

Navel Dipping

The first order of business should be to provide for a clean birthing environment to reduce the total pathogen load that the lamb is exposed to. Immediately after birth, the newborn’s navel should be dipped with a disinfectant. Care should be taken to get disinfectant both outside the navel and inside the navel opening. Land O’Lakes’ research team has found the use of a syringe or bottle (figure 1) to be helpful to get disinfectant inside the



Figure 2	No. Of Calves	% Mortality	% Treated for Scours	% Treated for Pneumonia
Disinfected	269	7.1	30.5	5.2
Not Disinfected	132	18.0	22.0	18.9

** Source: Calf Survival Study. Univ. Of Wisconsin*

navel opening. 7% tincture of iodine is the first recommendation for a dip (alcohol base helps dry the navel cord quickly). Betadine or Nolvasan can also work, however lacks drying effect. Don Sockett, DVM, PhD; (WI Diagnostics Laboratory) recommends a 50:50

blend of undiluted Nolvasan plus rubbing alcohol. University of Wisconsin research data shows that the mortality and treatments for pneumonia are significantly reduced in calves, when navels are disinfected (figure 2).

Colostrum Feeding & Management

Key points relative to colostrum management in sheep. (Source: Iowa State Extension Publicationⁱⁱ)

- Colostrum is the “first milk” that ewes produce after lambing.
- Colostrum has a high level of several nutrients that are important for lamb health and performance.
- Colostrum contains a high concentration of antibodies against a variety of infectious agents.

- Immediately after birth, the lamb is exposed to a variety of infectious agents present in the environment, the dam, and other ewes and lambs. Without any protection from these infectious organisms, the lamb may become diseased or die.
- At birth, the lamb does not carry any antibodies against these organisms because antibodies in the ewe's bloodstream do not cross the placenta. However, these antibodies are concentrated in the colostrum and provide a natural and efficient source of protection against many intestinal, respiratory, and other diseases.
- Vaccinating ewes for diseases such as enterotoxemia and tetanus prior to lambing is important, since antibodies against these diseases will then be contained in the colostrum.
- Additionally, colostrum provides needed energy to help lambs stay warm and acts as a laxative to ensure excretion of meconium.

The first feeding of colostrum to the newborn lamb should be within the first hour of life. The highest concentration of antibodies and nutrition is found in colostrum within the first hour after birth. Research results conducted by the Department of Sheep and Goat Breeding at the University of Krakow in Polandⁱⁱⁱ showed that the solids content in ewe's colostrum taken at 1 hour averaged 32.8% and decreased within the next 6 hours by 8.3 and 8.5 percent units in two sample groups. Fat content averaged 10.05% at 12 hours and only 6.55% at 72 hours. Protein level during this period was fairly stable and ranged from 6.0 to 6.9%.

If hand feeding colostrum the following guidelines are recommended. (Source: Iowa State Extension Publicationⁱ⁾

- Colostrum should be fed with a nipple bottle if lambs are capable of nursing.
- They should be given 2 to 4 ounces of colostrum at 3- to 4-hour intervals.
- Weakened or chilled lambs, if handled properly, will require only one supplemental feeding in most cases.
- Lambs that have lost their mothers or are born to ewes that have inadequate colostrum should be fed the entire 16 ounces of colostrum within the first 24 hours.

If hand feeding colostrum, care should be taken to hygienically collect the colostrum to avoid bacterial contamination. Check concentration with colostrometer as an indicator of total solids in the colostrum and an indicator of quality. If OPP is a concern, colostrum should not be pooled. To control pathogens that may have contaminated the colostrum during collection consider heat treating^{iv}. Heat treating should not be confused with pasteurization; 165° F (73.9° C) for at least 5 seconds. Above 135° F (57.2° C) colostrum begins to cook and solidify and a sharp loss in antibodies & nutrition will occur. To properly heat treat colostrum, heat to 135° F (57.2° C) and hold at that temperature for 60 minutes.

Colostrum is more than antibodies and nutrition! In dairy calves failure of passive transfer (FPT) reduced long term performance, feed efficiency and growth rates. Data shows that calves with FPT, had delayed time to first calving (Can Vet J., 1986, 50:314); decreased average daily gain (Nocek et al., 1984; Robison et al. 1988) and decreased milk and fat production at first lactation (DeNise et al., 1989). Inadequate colostrum intake has also been shown to reduce long-term performance of dairy heifers (Professional Animal Science, 2005^v). Brown Swiss heifer fed 2 liters of colostrum vs. 4 liters, over the course of 6 to 8 feedings; had reduced average daily gain (1.76 lbs vs. 2.2 lbs.), increased time to first conception in months (14 vs. 13.5), reduced

survival through 2nd lactation (75.3 vs. 87.1%) and over 2000 lbs less milk production through the 2nd lactation (35,297 vs. 37,558).

Choosing a Lamb Replacer

Is the milk replacer made specifically for lambs? An all-purpose, multi-specie milk replacer is all about compromise. Calves, lambs, kids, pigs, alpacas, puppies and kittens; do not all have the same nutrient requirements.

Milk replacers formulated for lambs should closely mimic the composition of ewe's milk. Composition of sheep's milk (source: Jandal 1996) on a dry matter basis is ~30% Protein and 37% Fat. The solids level of ewe's milk on as-fed basis is ~18% solids solution. It is important that not only should the protein and fat be similar to ewe's milk, but the total solids of the milk replacer solution should be similar to ewe's milk. There is a simple formula for calculating total solids in the final solution based on the mixing instructions for the lamb milk replacer. This formula is:

- $\text{Weight of Powder} + \text{Weight of Water} = \text{Weight of Final Solution} \div \text{Weight of the Powder} \times 100 = \% \text{ Solids of Final Solution}$

Comparing feed analysis tags on various lamb milk replacers can be confusing. Although the ingredients and specifications may be similar based on the feed analysis tag, it is difficult to truly tell the differences between the product based on this comparison. For example; sometimes tags will have slight differences in protein or fat, i.e. 30% fat vs. 35% fat. If there is a higher guarantee on one nutrient one product compared to another, does that make it better? A more informed decision can be made by asking some key questions of the supplier or manufacturer.

- What research has been done to prove this formula performs in lambs? Ask for a summary of those results.
- Do the ingredient sources utilized in the formula meet human food grade quality standards?
- Are the protein sources milk based?
- What are the fat sources and has any consideration been made to formulating not only to a fat level, but to provide the lamb with a specific fatty acid profile?

Choosing the Right Feeding System (Mole Valley Feed Solutions^{vi})

Bottle Feeding

- Pros
 - a. Ensures an appropriate controlled volume of (usually warm) milk replacer
 - b. Useful for rearing small numbers of lambs
- Cons
 - a. Very labor intensive feeding and cleaning of the equipment
 - b. Must feed at the same time each day

Lamb Bar Feeding

- Pros
 - a. Provides opportunity for several lambs to feed ad-lib, so they can drink several times a day
 - b. Milk can be fed warm or cold
 - c. Feeding is little and often, thereby reducing digestive upsets
 - d. Faster growth rates compared with bottle fed lambs
 - e. Less labor involved: milk is made up in bigger volumes and it doesn't require holding bottles
- Cons
 - a. Diseases can spread more easily through shared nipples
 - b. Teats and tubing should be cleaned daily
 - c. Buckets must be emptied and cleaned regularly to reduce the risk of nutritional scours
 - d. Requires milk replacer to include a preservative

Automated Mixing & Feeding Systems

- Pros
 - a. Milk consumed little and often
 - b. Low risk of digestive upsets
 - c. Highest growth rates
- Cons
 - a. Highest set up cost
 - b. Best hygiene critical. Tubing and mixing bowl must be cleaned daily and the machine calibration checked at least once a week

Water & a Dry Feed Management

Water and dry feed management are critical to assure the proper rumen development in the lamb. Quigley (1997a, 1997b^{vii}) describes 5 key factors required for rumen development.

1. Liquid (water, saliva)
2. Dry feed (substrate)
3. Establishment of bacteria in the rumen
4. Absorptive ability of the tissue (papillae)
5. Out flow of material from the rumen (muscular action)

Rumen development is a gradual process. In order to understand this process it is helpful to understand the function of the esophageal groove and its role in passing the milk to the abomasum. According to the Review of Veterinary Physiology^{viii}, only when animals suckle voluntarily, and with characteristic juvenile excitement, does this groove close efficiently. When the calf drinks water (not suckled from a bottle), the esophageal groove does not close and goes to the rumen. It is important to provide clean, fresh, free-choice water available alongside or near proximity of dry feed.

Quigley (1997^{ix}) writes that fresh, clean water is critical to successful rumen development. An important part of the calf's development is the ability of the rumen to ferment the concentrate and forage that it eats. This is termed rumen development, and is necessary before the calf can be weaned successfully. Fermentation of feeds in the rumen produces volatile fatty acids (VFA). These acids cause dramatic changes in the size and activity of the rumen, and prepare the calf for weaning. Unless the calf consumes sufficient dry feed within the first few weeks of life, weaning

will be delayed, or unsuccessful. Water is a critical ingredient in the development of bacterial growth and the beginning of rumen fermentation.

The role of grain in the in rumen development is to provide the substrate for bacterial growth and fermentation. Quigley (1995^x) demonstrated that the feeding of grain encouraged the volatile fatty acids—VFA. Grain fermentation produces butyrate, and butyrate encourages papillae growth. Forage will develop the musculature of the rumen. Forages contain too little energy to meet the energy requirements of the fast growing ruminant.

In addition to the significant calf data that supports the feeding of grain vs. forage for encouraging rumen development, G.A. Abou Ward (2008^{xi}) reports that creep (grain) fed lambs had heavier ($P<0.05$) rumen fresh weight (82%) relative to the total fore-stomach weight in comparison with only 70.2% for the solely milk-fed group. The papillary length was in favor of the creep fed lambs (2.24 mm vs 1.15 mm). The creep fed lambs also had higher ($P<0.05$) circumference (mm), surface area (mm²) and total papillary surface area.

Weaning Management

Purdue University provides the following guidelines in ANSC 442 Sheep Management on-line resources.

Rules of Thumb for Weaning

1. Clean, fresh water available -- always
2. Creep feeding before weaning will encourage a smoother transition
3. Lambs may be weaned at 21 days of age in artificial rearing systems
4. Provide a very high quality, high protein diet at weaning (18 to 25% protein). Some animal or other very high quality protein is required. Utilize partially processed grains in weaning systems; processing may be discontinued as animals reach 50 lb. body weight
5. The diet must be highly palatable, more so than in any other stage of life. Molasses may be useful to minimize dust and sorting, and may improve palatability. A commercial pelleted diet may be considered to reduce sorting, but intakes tend to be lower than with molasses enhanced, rolled grain diets
6. Urea (if fed) must not be fed until two weeks after weaning, unless late weaned and animals have consumed solid feed to allow rumen development.
7. Urea should not be fed at more than 1% of ration dry matter (DM); only feed grade urea should be used
8. Consult and follow the guidelines of a lamb ration program as set out by a qualified nutritionist

Steps to Weaning

1. Plan weaning protocol, timing and facilities 14 to 21 days prior to weaning
2. Ensure animals are consuming creep feed (1% of Body Weight *e.g.* if lambs weigh 20 lb. they should consume $20 \times 0.01 = 0.2$ pound)
3. Ensure animals are utilizing water
4. Remove milk replacer or ewe (weaning)
5. Feed high protein ration (18 to 25% CP); sample diet.

Conclusion. Successfully raising lambs on milk replacer involves successfully implementing a total management system. Navel dipping and colostrum management practices are no different than the recommended practices for ewe raised lambs. Research in dairy calves has shown that colostrum not only provides critical antibodies for passive immunity and high quality nutrition; it also has an impact on the future health and productivity of the animal far beyond the milk fed phase.

Choosing the right milk replacer can be confusing if the selection is made simply by comparing nutrient guarantees, one product versus another. To help the lamb raiser to make a good selection it is recommended that key questions be asked of the supplier or manufacturer. The most important question is to ask whether research has been done to prove the product works well for lambs. It is important to not only the question, but to ask for a research summary.

There are three primary means of feeding lambs on milk replacer. Bottle feeding, free-choice feeding via a “lamb bar” or automated free choice feeding. Choosing the right milk feeding system should be based on which system best fits the lamb raisers facilities, size of operation, labor situation and performance objectives.

Water & a dry feed introduction are critical elements for rumen development. Water is necessary for providing the right environment for rumen micro-organisms to grow along with dry feed to act as a substrate for those micro-organisms. Along with free-choice water, grain or creep feeding has been shown to work best for the development of rumen function as it promotes Volatile fatty acid (VFA) production. This VFA production encourages rumen papillae growth, which provides the greatest surface area for nutrient absorption. Roughage feeding encourages rumen musculature but not efficient rumen function and therefore should not be fed prior to weaning. Successfully implementing a good water and dry feed introduction are the foundation to a good weaning system. Lambs should be consuming an equivalent of 1% of body weight of a high quality creep feed along with adequate water before being a candidate for weaning.

i

ⁱⁱ Source: IA State Extension Sheep Management Fact Sheet #12, Colostrum & Health of Newborn Lambs, Pm-989-12 | Revised | June 1995

ⁱⁱⁱ Chemical composition of colostrum and milk of Polish Merino sheep, Arch. Tierz., Dummerstorf 47 (2004) Special Issue 129-134, Dept. of Sheep & Goat Breeding Agricultural University of Krakow, STEFAN CIURYK, EDYTA MOLIK, URSZULA KACZOR and GENOWEFA BONCZAR

^{iv} UC Davis Publication 8160, Raising Dairy Goat Kids Authors: Jolene Berg, Peter Robinson, Deborah Giraud

^v Effects of Colostrum Ingestion on Lactational Performance, Prof. Anim. Scientist, 2005

^{vi} Sheep Management Feeding Systems, Mole Valley Feed Solutions Ltd, Head Office, Station Road, South Molton, North Devon EX36 3BH www.molevalleyfarmers.com

^{vii} Quigley, J.D. 1997b. Calf Notes #27—How calf starter intake drives rumen development. <http://www.calfnotes.com/pdfiles/CN027.pdf>

^{viii} Review of Veterinary Physiology, Larry Engelking, BS PhD

^{ix} Dr. Jim Quigley (02 March 1997) ©2001 by Dr. Jim Quigley, Calf Notes.com (<http://www.calfnotes.com>)

^x Source: Quigley et al 1995

^{xi} G.A. Abou Ward, American-Eurasian J. Agric. & Environ. Sci., 3 (4): 561-567, 2008 Effect of Pre-Weaning Diet on Lamb's Rumen Development

CURRENT REGULATORY REQUIREMENTS FOR OVINE SEMEN AND EMBRYOS

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Note: the observations and statements of the author in this document pertaining to the scope and types of regulatory oversights for animals of various types are solely those of the author. They are provided in a context of background material covering the general regulatory processes involved for certain animal commodities; and while they reflect USDA APHIS' current policies, should not be taken as, or in lieu of, legal expertise or the regulations themselves. The author's observations do not bind USDA APHIS or any other regulatory entities in any obligatory or figurative sense; nor do these remarks confer any specific rights on anyone in the public, private or government sectors with respect to the interpretation of the requirements governing the importation of regulated animal commodities.

Ruminants are currently defined in the United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA APHIS) regulations as '*all animals which chew the cud*'. This category includes all sheep and goats, regardless of intended use(s) after importation, but the terms 'sheep' and 'goats' are not actually further defined in the current regulations.

APHIS, through its Veterinary Services (VS) sector, regulates the importation of live ruminants of all types, and for a variety of end-purpose uses, under Title 9 of the Code of Federal Regulations (CFR), Part 93, Subpart D. The importation of ruminant semen and embryos (also referred to in this document as 'germplasm') is regulated through Part 98. The U.S. domestic (interstate) regulations for ruminants are located in other sections of the CFR. Another part of the regulations in Title 9 deals with the humane handling or other animal-care issues associated with the movement of APHIS-regulated animals; these requirements may also have some application to ruminant species moving in commerce or otherwise.

The importation of ruminant products and by-products is also regulated by APHIS VS in Parts 95 and 96 of Title 9 of the CFR. Other types of ruminant-associated material (for instance, ruminant proteins used in the development of vaccines or test kits; or viruses and other micro-organisms affecting ruminants) are covered in other Subparts within Title 9.

Generally speaking, APHIS derives its broadest authority to regulate the animals it does through the Animal Health Protection Act (AHPA), which was most recently re-authorized by Congress in 2008 under the so-called 'Farm Bill', which itself came up for re-authorization in 2012. (The AHPA is also referenced in the U.S. Code under Title 7.) The AHPA gives the Secretary of Agriculture the means to take whatever actions may be needed to provide the level of oversight that is deemed necessary by the Secretary to prevent, control, eliminate, or otherwise mitigate against animal health emergencies. In this context, 'animal' is defined as any member in the animal kingdom, except humans.

The CFR represents the codified requirements, or ‘rules’, that have been published in the Federal Register at one time or another by APHIS and other government agencies. The CFR is divided into 50 Titles, many of which are updated annually; bound copies of each Title are available from the Office of the Federal Register, but a more continuously-updated electronic version of the CFR is also maintained on the internet. As of October 9, 2012, the new website to access the electronic CFR will be www.eCFR.gov. This site provides quick reference to all federal regulations, and can be easily bookmarked by separate Titles or by sections within Titles.

Prior to publication in the CFR, APHIS’ rules are made public through a notice placed in the Federal Register, and are usually also described on internet sites belonging to APHIS, or through stakeholder registries. Such notices usually entail a statement of a rule or other action that is being proposed by APHIS, and solicit public comments for a specified period of time, after which no further comments are taken unless the agency elects to re-open the comment period. Public comments are published on an internet website as they are received. At the close of the comment period, APHIS then addresses all comments received for a proposed rule prior to another notice being placed in the Federal Register indicating that the proposed rule is being finalized, changed, or withdrawn. The final version of a rule may reflect certain modifications that may be made to the proposed rule, based on public comments or for other reasons; but such differences are generally not very substantive. Certain types of rules don’t need to be published as proposals, but can be published as direct final rules, if they meet certain administrative criteria. These are rare and usually limited to wording changes that do not substantively affect an existing rule. Most final rules take effect after a specified period of time, usually between 30 and 60 days, in order to allow compliance with any new requirements. Other types of rules (known as interim rules) can be quickly, immediately, or even retroactively implemented by APHIS on an emergency basis; although interim rules may remain unchanged for a period of years, they are supposed to be finalized at an appropriate time.

In addition to APHIS’ nominal authority under the AHPA and its published regulations in the CFR, animal commodities (and their movements) may also be affected by several other administrative mechanisms, collectively referred to as policy or administrative documents, including VS Directives, Notices, Memoranda, Bulletins, protocols, guidances, and Import Alerts. The agency can also seek other means of restricting animal movements through Federal Orders or injunctions. In addition, APHIS works closely with state animal health authorities (acting under state legislation such as statutes and other legal means) to quickly place holds or quarantines on animal commodities or physical premises when animal health emergencies may arise.

APHIS regulates the importation of ‘ruminants’ of differing types for several reasons. Many ruminant species share a susceptibility to diseases that may have been eradicated from the United States (also known as foreign animal diseases, or FADs), the introduction of which could quickly and negatively impact the health of domestic livestock species. Examples of ruminant FADs include foot-and-mouth disease, Akabane virus, contagious bovine pleuropneumonia and malignant catarrhal fever. As a result of the introduction or dissemination of FADs such as these, the status of U.S livestock exports could just be impacted just as quickly and negatively. Since the annual combined direct and indirect economic value of the U.S. domestic and export

markets for livestock animals is in the hundreds of billions of dollars, the prevention of such FADs through regulation is of paramount concern to APHIS.

Besides FADs, there are a number of important other pathogens and diseases of ruminants that may already exist in the U.S., but in a limited, controlled or otherwise manageable distribution. Bovine tuberculosis, scrapie and tick-borne diseases such as bovine babesiosis fall into this category, as do certain serotypes of bluetongue virus. APHIS' import regulations may reflect these enzootic distributions by requiring certain types of entry or post-entry testing, or require imported ruminant commodities to be imported to, or to remain permanently under, some type of location that has been approved for a specific purpose under an APHIS program or through some other official oversight.

Ruminants may also be regulated because they can transmit some pathogens that infect humans; these are referred to as zoonoses and include the agents that cause brucellosis, Q fever, and certain types of transmissible spongiform encephalopathies (TSEs). Several of these zoonotic diseases are also regulated under the Select Agent rules shared between APHIS and the Center for Disease Control (under the Department of Health and Human Services). Yet another reason for regulation is to deal on a pre-emptive basis with new or emerging diseases that could present control problems if they were to appear in the U.S., or which could jeopardize export markets for U.S.-origin commodities.

And finally, the controlled movement of imported ruminant commodities through various regulatory oversights such as permits, seals, and associated documentation, helps ensure that the people who need to be aware of the applicable requirements to facilitate such movements, including federal regulatory officials, VS port personnel, state authorities, or others are aware of them at the appropriate place and time.

In general, and the extent that may be recommended or required under international trade agreements such as the World Trade Organization (WTO), or through other venues such as the World Organization for Animal Health (OIE), the World Health Organization (WTO), or the Food and Agricultural Organization (FAO), among others, APHIS tries to harmonize its regulations for the importation of regulated animal commodities with these entities as well as with its regulations for interstate or other domestic movements.

Receiving states in the U.S. might also have specific health or certification requirements that could be different from federal requirements. These requirements could be enforced by a state at the time of entry into a particular state, or after entry; but are not enforced by APHIS as a condition of entry into the U.S. Native American tribes are also accorded certain powers of authority (mainly for implementation) for animals regulated by APHIS but which may be located on tribal lands. In terms of importations, especially if there are no specific federal regulations for a ruminant commodity, state or tribal requirements may sometimes exceed federal regulatory requirements, but generally cannot be less stringent. However, even in cases where state requirements may exceed federal ones, interstate commerce may not be impeded as a direct or even indirect result of state or tribal-level regulations. Occasionally these differing regulatory situations result in lawsuits or other actions to clarify the interpretation or implementation of overlapping or independent oversights.

Other federal agencies may co-regulate the importation of ruminant commodities; these include the Food and Drug Administration; the Food Safety Inspection Service, the U.S. Fish and Wildlife Service, the Centers for Disease Control, and the Department of Homeland Security, among others.

APHIS' regulations for imported ruminants (and their germplasm, products and by-products) have not been holistically revised for a number of years, and do not currently reflect the level of science or risk-based determinations that must apply to effect the safe international trade in such commodities. VS is currently in the process of reviewing and revising all of the relevant regulations in Title 9, as well as all of its other types of policy documents. In addition, USDA has recently provided guidelines for revamping the Department's internet sites, and all agency content must be reviewed for compliance with these guidelines, a process which will help to update, simplify and standardize a large amount of the information provided to the public.

APHIS' rules for imported animal commodities are typically developed by the National Center for Import and Export (NCIE), through an analysis of several factors, including the animal health status of the exporting country, the distribution of animal diseases in the U.S., and the environmental, economic, and other impacts that might be felt as a result of taking or not taking a particular action. NCIE subject matter experts consult with a number of other sectors in VS and APHIS in the development of such rules; industry is also typically consulted until a rule is published, at which point communications with public entities becomes more limited under the Administrative Procedures Act (APA) that governs the rulemaking process. Scientific supporting documents, risk assessments and other types of technical analyses typically are part of a rule's publication in the Federal Register. There is no finite timeline for a rule's development and finalization, but the process can often take months or years, since the numerous steps necessary under the APA and agency regulatory guidelines are mostly sequential in nature. APHIS is striving to reduce this timeline in as many ways as it can, while still complying with the APA.

The conditions for importing animal commodities that enter the United States and which are released for unrestricted (or restricted) commerce are usually the same for such commodities that are transiting the U.S. to a third country, with certain exceptions that may be made by the APHIS administrator on a case-by-case basis. In addition, a number of other mitigations must be in place for transits, including the identification of dedicated contingency space where the shipment may be held and monitored by APHIS personnel in case of any breakdowns while in transit through the U.S. The Administrator may also consider case-by-case requests for imported commodities that enter commerce, but generally does not make exception to established rules and policies for specific requests of this nature.

The current requirements for imported ovine (and caprine) germplasm as listed in Title 9 of the CFR, Part 98, include the need for the importer or importer's agent to obtain an import permit (VS form 17-135, available by applying via VS form 17-129 by mail or through the internet) issued by APHIS; a VS for 17-29 Declaration of Importation (available at most ports of entry or through the internet), and a health certificate with specific types of certifications that depend on whether donors originate from various countries. In addition, the level of certification

and/or testing required often depends on the extent to which APHIS recognizes the ability of an exporting region to attest or officially endorse such statements, which may further depend on the nature and scope of documentation that has been provided to APHIS. Unless a country or region is considered free of a regulated disease, certain mitigations may be required through an import protocol or import permit.

An example of this process involves foot-and-mouth disease, which generally affects all cloven-hooved ruminant species. If a country (or region within a country) is listed by APHIS as free of FMD, APHIS requires certain certifications, but no specific FMD testing of germplasm donors. If a country, or region within a country, is not recognized by APHIS as free of FMD, the CFR allows for importations of ruminant germplasm provided that a rigorous series of mitigations is followed, including pre-export isolation, testing of donors (and semen samples), and various chain-of-custody certifications, all of which must take place under direct APHIS supervision in the country/region of export before any germplasm becomes eligible for importation to the U.S.

For ovine/caprine semen originating from FMD-free countries/regions, health certifications generally reflect the disease of concern for the susceptible species in that country/region. These diseases can vary widely by region of the world. Import protocols generally are developed for specific countries, but most protocols share a similar format and generally provide for a country's competent authority (official veterinary services) to either declare freedom for a disease or to comply with specific certification statements and/or testing requirements for germplasm donors. The CFR provides very basic guidance for how APHIS can evaluate the reliability of such certifications, but typically if there are any questions as to the distribution of a disease/pathogen, the National Center for Import and Export will request additional information to be provided for analysis and follow-up.

This process works well for diseases such as scrapie and brucellosis that probably fall within an exporting country's national program for animal (and/or zoonotic) disease control. However, there are limitations involved when diseases are not, or are not effectively, controlled in exporting countries. A good example of this is the syndrome caused by Schmallenberg virus (SBV), which emerged in mid-2011 in Europe as a pathogen mainly affecting cattle, sheep and goats. SBV is related to akabane and other orthobunyaviruses, and is apparently vector-borne through *Culicoides* midges (and possibly through mosquitos). There may also be intermediate hosts or wildlife reservoirs in Europe; and some of the known vectors could have counterpart populations in the United States. SBV causes a mild transient illness in infected animals, but its main affect is reproductive in nature, resulting in stillbirths, abortions, and full-term deliveries of animals with birth defects, best described as a variant of arthrogryposis-hydranencephaly syndrome. Although the period of viremia (during which virus can be shed) after infection of ruminants with SBV is relatively short, the period of immunity after exposure hasn't been sufficiently characterized scientifically for cattle, sheep or goats. Although APHIS commissioned its own SBV pathways analysis, and has developed case definitions and a response plan if SBV were to be introduced into the U.S., the agent is still considered one that is not desirable to have in the U.S. and one which can be excluded from the U.S. through the current trade restrictions. Although research into the syndrome continues, and additional tests or a vaccine may eventually become more available, the scientific literature at the present time does

not allow APHIS to accurately gauge the risk of transmission through germplasm. APHIS has recently revised its original restrictions for bovine semen and embryos (placed in February, 2012) to allow for donor testing and certification statements. The testing regimen includes additional testing of serologically-positive animals by agent identification tests such as virus isolation or polymerase chain reaction assays. As existing import protocols for sheep and goats are revised, APHIS will likely continue to require that germplasm from these species was collected in the EU prior to June 1, 2011, or that donors were tested and certified by the tests applicable to bovine germplasm donors.

In addition to agents or diseases falling into the categories above (meaning foreign animal diseases, program-type controlled diseases, and emerging diseases) there are many other ovine and caprine diseases that could be of concern to APHIS or to importers; these include a number of viral, bacterial, fungal or parasitic agents. Generally speaking, APHIS' import protocols for germplasm try to reflect whether there is a corresponding domestic approach to control such agents, and/or whether the export eligibility status for susceptible ruminant commodities would be adversely affected if the agent were to be introduced to naïve (previously unaffected) areas in the U.S. Any necessary restrictions or additionally required mitigations that APHIS decides are warranted for such agents can be tailored in individual import permits, or through import protocols. Pre-export quarantines and testing of donor animals, or post-entry restrictions of use, or both, may be sufficient to adequately mitigate against such disease agents. NCIE is currently updating a number of its older import protocols, including those for sheep and goat germplasm, to standardize the conditions as far as possible, and to reflect the current testing criteria recommended by APHIS' National Veterinary Services Laboratories.

Lastly, APHIS published a proposed rule in March 2012 with updated restrictions for bovine spongiform encephalopathy (BSE) that apply specifically to cattle and bison as 'bovines'. The rule provides a streamlined approach to recognize the eligibility status of any country or region to export ruminant commodities affected by BSE. Until that rule becomes final, APHIS' current import restrictions for BSE continue to apply to importations of live 'ruminants' of all types, including sheep and goats. Since sheep and goats are not specifically excluded from BSE considerations in the current regulations, these requirements have resulted in the ineligibility for importation of live sheep, goats and other non-bovine ruminant species from BSE-affected countries. However, BSE considerations do not apply to ruminant semen or embryo donors (since the disease is not known to be vertically transmitted).

APHIS is currently revising its regulations for these animals to better reflect the current status of scientific information available about the susceptibility of non-bovine ruminants to infection with the BSE agent. As part of this revision, which will more closely align APHIS' restrictions for BSE with the recommendations of the World Organization for Animal Health (OIE), APHIS will address the general issue of transmissible spongiform encephalopathies (including both BSE and scrapie) of sheep, goats and other (non-bovine) ruminants of all types. As these proposed regulations are developed, most of the current mitigations for scrapie that are in the regulations for sheep and goat semen and embryos now will continue to apply; but additional criteria will be included to allow APHIS to more effectively recognize the status of exporting regions for scrapie, a process that can typically take a long time under the current regulatory provisions for such recognition. The new regulations for sheep, goats and other, non-

bovine, ruminants are expected to be published as a proposed rule in fiscal year 2013, with the intention that this rule will be finalized at roughly the same time as the proposed rule regarding BSE in bovines.

CREATING ARTISANAL CHEESES: A MIX OF ART AND SCIENCE

**Sidney M. Cook
Carr Valley Cheese Co.
La Valle, Wisconsin, USA**

Milk Quality, Handling, and the Properties of Sheep Milk That Affect Cheese Making

Milk quality starts on the farm with healthy, happy, well feed and managed milking sheep. Sanitation, milking practices, herd health all determine and affect milk quality and cheese making. One must consistently test for milk quality, and continue improvements that are necessary to produce the best quality milk.

There are other factors besides somatic cell, plate count, butter fat and protein tests that cheese makers are concerned with. Testing for water, antibiotics, temperature at delivery, Ph or acid test, and just smelling the milk can indicate improper cooling or other deficiencies. In addition, frozen milk poses other quality issues for both farmers and cheese makers such as off milk flavors that transfer and are magnified in the finished cheese.

Faulty or dirty pumps that introduce air and unwanted bacteria, unknown or wild bacteria can have both positive and negative effects on raw milk cheeses and pasteurized cheeses. Dirty milk lines, holding tanks, and trucks. Improperly sanitizing vats, forms, utensils, and hands are just some of the procedural events that can render a vat of cheese worthless.

A clean plant environment, proper manufacturing flow, clean coolers, clean affinage rooms, the right temperature and humidity, and Good Manufacturing Procedures, GMP's are necessary. Documentation of what you are doing is also necessary and meaningful when you search back to uncover why a certain vat of cheese didn't turn out as you had hoped.

As I have touched generally on milk quality and handling, the properties of sheep milk are uniquely interesting. Frozen milk was first marketed in Wisconsin and research showed that frozen milk could be used to make quality cheese. I think "properly" frozen would be the key to the validity of this statement.

We have had experience with off frozen milk both positive and negative. We now very seldom use frozen and insist on fresh milk even though it is seasonal in our area of the country. In fact, we are very demanding that all loads be fresh and believe this to have had a very positive effect on the sheep milk industry in Wisconsin.

Higher yields and low milk volumes pose some issues in the cheese vat because of high cheese yields. If the vat is full, will the agitator mix the heavier amount of cheese than the vat is designed for? And with a less volume in the vat will the cheese dispel the needed amount of moisture and have the right weight and density on the curd? Batch sizes should be consistent for the cheese to be consistent.

Tests Done On Received Milk and Changes in Processes

We test for milk fat, protein, somatic cell, plate count, water, Ph, temperature, and antibiotics. Some tests are done on a regular basis and some we do periodically. Of course, we always test antibiotics, Ph levels, temperature, and we rely on the Coop's test for fat, protein, and plate count for quality on a regular basis, however we periodically test the coop's results to double check their results with ours.

We rarely change a process unless we buy frozen milk and then we have several proprietary methods to handle off flavors in frozen milk that have been in effect in the past. We try to make all of the same cheeses within a few weeks so we can achieve more consistency in each product. Most of our cheeses are made one year and sold the next or several years later. In this way our cheese type for that year is consistent.

Issues Unique To Working with Sheep Milk

The ability to freeze sheep milk, the small size of the fat globule, the high fat and casein test that reflect higher yields, the smaller amounts of culture and other ingredients for ripening and coagulation are some of the issues that set sheep milk apart. Every milk variety has certain unique characteristics and as cheese makers we celebrate those differences and utilize them to make unique dairy products.

It has been a great privilege to work with the Wisconsin Sheep Dairy Cooperative for the last 14 years which has enabled me to create some of the most celebrated cheeses in the world, "American Originals".

Milks are the single most ingredients in cheese manufacturing, they have many similar flavors and textures and yet with the magic of cheese making, coupled with a combination of art and science, the different flavors, varieties, textures, cures and affinage techniques produce artisan cheese. Quality milk starts at the farm, is massaged into quality cheese, sold 3 or 4 ounces at a time, and savored just a bite at a time.

THE ART IN THE SCIENCE OF SHEEP CHEESE MAKING

Dane Huebner
Grafton Village Cheese
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A lot of hard work and hours have been spent studying the science of cheese making and yet we still don't fully understand this complex living matrix. With the infinite number of variables in making cheese; creating artisan cheese is more art than science. For 10,000 years humans have been milking, consuming and making products from dairy animals. Early humans milked sheep and goats at first and then cows, buffalo, camels, mares, etc. Humans and dairy animals have been evolving for a long time together and our connection is possibly the longest with the Ovines. We have only been focused on industrialization of dairy products for about the past 150 years. Research has only really just begun. With our long history with sheep we are bound to unravel more about our co-evolution. The microbial ecology that we share with these animals is probably one of the oldest of our many evolutionary microbial relationships that we share with domesticated animals. Sheep and sheep milk products gives us one of our oldest connections to slow and sustainable living.

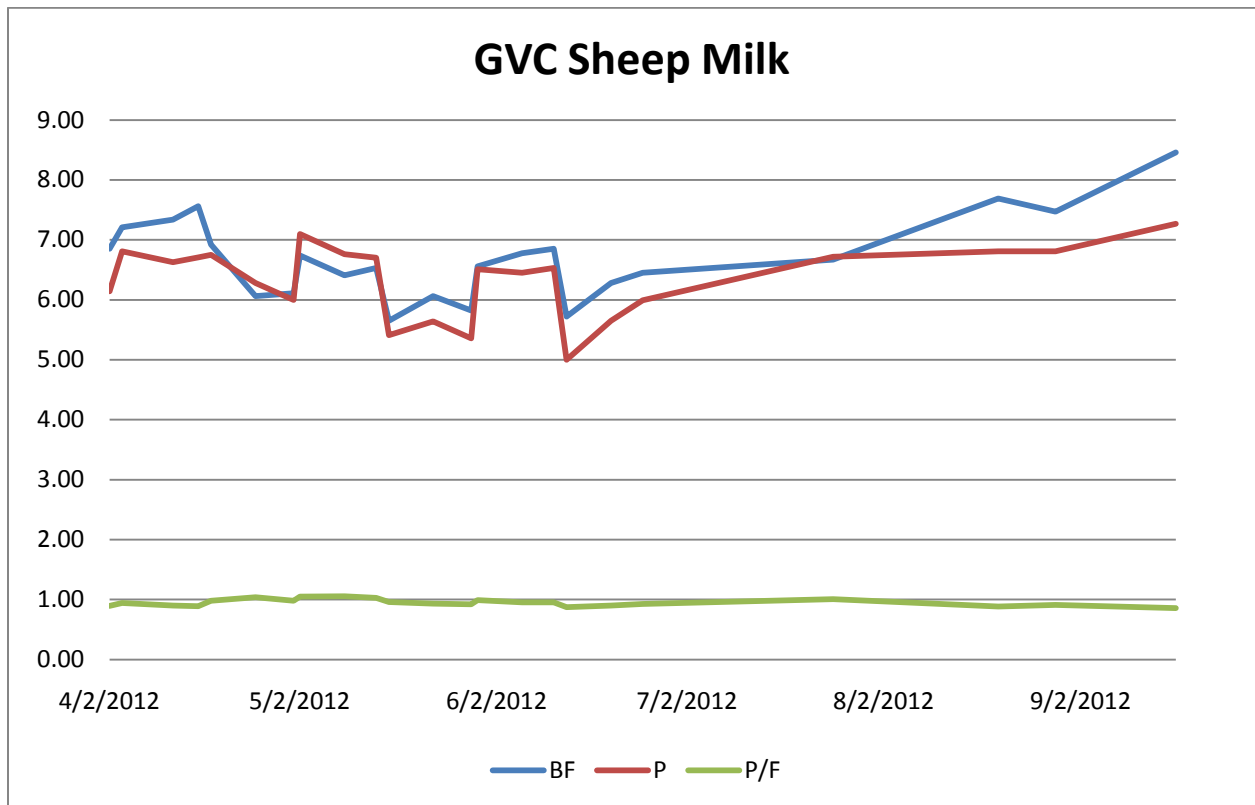
When I first got into cheese making, it was not to make a better cheese, but to make new, diverse varieties of cheese. Creating a cheese is like producing a work of art. Using different milks is like using different paints. When I was given the opportunity to work with something other than cow milk, I jumped on it. I started with sheep milk first, followed by goat milk. These different milks are like special colors. The different components in each species' milk provide unique precursors for flavor development. By combining different milks in different ratios, with different enzymes, microbes and aging environments, we have almost unlimited creative possibilities.

Unique Properties of Sheep Milk

In general terms, sheep milk is higher in fat, protein, lactose, and minerals than cow or goat milk. The table below shows basic composition characteristics of sheep, cow, and goat milk.

Table 1: General Composition of Milk in Sheep, Goat and Cow

	Sheep	Cow	Goat
Dry Matter %	17.4-18.9	10.5-14.3	11.9-14.0
Fat%	6.0-7.5	2.8-4.8	4.1-4.5
Protein %	5.1-5.6	2.85-4.10	3-3.9
Lactose %	4.3-4.8	4.2-5.0	4.1-4.4
Ash %	0.9	0.7-0.9	0.8



Graph 1: Grafton Village Cheese Sheep Milk Components: BF- Butterfat, P- Protein, P/F- Protein to Fat Ratio

Proteins

Sheep milk contains more protein than cows and goats. Sheep milk shares similar proteins with the rest of the mammals. Both major types of proteins found in milk, casein and whey proteins, can be found in sheep milk. Casein accounts for 80% of the total protein in sheep milk. In the 5 major components of casein, $\alpha\sigma_1$, $\alpha\sigma_2$, β , κ and γ , the α -sub units are higher in sheep than in goats but lower than cow. The amount of β casein is highest in goat then, sheep and then cow. The major whey proteins are α -lactalbumin and β -lactoglobulin. Polymorphic variants occur in all the major proteins. These polymorphisms cause the milk of individual sheep and breeds to have different functional characteristics of gelation, emulsification, curd firmness and digestion. For example, in Sarda sheep the CC phenotype for $\alpha\sigma_1$ gene has higher protein to fat ratios, smaller casein micelle diameters and better renneting properties than CD and DD phenotypes. More research and screening is needed to produce sheep that provide milk with excellent cheese making characteristics and yields. These different casein and whey proteins can contribute to differences in micelle structure and cheese making functionality as well as different substrates for flavor development.

Fat

Table 2: Fat Globule Diameter

Fat Globule Diameter (μm)	Sheep	Goat	Cow
Average	3.30	3.49	4.55

Smaller fat globule diameter contributes to ease of enzyme attack for both humans and microbes.

Fat in sheep milk is higher in than cow or goat milk. Besides a greater amount of fat, the composition of the fats is more varied than cows' milk.

Table 3: Fatty Acids Profile

Fatty Acid (%)	Sheep	Cow	Goat
C4:0 Butyric	4.0	3.3	2.6
C6:0 Caporic	2.6	1.6	2.9
C8:0 Caprylic	2.5	1.3	2.7
C10:0 Capric	7.5	3.0	8.4
C12:0 Lauric	3.7	3.1	3.3
C18:0 Stearic	12.6	14.6	12.5
C18:1 Oleic	20.0	29.8	28.5

Sheep milk is white due to the lack of β -carotene in the fat. Sheep's milk fat contains about 20% short chain (C4-C12) saturated fatty acids, whereas cow's milk contains only 12%. Most of the fatty acids are in the form of triglycerides. Triacylglycerol structures determine the rheological and melting properties of milk fat. Sheep milk has higher levels of short chain triacylglycerols (C26-C36) and medium chain triacylglycerols (C38-C44) than cows' milk. Higher amounts of long chain (C46-C54) are found in cow milk than in sheep milk.

Carbohydrates

The amount of lactose in sheep milk is similar to cow and goat milk. Carbohydrates other than lactose, such as glycopeptides, glycoproteins, and oligosaccharides are also present and may be used by Non Starter Lactic Acid Bacteria (NSLAB) as energy sources.

Minerals

The most abundant elements are Ca, P, K, Na, and Mg. The concentrations of Ca, P, K, and Mg elements are higher than those found in cow's milk. Ca and P are the most important of the major minerals, both in nutritional terms and for their role in the structure of casein micelles and renneting ability of the cheese milk. Sheep milk contains more calcium per casein weight than cow's milk.

Enzymes

Similar enzymes can be found in all mammal milk. Particularly important for cheese making are proteases and lipases. Plasmin is responsible for a significant amount of proteolysis in cheese

and contributes to flavor development. Lipase, lysozyme, ribonuclease, and xanthine-oxidase are less active in sheep's milk. However, alkaline phosphatase is more active in sheep milk than cow's milk.

Bioactive Proteins

Bioactive peptides are formed from the precursor inactive proteins by enzymatic hydrolysis.

These protein fragments have specific biological activities, such as antihypertensive, antimicrobial, opioid, antioxidant, immunomodulatory, or mineral-binding. These bioactive peptides may influence the cheese matrix and steer flavor development.

Flavor profile of Sheep Milk

The fatty acid profile of sheep milk contributes to the unique and rich flavor and mouthfeel. Sheep milk should be fresh and pleasant with no objectionable odor. Due to larger amounts of protein and fat, sheep milk is more susceptible to enzyme activity. Sheep milk can be damaged due to excessive mechanical processing liberating fatty acids that can be attacked by lipase. Lipase from bacteria such as Psychrotrophic bacteria, which can grow at refrigeration temperatures, can produce off flavors.

Quality

Animal health is essential to production of high quality milk. Good quality raw milk should have bacteria counts: SPC < 70,000cfu/ml, Coliform <10 cfu/ml, E.coli <1cfu/ml.

Somatic Cell Counts (SCC) for Grade A Raw Milk <750,000 cells/ml. However, high SCC (<500,000cells/ml) milk has less protein and fat which causes slower renneting times and poorer solid recovery. Cheese yields usually decrease with increased SCC. High SCC can also contribute to off flavors due to cell lyse and release of enzymes and food substrates for NSLAB. High SCC also may be linked to a higher bacteria count which can also contribute to undesirable flavors.

Sheep Cheese making

Heat Treatment

Lots of flavor change can occur with heat treatment. Pasteurized sheep milk cheeses has significantly lower levels of lipolysis than raw milk cheeses. This effect is due to heat inactivation of indigenous milk lipase as well as the decrease in NSLAB and other microbes. Thermalized cheese milk has the advantage of destroying a majority of harmful bacteria while allowing some NSLAB to survive. These bacteria will contribute to flavor development. Raw milk cheese will ripen faster and develop a more intense flavor but may also be more dynamic. Different heat treatments can provide different flavor outcomes.

The Art of Coagulation

With many variables, coagulation is not a simple equation. In general, sheep milk coagulation is faster than in cow's milk. Therefore, less rennet is needed to coagulate in the same amount of time. Sheep milk also produces a firmer gel than either goat or cow. The reasons for these differences are that sheep's milk contains more casein, ionic calcium, and colloidal calcium than those contained in cow's milk. Coagulation of sheep milk is also affected by physico-

chemical properties, including pH, larger casein micelle, more calcium / casein weight, and P in milk, which cause changes in coagulation time, coagulation rate, curd firmness, and amount of rennet needed compared to other milks. With the higher concentration of available Ca for coagulation, CaCl₂ is not needed in sheep cheese making. SCC greater than 500,000 cells/ml, can significantly lower the firming rate of the gel. With all the variables that can influence the formation and firmness of the coagulum, determining the correct firmness at which to cut the gel is part of the art of cheese making.

Curd Handling

The high mineral content provides sheep milk with a higher buffering capacity than cow milk. This may cause a delay or slow the rate of pH change. In general, more components, less water - less draining.

Aging

Many variables influence the development of flavor in cheese but the 4 major contributors are: coagulants, indigenous enzymes, added microbes (including starter LAB), and other microbes (including NSLAB). These major players develop flavors by 3 primary reactions: glycolysis, proteolysis, and lipolysis. The majority of lactose is converted to lactic acid by starter bacteria. However if primary glycolysis is slowed or halted by cooler temperatures or high salt concentration, NSLAB or other advantageous organisms may grow and develop off flavors. Proteolysis is very complex and important to the final flavor and texture of cheese. Lipolysis of sheep milk fat produces unique free fatty acid profiles. Since yields are higher for sheep milk cheese the amount of starter bacteria may be lower than a similar cow cheese and may develop flavor at a slower rate.

In conclusion, sheep milk can be a new color in the dairy industry. The many unique components of sheep milk provide numerous precursors to flavors that do not exist in other milks. As well as providing exceptional flavors, using sheep milk helps develop more diversity in our food system and our agriculture.

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CREATING ARTISANAL CHEESES: A MIX OF ART AND SCIENCE

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Hidden Springs Creamery and Farm
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Hidden Springs Creamery is a farmstead cheese operation including 76 acres, homestead, farm buildings, B&B for guests and the creamery, where wonderful sheep cheeses are made from the sheep on the farm. Brenda and Dean Jensen have been milking dairy sheep for over 10 years and making cheese for 5 years.

Hidden Springs makes a variety of cheeses. Our 1st cheese made is the Driftless; a soft spreadable sheep milk cheese. We also have 6 other flavored varieties of the Driftless: Honey/Lavender, Basil/Olive Oil, Tomato/Garlic, Cranberry/ Cinnamon, Maple/Cream, Pumpkin/Spice. These cheeses have won in National and International Competitions.

Ocooch Mountain Cheese is a raw milk, cave aged, wash rind cheese. This cheese is our biggest seller and a labor of love with all the affinage work.

Bad Axe is a waxed cheese that tastes great for slicing as well as our best melting cheese. We use this on pizzas, with pasta, fondues and makes awesome grilled cheese sandwich.

Meadow Melody is a washed rind cheese that is made from our sheep milk and local cow milk blend. We make this cheese at the beginning and ends of the season when our sheep milk is low.

Farmstead Feta is a wonderful tangy, 1 year old aged feta style. This Feta is a softer, not as salty as most feta's and we like it that way!

Bohemian Blue is a blue cheese that we have made for us from our own milk. This penicillium roqueforti blue mold loves to travel, so we have it made at a blue cheese plant. As the label reads "This cheese is for people with artistic or literary interests who disregard conventional standards of behavior."

Timber Coulee is our newest cheese. It is a all sheep milk cheese that was taught to me by a French cheese-maker to replicate a French sheep cheese.

We love to make new cheeses! We have learned a lot in this arena. Every new cheese is expensive to start up. There are new labels; new learning curves, new marketing. What new forms will the new cheese need? What temperatures does the new cheese need to be aged at? Is it

easily distributable? A lot to thinking, time and energy should go into the decision making before jumping into a new cheese.

We have hired consultants in the past to teach us new cheese recipes. Now we like to try things in the vat. We have also have a great small group in the other small artisan cheese makers in Wisconsin that we talk about cheese, questions and what we have tried etc. In Wisconsin we also have the Center For Dairy Research, where you can get generic recipes and go from there.

At Hidden Springs our batches are small and hand made. Our maximum batch is 200 gallons. Our pasteurizer and vat are both 200 gallons. We will be milking approximately 500 sheep throughout the season this next year. We are currently working on milking and making cheese year round.

Great cheese starts with great milk. Our farming practices and sheep management can be directly seen in our milk. We monitor our milk and have set goal much more stringent than the state requires. If the numbers start to climb we react immediately. We dip and wipe our sheep pre and post milking. We have our own milk meters and can pull samples and weights easily from these and have results back within hours. We are constantly learning better herd management.

We are expanding the herd, adding a new loafing shed, and building a new lamb barn with automatic feeders to accommodate the growth. We will be expanding the creamery in fall 2013 to add additional caves and coolers.



EWE (AND FLOCK) HEALTH OVERVIEW

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Maintaining a healthy ewe is vital to the success of any flock regardless of the production system or intended use. Volumes could be required to outline every detail of understanding, recognizing, treating, and preventing every health issue of the ewe. The following will outline some basics.

The Normal Animal

In order to understand and recognize what is abnormal, first we must have a grasp on what is normal.

Rectal Temperature	102-103°F
Heart Rate (beats)	60-90 per minute
Rumenations	1-2 per minute
Respiratory Rate (breaths)	12-24 per minute
Packed Cell Volume (hct)	22-28% (28 average)
FAMACHA® score	≤ 3

Temperature is taken per rectum with any household/pharmacy thermometer. Heart rate is easiest taken with a stethoscope by listening to the left side of the chest just behind the left elbow. In the absence of a stethoscope, the heart rate can often be felt with the palm of a hand held firmly against the chest wall in the same location. Rumenations are best assessed with a stethoscope in the left flank (the soft spot of the abdomen just behind the ribs). Inexpensive stethoscopes can be obtained at many pharmacies and also from your local veterinarian.

The Power of Observation

Sick animals give us signs to tell us they aren't feeling well. The trick is to know what to watch for. The normal, healthy animal exhibits the following signs that to most of us are intuitive: head up, eyes bright, healthy wool coat, good appetite, cud chewing, curious, agile and normal gait, and keeping up with the flock.

Conversely, the sick animal exhibits any of the following: Isolation, head down, not eating (anorexia), not drinking, limping, rapid breathing, diarrhea, distention of the abdomen, inability to rise and straining.

Time should be taken each day to simply stand back and watch from a distance the way in which the individual animal acts.

The Spread of Disease

Knowing how disease is spread among sheep can help the observer understand how to potentially prevent it. And prevention is the greatest medicine. Remember your Grandma's advice, "An ounce of prevention is worth a pound of cure".

Below is a chart that outlines the transmission routes for disease and some of the more common disease processes that occur as a result of that transmission.

Fecal-Oral	Johnes, Salmonella, Clostridial diseases, Coccidia, and Intestinal Parasites
Aerosol (environment)	Respiratory diseases (pneumonia), Mycoplasma
Direct Contact	Ringworm, External parasites, Caseous Lymphadenitis (CLA), Sore mouth
Body Fluids	Abortions, OPP, CAE, Respiratory diseases, Rabies
Fomites	Mastitis, CLA, Sore mouth, Ringworm, External parasites, Abortion disease
Vectors	Some viral diseases (Bluetongue, EHD)

Preventing Disease

Disease prevention is accomplished by adherence to three methods:

- 1.) Avoiding/reducing exposure
- 2.) Vaccination
- 3.) Improving immune status/function

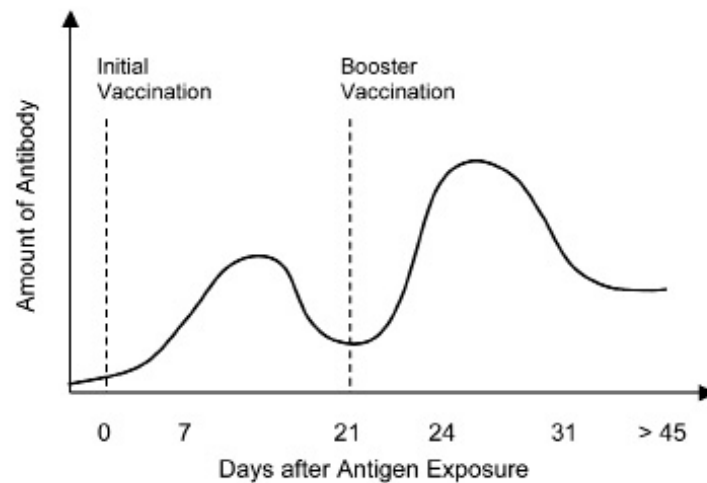
Avoiding and reducing exposure in ewe flocks is centered around good biosecurity practices. Biosecurity involves buying healthy stock from reputable breeders, transporting animals in a clean/disinfected trailer directly from source flock to isolation area, isolating any new additions for 30 days, and working towards maintaining a closed herd.

Quarantine recommendations include isolating new additions for a minimum of 30 days at a distance of not less than 100 ft. from other animals. Before or during the quarantine, animals should be inspected for foot rot, caseous lymphadenitis, external parasites, internal parasites by fecal egg counts, testing for OPP, Johnes, CLA, and starting on a good plane of nutrition.

Don't forget that practices such as loaning breeding rams, sharing equipment and trailers, taking animals to fairs or exhibitions and shearing are all potential sources of introducing disease into your flock.

Vaccination is one of the best ways to prevent disease establishment in flocks. Core vaccines for sheep are both inexpensive and relatively effective. Even when vaccines fail to prevent the disease, they can reduce the incidence and/or severity of the disease process. Clostridial diseases are the only class of vaccine organisms that should always be used in ewe flocks.

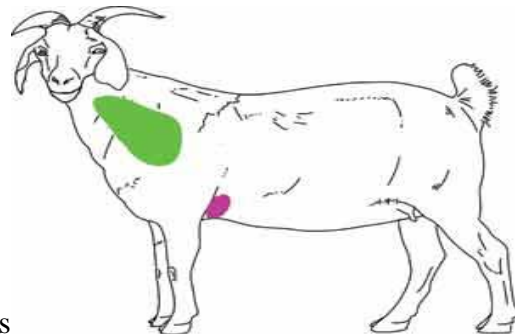
Keep in mind that vaccines need to be boosted. Giving a ewe lamb one dose of vaccine at 3 months old does not mean that she has been properly vaccinated for life.



A whole flock vaccination plan should include annual boosters for adult ewes and rams. Ewes should be vaccinated 4-6 weeks before lambing (parturition). Rams should be boosted 1 month prior to breeding season. Ewe lambs are generally given two doses of clostridial vaccine 6 and 3 weeks prior to lambing.

Lambs born to properly immunized ewes are vaccinated at 2 months of age and then boosted one month later. Lambs born to un-immunized ewes should be given clostridial vaccine at 1-3 weeks of age and then boosted twice following at one month intervals.

Other vaccines to consider for ewes would include: abortion diseases (*Campylobacter fetus* and *Chlamydia*), foot rot vaccine, caseous lymphadenitis vaccine, rabies and bacterial pneumonia diseases.



Proper locations for vaccination in sheep and goats

Anemia

Anemia is a condition when the body does not have enough functioning red blood cells. In the ewe, this is most often caused from a loss of blood, destruction of functioning red blood cells, or an inability to make new cells (less common).

Blood-loss anemia is by far the most common reason for anemia in sheep and goats. The most often diagnosed reason for blood loss in small ruminants is loss due to parasitism. The intestinal parasite *Haemonchus contortus* is almost always implicated in anemia due to parasitism of the ewe.

Anemia can be evaluated by examining the mucous membranes of the mouth, eyes or vulva. The FAMACHA© system was developed to give producers a tool to quantify the level of anemia from *Haemonchus contortus* and develop a treatment plan.

FAMACHA© Anemia Guide	
1	Optimal, no dosing required
2	Acceptable, no dosing required
3	Borderline, dose???
4	Dangerous, dose!
5	Fatal

Intestinal Parasites

Internal parasites (worms) are a major concern on sheep operations in the United States. Resistance of the parasites to anthelmintics (drugs designed to kill worms) has become a serious and ongoing problem.

The major intestinal parasites of importance in the ewe are:

- *Haemonchus Contortus* (barber pole worm)
- *Ostertagia circumcincta* (brown stomach worm)
- *Trichostrongylus* (bankrupt worm)
- *Cooperia* (small intestinal worm)
- *Strongyloides papillosus* (common threadworm)
- *Coccidia* (protozoal parasite)

Clinical signs of the parasitized animal include bottle jaw (protein loss causing edema to develop under the jaw), diarrhea, weight loss, poor thrift and wool coat, and anemia (*Haemonchus Contortus*). *Haemonchus* is probably the most significant parasite of sheep today. It is a voracious blood feeder and can cause serious anemia along with production and death losses. Intense resistance of the parasite to anthelmintics has developed as a dominant trait.

Resistance to drugs intended to control internal parasites in sheep has developed over time as a result of over-exposure or frequent exposure of the worm populations to the anthelmintics(drugs). Historically sheep were de-wormed with a single drug over and over, or given drugs when treatment wasn't needed. These practices have led to a situation in which the drugs are no longer effective. Worm populations exposed to frequent dosing develop resistance to the drug such that the remaining population of worms are not affected by the drug.

A complete flock management plan for control of intestinal parasites must be adopted today as few novel anthelmintics are being developed. Drug use for parasite control cannot be the only

method by which producers rely to control parasitism. Here is a list of practices that can be implemented:

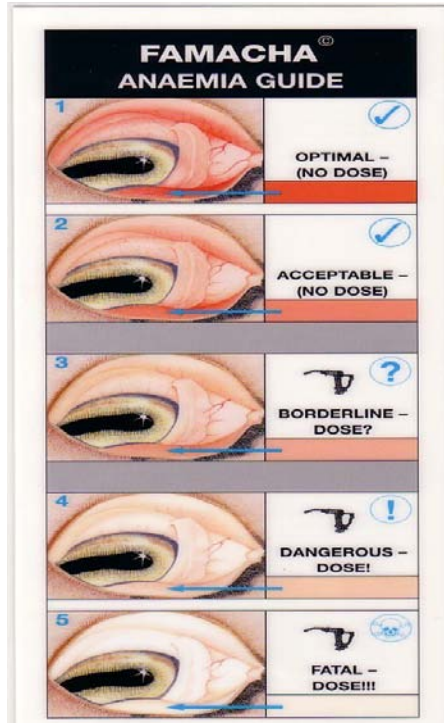
- Pasture management – proper rotation
- Select or breed for resilient animals – those that can withstand infestation of worms
- Introduction of certain plant types
- Non traditional treatments (i.e. copper wire)
- Use of some traditional anthelmintics
- FAMACHA©
- “Smart Drenching”

Smart Drenching
Ray Kaplan – University of Georgia

- Find out which dewormers work for your farm (fecal egg counts, Drench Rite©)
 - Weigh animals for correct dosing
 - Dose properly
 - Deliver drug over the tongue in the back of the mouth
 - Withhold feed 12-24 hours before drenching
- Repeat a dose 12-24 hours later depending of drug class
 - Drench only animals that need it

Fecal egg counts (FEC) are a great way to assess the level of parasitism in an individual animal or in a flock. FEC's can also be used to determine the effectiveness of a particular dewormer or class of dewormers on your farm. Fecal egg counting must be part of a sustained whole flock parasite management program. Fecal sample(s) for FEC's should be taken just prior to drug administration. Two weeks following treatment repeat the fecal exam (FEC). A “control” group (not treated) should be utilized and evaluated similarly along with the treated group. A significant (10-15) number of animals should be tested at any one time. A marked reduction in eggs in the manure indicates effective treatment providing the control group did not also experience the same reduction at the same time.

FAMACHA was developed in South Africa as a “sheep side” test for determining the level of anemia from infestation of *Heamonchus contortus*. Treatment decisions can be made based on the results of the examination. This is a labor intensive, but effective method of selective deworming for sheep on pasture. During grazing season, sheep should be scored using the FAMACHA system about every two weeks. Proper training should be done prior to using this system as poor technique can lead to drastic incorrect interpretation.



Take home points on internal parasites:

- Selective de-worming **MUST** be utilized in order to assure some level of anthelmintic effectiveness and assure sustainability
- Fecal egg counts **MUST** be implemented on every farm
- Anthelmintic efficacy **MUST** be evaluated at least every 2 years
- Treatment and control protocols **MUST** be tailored for each farm individually
- The days of “regular”, often and complete de-worming of all animals **MUST** stop

Mastitis

Mastitis is, simply put, inflammation of the mammary gland. Several different processes cause inflammation of the mammary gland including: infection with microorganisms, injury, allergy or neoplasia (less common).

Infectious agents include: bacteria (most common), *Mycoplasma* species, some yeast and algae and viral infection (OPP).

Dairy ewes are most susceptible to mammary infections with most disease occurring at parturition, the first two weeks of lactation, and at weaning time. However, ewes can be affected any time during lactation. At 4-6 weeks after lambing rapidly growing lambs can cause physical injury to the teat(s) from zealous nursing or head butting of the udder which can increase a ewes' probability of developing mastitis.

Mastitis leads to decreased milk production as a result of udder damage. Mastitis in ewes has been shown to reduce milk production by 12-58% with one or both halves affected,

respectively.¹ In 1985, a Sheep Industry Development Report estimated that mastitis costs the U.S. Sheep Industry \$20-25 million annually. These losses can be attributed to death or loss of ewes, replacement costs of ewes, lamb mortality and/or morbidity, labor cost, feed costs for orphans, and veterinary costs.¹

Studies of cull ewes at slaughter in Britain show a very high prevalence ranging from 13 to 50% , indicating that clinical mastitis is likely an important cause of culling of ewes in the UK. In American range flocks, prevalence of clinical mastitis ranges from 1 to 3%, but the prevalence is much higher if the udders are cultured as well (5 to 30%) or a positive SCC reaction is obtained (14 to 20%). Dairy sheep have been reported to have a prevalence of mastitis, as determined by a positive milk culture, of up to 35% of ewes and by positive SCC and milk culture of 4 to 17%.³

Agalactia (no milk production) can be due to infectious causes such as OPP or *Mycoplasma* spp., previous cases of mastitis that destroyed milk producing tissue, poor genetics, poor nutrition or abnormal gestation.²

Mastitis can be classified by the type of disease it causes:

- Clinical Mastitis – a basic definition would include abnormal appearing milk. There are observable abnormalities in the udder secretions. Clinical mastitis can be further categorized as peracute or subacute.
 - Subacute (acute) Mastitis – clinical mastitis characterized by a swollen, painful, and discolored gland. The animal is depressed, has a fever initially (Temp 105-107°F) and later might have a lower than normal temperature, is off feed (anorexic), dehydrated and depressed. The udder secretions are serum-like and may contain gas. The animal may be lame as a result of a painful udder and later becomes weak and can progress to recumbency. Case fatality rates can be 30-40% in untreated cases.³ *Staphylococcus aureus* is often isolated from these glands as well as *Pasteurella* spp. and sometimes coliforms.
 - Subacute Mastitis – clinical mastitis with visible changes such as clots (gargot) or flakes accompanied with minimal swelling and sensitivity of the udder.¹ The animal is usually not systemically ill.
- Subclinical Mastitis – there are no observable abnormalities to the udder or to the milk. There are, however, microorganisms present in the milk that cause an increase in white blood cell levels (neutrophils) in the milk. These white blood cells (referred to as somatic cells) can be detected with special tests that indicate an abnormally high level. The California Mastitis Test is an animal-side test that gives a subjective level of somatic cells. More exact cell counts can be determined with an electronic cell counter (Coulter Counter). As in cattle, subclinical mastitis is probably more prevalent than clinical mastitis in sheep flocks. This type of mastitis is particularly troublesome in that

it causes the greatest economic losses due to decreased production without otherwise having signs of an inflammatory process. Diagnosis is also possible by bacteriologic culture.

- Chronic Mastitis – This is long-term mastitis (more than 2 months usually). Systemic illness does not usually occur, but the milk can alternate between clinical and subclinical. Fibrosis (scarring) of the udder is an eventual outcome and animals are often culled due to low production and poor lamb performance.¹
- Mycoplasma Mastitis – *Mycoplasma* mastitis should be suspected when there is clinical signs of mastitis, but attempts to culture and/or treat the disease fail. *M. agalactiae* is the causative organism of contagious agalactia in sheep. This organism can cause both acute and chronic mastitis.² Clinical cases observed most often during the spring months. Infection occurs most commonly during the last part of gestation. Often the organism is ingested, gains access to the bloodstream and then can establish infection in the udder, uterus, eyes and joints.² Agalactia is often followed by atrophy of the udder, but the ewe can have normal lactation in subsequent lactations.²

Multiple organisms (agents) are implicated in mastitis in ewes.

- 1.) *Staphylococcus aureus* – a major pathogen of sheep mastitis. Up to 35% of clinical cases are caused by this organism.³ This is a contagious organism that can also cause subclinical mastitis that easily becomes chronic. This organism imbeds itself deep in the glandular tissue and can cause fibrosis that ultimately decreases milk production. The infected udder serves a reservoir for new infection. Spread of this bacteria often occurs at milking time.
- 2.) *Pasteurella hemolytica* – these bacteria are a common inhabitant of the upper respiratory system in normal sheep and can cause pneumonia. It is theorized that the most common source of *Pasteurella* infection is from the nose and throat of nursing lambs. This organism is implicated with “blue bag” in ewes. Blue bag gets its name from a change in udder color following alteration in blood flow to the mammary gland.² *Staph. aureus* can also cause blue bag. These bacteria are usually spread to the teat by flies or other insects. Aggressive or over-zealous nursing can also lead to infection. Blue bag infection is usually followed by pain and inflammation. Severe thrombosis can occur (usually from *Staph. aureus*). *Pasteurella hemolytica* infection can lead to abscesses that break through the skin.²
- 3.) Coliforms - (*E. coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia* are the most common, with *Salmonella* spp being more rarely isolated. *Pseudomonas aeruginosa* has been implicated in outbreaks of acute mastitis with high levels of mortality in lactating dairy sheep.³ *E. coli* is easily found in the environment and is often the cause of watery, toxic mastitis (severe systemic disease). Prevention of coliform mastitis should be aimed towards udder hygiene achieved through environmental management.

- 4.) *Streptococcus* spp. are a common environmental agent of dairy cattle, but seem to be less often implicated in mastitis in ewes. Mild clinical mastitis can occur around lambing time.
- 5.) Coagulase Negative staphylococci (CNS) – these bacteria are the most commonly isolated organism group from subclinical cases at any stage of lactation.³ They are a common inhabitant of the skin of the udder. CNS can account of >90% of infections from well managed flocks.¹ The infection with CNS is variable and typically causes only small amounts of inflammation and inconsistent results of the CMT.
- 6.) *Mycoplasma agalactiae* – cause of contagious agalactia. Should be considered where arthritis, conjunctivitis, pneumonia is present in the face of mastitis that is variable and doesn't respond to treatment. Much more common in Europe, this disease is rare in the United States.
- 7.) Maedi-visna virus (MV-v), also known as Ovine Progressive Pneumonia virus (OPP-v) has been implicated in chronic progressive pneumonia and weight loss as well as changes to the mammary gland in sheep. The udder is hard (“Hard Bag”) and appears to be full of milk but little milk can be expressed from the glands. “Hard bag” and decreased milk is far more prevalent in OPP-v serologically positive flocks when compared to OPP-v negative (63.1% vs 8.0% in one study). OPP-v can be isolated from the mammary tissues and from the milk. Much higher levels of virus are found in colostrum at parturition than in milk suggesting that colostrum is an important method of infection of lambs. Unfortunately this viral form of mastitis has a detrimental effect on ewe productivity. Some western US sheep producers reported culling as many as 10% of ewes each year due to “hard bag”. Another study found that ELISA positive ewes were less productive in terms of lamb growth (8.5 lb per ewe lambing) although it isn't known if this difference is due to mastitis or other effects of the disease. However it has been found that there is a significant negative correlation between lamb weaning weight and the damage in ewes' udders due to OPP-v. Lambs nursing the most affected ewes, weighed 5 kg less at weaning than lambs nursing unaffected ewes.³

Diagnosis of mastitis depends on whether the mastitis is clinical or subclinical. Subclinical mastitis is diagnosed by elevation of SCC usually done with by CMT. Routine udder palpation can give clues about subclinical infections as well. CMT of trace or 1+ should be considered normal for sheep as sheep and goat milk contain higher somatic cell counts than do cattle.² A normal cell count for sheep is 50,000 to 500,000 cells/ml, and mild inflammation increases the count to 500,000 to 2,000,000 cells/ml. It is generally accepted that cell counts greater than 1,000,000 indicate mastitis in the ewe. Cell count is inversely related to milk production.² As a ewe progresses through lactation, her SCC will increase under normal circumstances. Wide disparity in SCC between udder halves is a good measure of the presence of subclinical mastitis in ewes. Older animals (more lactations), and animals later in their lactation will tend to have higher cell counts. Culture should follow detection of subclinical mastitis by CMT to determine the causative organism.

Clinical mastitis is diagnosed by enlarged, swollen udders and milk that has observable changes. Bacteriologic culture is then used to determine the causative organism.

California Mastitis Test

Negative	No gelling seen
Trace	Small amount of gelling with tipping of paddle
1+	Significant gelling when tipped
2+	Gel clumps in the middle with swirling of paddle
3+	Mixture complete clumped

Treatment of Mastitis in Ewes

Use of Antimicrobial Drugs in Dairy Sheep - Very few drugs are approved for use in lactating dairy sheep in the USA. Veterinarians in North America are allowed to prescribe drugs in an off-label manner but they are then obligated to assure that residues do not enter the food chain. Sparse literature exists on appropriate withdrawal periods for the milk of dairy sheep.

It is strongly recommended to consult FARAD (<http://www.farad.org/>) and to use antimicrobial detection tests for milk whenever antimicrobial drugs are used to treat dairy sheep, although false positives and negatives are possible when bovine kits are used in these species particularly if the milk is heated or a preservative is added.³

Clinical Mastitis - Little scientific research has been done on the effectiveness of drugs used for the treatment of mastitis in sheep. For toxic or gangrenous mastitis (where the animal is sick), therapy should include:

- IV or oral fluids
- Hypertonic Saline
- Non-steroidal anti-inflammatories (NSAID's)
- Frequent "milk out" of the affected gland – every two to three hours
- Oxytocin at milking aids in full milk removal
- Antibiotics??

Your veterinarian should be involved in any treatment plan or protocol on your dairy and only they can recommend exact doses and withdrawal periods for pharmaceuticals.

Sheep with gangrenous mastitis are at grave risk of dying.

No recently published information exists on treatment of dairy sheep with intramammary infusion products during lactation. Commonly used in dairy cattle, the benefit to sheep with clinical mastitis is essentially unknown.

Subclinical Mastitis Therapy – There is little research in the effectiveness of treating subclinical cases of mastitis in sheep. Cultures should be completed on chronic, high SCC cases and therapy or culling decisions based on those results. Udders infected with *Staph. aureus* are

generally considered permanently affected as success rates for bacteriological cure are low (<30%).

Dry period therapy - The use of dry cow intramammary therapy in sheep has been well studied.

There is evidence of improved cure rates and decreased level of new infections, although these levels vary considerably between studies. One study showed an improvement in milk production in the group that received procaine penicillin at weaning, although a 72 hr. fast post-weaning produced a similar improvement. In a study conducted recently in Ontario, the prophylactic injection of tilmicosin one month prior to lambing (at the same time as the routine pre-lambing clostridial vaccination was done) has been shown to be of benefit in terms of a 43% reduction in udder abnormalities at weaning, and increased weaning weights of lambs (0.52 kg heavier than the control group). The decision to use a form of dry period antimicrobial therapy needs to be based on the prevalence of mastitis in the flock as well as ease of treatment (e.g. injection vs intramammary infusion) and withdrawal considerations.³

Other factors involved in mastitis prevention and control include: Vacuum levels of the milking machine, pulsation rate and ratio, machine “on-time”, udder preparation routines, teat dips, and cluster/claw size. Evaluation of these factors should be completed, at minimum, on an annual basis.

Abortion Diseases

There are three primary pathogens that cause abortion in the ewe. Other causes exist, but are less common.

- 1.) Chlamydial abortion (enzootic abortion in ewes)
 - Caused by *chlamydi psitacci*
- 2.) Campylobacter abortion (vibriosis)
 - Caused by *C. jejuni* of *C. fetus* ssp. *intestinalis*
- 3.) Toxoplasmosis abortion
 - Caused by protozoan *Toxoplasma gondii*, the coccidia of cats

When an outbreak of abortions occur in ewes, aborted fetus and fetal membranes should be handled carefully and testing should be done on fresh samples until diagnosis is made. Some abortion disease of sheep are zoonotic (infectious to humans).

Treatment and control of abortion outbreak focuses on therapy with tetracycline. 8-10 mg/lb. of LA 200® injection followed by 400-450mg/head/day of oral tetracycline in the feed.

In endemic flocks, 100-150 mg/head/day of tetracycline in the feed 2-3 weeks prior to breeding is recommended.

Summary of Sheep Abortion

- Be aggressive in therapy and hygiene in the face of an outbreak
- Use an effective vaccination program
- Chlamydia 60 and 30 days before breeding
- Campylobacter 30 days prior to breeding and booster 60-90 days later
- Monensin 15-30 mg/head/day once ewes are yarded
- Do not feed sheep on the ground
- Maintain first lambing ewes as a separate unit
- Dispose placenta and dead or aborted lambs immediately
- Avoid excessive stress on the ewes

Summary of Abortion Therapy

- Submit aborted fetuses and PLACENTA to diagnostic lab.
- Inject long acting tetracycline (LA 200) and begin feeding 400-500 mg. tetracycline per head per day for five days, then reduce to 250 mg.
- In EAE repeat LA 200 in 14 days
- Isolate aborting ewes from the flock
- Keep pregnant women out of the lambing barn

Pregnancy Toxemia

Metabolic disorder of late gestation ewes (usually in the last 2-3 weeks). Thin ewes or very over-conditioned ewes are more likely to develop pregnancy toxemia (ketosis). It is characterized by negative energy balance (low blood sugar). Ewes are usually recumbent down and off feed. Ketones are toxic by-product of excessive breakdown of body fat to compensate for negative energy condition. Ewes carrying multiple pregnancies are much more likely to experience ketosis.

Treatment of pregnancy toxemia

- Oral propylene glycol (2 oz. twice a day)
- IV 5% dextrose drip
- 100-300 ml dextrose (50%) bolus IV
- B vitamins
- Remove Fetuses (induce labor or c-section)
- Antibiotics to prevent pneumonia?

Preventing Pregnancy Toxemia

- Provide adequate energy in ration especially during last 4-6 weeks of gestation
- Good quality hay with grain supplementation (begin with about 0.5 lbs. per day and increase to 1.5-2.0 lbs per head per day until the time of parturition)

- Avoid abrupt feed changes
- Avoid stress when possible
- Provide adequate feeder space
- Aim for body condition score of 3 to 3+ at lambing
- Monitor and control parasitism

Pneumonia

- Sheep pneumonia is common in newborn and feedlot lambs
- *Pastuerella multocida* and *Mannheimia haemolytica* are the most frequently isolated bacteria from affected lung tissue
- Results from the interaction between the microorganisms, a stressful environment, and the sheep's immune system
- Close contact housing, intensive management, heavy ammonia on deep manure packs, and prolonged confinement all contribute to an increase in pneumonia
- Young lambs are most affected and death losses can be as high as 50%
- Newborn pneumonia can lead to chronic poor doing lambs, reduced feed efficiency, reduced daily gains and possibly poor reproductive performance in the future

Necropsy of dead animals that have exhibited signs of respiratory disease is vital to obtaining an accurate diagnosis. Laboratory samples should also be submitted at necropsy. Vaccination with *Pastuerella multocida* and *Mannheimia haemolytica* products has some benefit. Show animals or animals that transport regularly are particularly susceptible to pneumonia.

Barn Cough

- “Barn cough” may appear like pneumonia, but rarely causes death loss
- Factors such as crowding, dust, damp humid weather, or stress increase the amount of cough
- May be bacteria, may be viral, may be a combination
- Seem a little better while on antibiotics
- Can lead to rectal prolapses
- Albon® in water, LA 200®, and Naxcel® seem to alleviate the symptoms

Milk Fever (hypocalcemia)

Hypocalcemia is more of a problem in dairy goats, but can occur, to some extent, in ewes. Usually milk fever occurs just before or just after lambing and is a direct result of low blood calcium levels. Ewes are most susceptible in late gestation and early lactation (6 weeks before lambing to 10 weeks after lambing), and can be exacerbated by a stress event.

Diets high in calcium, phosphorus and potassium, increase a ewes' likeliness of developing hypocalcemia.

Initially ewes have tremors and a stiff gait. Eventually ewes become ataxic and progress to depression, decreased rumenations, and eventually recumbency. Rectal temperatures are often low and pupils respond slowly to light.

Diagnosis is based on classic clinical signs with serum calcium levels less than 4-5mg/dL.²

Immediate treatment is recommended. 100ml of 23% calcium borogluconate is administered IV slowly while listening to the heart to monitor for arrhythmias. Subcutaneous calcium administration can prevent relapse.² Successful treatment results in a quick reversal of sings.

Hypocalcemia can be prevented by feeding a diet low in calcium. Reducing alfalfa/legume hay or additional calcium and phosphorus in the diet helps prevent cases. Decreasing stress around the time of lambing is also important.

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PROGRESSIVE WASTING DISEASES OF EWES

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Wasting diseases of ewes are a frustrating part of sheep rearing. Often slowly progressive and chronic in nature, these diseases can be very difficult to differentiate and diagnose. Generally the diagnosis is made post-mortem and even then can still be elusive. Some of the more common reasons for continued weight loss in ewes are outlined here.

Johnes Disease

This chronic wasting disease is also known as *paratuberculosis* and is the result of gastrointestinal infection with *Mycobacterium avium* subspecies *paratuberculosis* (MAP). There are currently three recognized Types of MAP in ruminants.

- Type I – the sheep or S-strain
- Type II – the cattle or C-strain
- Type III – Goat strain

Transmission of the bacteria occurs mostly to young stock as adult animals are much less susceptible to the disease. Transmission is primarily by the fecal-oral route. Small amounts of MAP-laden manure can be infective to a lamb. Bacteria are shed in manure and milk of an infected ewe and trans-placental infection (in utero) has also been theorized. Shedding of bacteria is more prolific in animals that are showing clinical signs of the disease, so the offspring of those animals are more likely to acquire the infection.^{1,2} Exposure to MAP will result in one of two outcomes. First, the animal might “clear” the infection on its own. Alternatively, a chronic and persistent infection may develop.³ Infected animals can be asymptomatic for years following infection.³ Sheep and goats tend to express disease more quickly following infection than cattle.

Weight loss is the cardinal sign of the disease in sheep. Evidence of disease is almost never apparent before 12 months of age and sheep and goats often remain asymptomatic until after two years of age.³ Decreased appetite is another clinical sign. Feces of infected animals are usually normal or pasty. Chronic diarrhea occurs in about 20% of cases.¹ The actual clinical course of the disease is usually only a few weeks long and the onset of the disease is often associated with a stress event such as lambing (parturition).^{1,2} Hypoproteinemia (low blood protein level) and anemia (low red cell count) are common in clinical animals and so submandibular edema can develop. This can make diagnosis confused with other protein losing diseases such as heavy parasitism.

It should be noted that when an animal in a flock is showing clinical signs this should be viewed as “the tip of the iceberg”. For every clinical animal there are several animals that are in the subclinical state and can be a source of infection within the flock to other animals, especially young stock.¹

Diagnosis of Johnes disease is made by fecal culture. In sheep the fecal culture routinely takes 3-4 months to complete, making diagnosis difficult and often retrospective. Strains of MAP in sheep and goats make fecal culture more difficult than in cattle and the sensitivity of culture in clinically infected sheep is only about 30-40%.^{2,4} This low sensitivity means that a negative test may likely not rule out the disease in an individual animal (cannot be sure the animal doesn't actually have the disease). The fecal culture has high specificity meaning that a positive result should be viewed as conformation that the animal is, in fact, diseased.

Other live animal tests are available to attempt to diagnose Johnes disease. A PCR test of feces is also available but the sensitivity is similar to that of the culture. The PCR does seem better able to identify infected sheep in a flock than for goats. Serum tests including agar gel immunodiffusion (AGID), enzyme-linked immunospecific assay (ELISA), and complement fixation are available. However, the sensitivity of these tests is quite poor for clinically normal animals. For clinically affected animals, the sensitivity increases to around 50% and the specificity is very high (>95%).^{2,4,5} Sheep tend to make antibodies to MAP later in the stages of the disease than goats making antemortem diagnosis even more frustrating.³ A milk ELISA test is available for cattle, but milk ELISA and PCR of individual animal milk and bulk milk has not been well validated for sheep and goats. ELISA and complement fixation tests can cross-react with *Corynebacterium pseudotuberculosis*. This makes those tests more difficult to use in flocks with endemic caseous lymphadenitis (CLA).^{2,6}

Necropsy is the best diagnostic test for Johnes disease. Thickened intestines, especially in the ileum and ileocecal junction are typical. Mesenteric lymph nodes are usually enlarged. Lymphatics are often dilated. In sheep the corrugated thickening of the intestinal tract is limited to the distal ileum and ileocecal junction. Acid-fast staining of tissues from that area confirm the diagnosis.³

There is no effective treatment for Johnes disease and control is difficult due to the cost in relation to the value of the animal. Flock prevention is the goal and screening and reducing exposure are the keys to trying to reach that goal. New animals should be screened with ELISA or AGID tests, keeping in mind that the sensitivity is low. An infected animal can test negative and those results are common.^{2,4} However, a positive test is a valid reason to not purchase that animal.

Reducing exposure to MAP involves the following practices:

- Wash and dry udders
- Clip udders before birth
- Keep barn clean
- Raising newborns separately from adults
- Disinfection of barns and pens between "groups"
- Remove newborns ASAP ????
- Tape teats to prevent nursing
- Workers should keep hands clean/wear gloves
- Identify all animals and keep good records

Feeding bovine colostrum can be a useful tool, but colostrum should only be used if the source bovine herd is known to be free of MAP. Bagged bovine colostrum replacers can also be used but are an expensive alternative. Colostrum (and milk) can be pasteurized to reduce the load of MAP in milk, but there is little research in killing MAP in sheep colostrum.

Culling animals from a flock by positive serologic tests is recommended as well as removing offspring from test positive animals. Pooled fecal cultures increase the sensitivity of fecal testing, and are a good way to identify if the flock is positive or negative. This testing method would do nothing to identify individual infected animals though. A vaccine is available for cattle, but is not approved for use in small ruminants. The vaccine does not eliminate the infections, but can decrease herd prevalence, delay the onset of clinical disease, and decrease fecal shedding and contamination.³

An overall flock plan should include:

- Keeping pens clean!
- Disinfect between groups
- Necropsy everything that dies!
- Milk low risk herd first
- Manage manure
- Cull infected animals quickly
- Consider the “iceberg”

According to the NAHMS (National Animal Health Monitoring System) 2001 data, only 30% of sheep producers surveyed were aware of Johnes disease in sheep before the study. Of producers that had heard of Johnes disease only 7% had herd health programs in place to control it. One percent of rams and five percent of ewes, were tested for Johnes before arrival on the farm.

Ovine Progressive Pneumonia (OPP)

OPP is one of the most economically important diseases affecting sheep in North America.³ OPP is the result of infection with OvLV (ovine lentivirus). It is closely related to the lentivirus infection in goats that causes caprine arthritis encephalitis (CAE).

This virus has a long incubation period (2-4 years) and as such animals don't typically show signs of disease until after 2 years of age. Direct and colostrum/milk transmission are the most likely routes of infection. Vertical transmission is rarely observed.^{3,7,8} Semen may that contains white blood cells may contain OvLV.¹⁰ Blood has not been demonstrated to be a source of transmission.³ Sheep typically become infected as lambs. The outcome of that infection depends on the dose of virus received as a lamb, colostrum antibodies present in ewe colostrum, the amount of colostrum ingested, the age of the lamb at infection, and genetic susceptibility of the host. Close confinement and the duration of exposure of lambs to the virus are important in transmission of the causative agent.

Many sheep remain asymptomatic carriers for life.¹¹ In flocks with both infected and uninfected ewes, approximately 40% of the offspring of infected ewes and 20% of the offspring of uninfected ewes become seropositive within one year.^{3,12}

Infected sheep stay infected for life and harbor the virus. The virus localizes in the lungs, central nervous system, and bone marrow, spleen and lymph nodes.³ In the lungs, chronic and permanent damage occurs. Other disease syndromes include mastitis, arthritis, and encephalitis.

Often the first sign of this slowly progressive viral disease is general loss of body condition. This is referred to “thin ewe syndrome”. This weight loss occurs despite the animal typically maintaining appetite. OvLV infection can have various patterns of disease as the virus itself has a good ability to mutate and form new “strains” of the virus.³ Clinical signs can become evident following periods of stress or inclement weather.

Difficulty breathing becomes evident as the disease progresses and is more apparent after exercise. These animals are known as “lungers” and can be seen tiring easily or trailing behind the flock.⁹ Secondary bacterial infections can be a problem in the lungs. In the absence of bacterial pneumonia, sheep do not elicit a fever and tend to maintain appetite. Other clinical signs include an unsteady gait, twitching, stumbling and progression to rear limb paresis (weakness) and paralysis. These signs slowly progress over weeks to months to rear limb paralysis or complete quadriplegia.^{13,14} Signs last for 3-6 months or persist for years.³ “Hardbag”, a mastitis condition characterized by a large, hard udder with abnormal secretions can occur.³ Once signs appear, the mortality rate is 100%. Animals typically die or are culled within a year of the onset of signs.¹⁴

Diagnosis is done by ELISA on a blood sample. An AGID test is also available with lower sensitivity than the ELISA. A PCR test can be used to test lambs while maternal antibodies are still present.³ Using both tests and/or repeating tests two or three times over several months is recommended for eradication purposes in flocks.

Necropsy of dead ewes reveals large, heavy lungs. Lungs can be two to three times normal size.³ Evidence of secondary bacterial pneumonia is possible. Arthritis may be found - especially in rear limbs.

According to the NAHMS (National Animal Health Monitoring System) data from 2001, 36% of sheep operations tested in the United States had at least one positive animal for OPP and overall 24% of all animals tested were positive on serology. Overall 92% of operations do not test new additions for OPP prior to arrival and only 5-10% of all new flock additions are tested before purchase.⁹

Control of OPP can be difficult, but maintaining a closed flock along with repeated testing and culling of positives can result in a “clean” flock over the course of several years. Seropositive animals should be culled or moved to a separate facility. The feeding of OvLV-free colostrum or milk replacer or grafting lambs to seronegative ewes can be employed.

Serial testing of the flock should be utilized. At least twice a year testing is recommended until two consecutive negative tests occur.³ Management of the disease must be directed at reducing positive animals in a flock and thus decreasing exposure.

Pasteurizing colostrum by heating it to 130-135°F for 60 minutes will kill the virus. Exceeding 140°F will result in destruction of antibodies in the milk.

Scrapie

Scrapie is the sheep (and goat) member of the slowly progressive and infectious disease group known as transmissible spongiform encephalopathy (TSE). TSE's in other species include BSE in cattle, CJD in humans, and CWD in deer. Scrapie is, ultimately, a disease of the central nervous system (CNS). It is a slowly progressive, degenerative disease. There is much that is now known about scrapie or the causative agent. Three theories currently exist regarding the causative agent.³

- 1.) The agent is a filamentous virus
- 2.) The agent is a self-replicating protein (prion)
- 3.) The agent is a very small nucleic acid with a protective protein coat encoded in the host DNA.

The glycoprotein PrP^c on the surface of the neuron in normal sheep has also been identified within neurons of scrapie-affected sheep. In scrapie-affected sheep, the protein is known as PrP^{sc}. Identification of the PrP^{sc} protein has been correlated 100% with scrapie infections in sheep.^{3,15} This abnormal prion protein binds to normal prions. Accumulation of these abnormal prion proteins in the CNS leads to death and dysfunction of nerve cells and onset of clinical signs.

Transmission of scrapie has been documented to occur horizontally and vertically. Most sheep with clinical signs of scrapie are around 3.5 years of age.¹⁶ The exact method of transmission is now known. Offspring of infected ewes and rams are more susceptible. Most scientists believe sheep are infected at birth and undergo a very long incubation period. The primary mode of transmission is also believed to be oral. Furthermore, this belief indicates the causative agent is infectious and transmission does not occur in utero, but instead after birth.^{17,18} After infection the agent takes 2-5 years to replicate. At the end of the incubation period there is conversion of the PrP^c protein to PrP^{sc} protein.³

Genetic factors are associated with susceptibility to the development of natural scrapie infections.³ A codon is defined as a set of three nucleotides that encode for a specific amino acid. Three codons that encode for amino acids at positions 136, 154, and 171 in the PrP protein (sheep genome) have been associated with scrapie susceptibility in sheep in the United States. However, codon 171 is thought to be the major determinant of scrapie susceptibility in the United States.¹⁹ Positions 136 and 171 are associated with increased susceptibility and decreased survival time.³

Not all breeds of sheep have the same genotype at the three different codon positions. Scrapie occurs primarily in Suffolk, Cheviot, Southdown and Hampshire breeds.³ All breeds seem to appear more susceptible to scrapie if they have a genotype encoding QQ₁₇₁.¹⁶ Sheep that have the genetic composition of A₁₃₆, R₁₅₄, Q₁₇₁ are the most susceptible to developing scrapie.³

Amino acid abbreviations

A: alanine

H: histidine

K: lysine

Q: glutamine

R: arginine

V: valine

Suffolks are the most commonly affected sheep in the United States. Most signs are related to the CNS. Initially, changes are subtle – staring, gazing, aggressiveness and failure to be herded.³ Later ataxia can develop along with drooped ears. Most sheep have intense pruritis with wool loss which is most noticed on the sides of the body and over the tail head. Affected sheep will react excessively to rubbing or scratching of the lumbar region. Eventually affected animals lose weight and have fine head and body tremors. Animals can develop blindness and seizures.

Diagnosis is by histological changes of CNS tissue. There is no detectable immune response to be measured because the scrapie organism contains no antigens to be recognized by the host.³ Immunohistochemical (IHC) staining of brain tissue is considered the standard for clinical diagnosis in sheep. This is a postmortem test. It is highly specific and highly sensitive.³ IHC of lymph tissue of the third eyelid or rectal mucosal can be used in live animals, but is not a validated test.

There is currently no treatment available for scrapie. Prevention of scrapie in sheep flocks is achieved by maintaining a closed ewe flock, genetic susceptibility testing and improved lambing hygiene. Keeping a closed flock is the best way and eliminates the need for additional genetic testing and other management practices.

Purchasing animals that have been genetically tested resistant (especially rams) or buying animals from flocks certified by the USDA Animal and Plant Health Inspection Service (APHIS) Voluntary Scrapie Flock Certification Program is the best way to prevent introduction of scrapie into a flock.

The Scrapie Flock Certification Program requires flocks to be assessed for five years to determine that they do not contain any scrapie-infected sheep. The program has four levels of clearance and when the final level is attained, producers are able to export and sell sheep both in the US and internationally without restriction.

Genetic susceptibility testing should be utilized for all flock additions. The amino acids at codon 171 are R, H, Q and K. R gives sheep the most resistance to scrapie. The other amino acids do not. The amino acids at codon 136 affect susceptibility of sheep to a more uncommon

type of scrapie. Sheep with a V at codon 136 are susceptible to this type of scrapie, including those that are R at codon 171.

The most cost effective way at improving resistance to scrapie is to purchase rams that carry the RR genotype. Therefore, all offspring will carry at least one R gene and will be more resistant to scrapie.

Lambing time hygiene is also important to reducing/controlling scrapie. Lambs should be born in individual “jugs” and fetal membranes and soiled bedding should be removed promptly and be composted or burned. Pens should be cleaned thoroughly and disinfected between uses.

A complete flock prevention program includes:

- 1.) Purchase ewes from flocks that are scrapie free
- 2.) Introduce new genetics into the flock by purchasing semen or rams that have been tested RR
- 3.) Maintain proper biosecurity as part of an overall flock management plan

Caseous Lymphadenitis

Caseous lymphadenitis (CLA) is caused by *Corynebacterium psuedotuberculosis*. This bacteria can cause abscesses in the skin or lymph nodes under the skin. The infected lymph nodes may break open to the outside. Abscesses can also develop deep in the body as well with lymph nodes in the lungs or chest becoming infected. Some animals present with signs of respiratory disease.³ Abscessed lymph nodes in the abdomen can occur as well leading to poor appetite and progressive weight loss.

The disease can be spread by the respiratory route if animals are harboring lung abscesses. Trauma to the skin from nails or wire in the barn is a common source of infection. Rapid spread through a flock can take place from contaminated shearing equipment or docking/castrating tools. Ruptured abscesses serve as a ready source of infection and the bacteria are highly contagious. Some evidence indicates that draining abscesses on an animal can contaminate the environment for 37 days after rupture.^{20,21} The bacteria can survive for long periods of time in dark and damp areas as well as soil and manure.³

Swelling of peripheral lymph nodes around the head and neck as well as prescapular (just in front of front legs) and prefemoral (just in front of back legs) is the first clinical sign typically seen. Occasionally, open, draining abscesses in these areas are noticed initially. Swollen lymph nodes in sheep can be easily missed if the animal is in full fleece. The abscessed lymph node contains thick, pale green exudate that with time can form “onion-like” layers and some develop hard, calcified masses.³ Multiple lymph nodes may be affected simultaneously or just a single node.

Along with weight loss from abscessation of the viscera, poor fertility, decreased milk production, decreased weaning weights and poor growth of body and wool are experienced.³ Even CNS signs and mastitis can develop if the organism spreads to those areas.

Diagnosis is usually made on the classic outward signs of disease in those animals that have infected peripheral lymph nodes. Confirmation of the organism is based on culture of the necrotic exudate from infect node(s). Necropsy can reveal abscessed internal lymph nodes with consistent pathological findings.³ The hemolysis synergistic inhibition test measures antibodies in the blood to toxins produced by the bacteria. Most infected animals produce antibodies within a month after infection.³ A positive test can indicate that the animal has been exposed to the organism but may, or may not, be suffering from fulminant disease associated with the bacteria at the time of the test.

Chronic weight loss is a prominent sign especially later in the disease, but other causes such as OPP, parasitism, tuberculosis and Johnes disease should be considered.²⁰

Treatment with systemic antibiotics alone has historically proven unrewarding. Culling is ultimately still the best treatment. However, animals to be maintained in the flock, should be quarantined at the first sign of disease. Affected animals should always be isolated for any treatment. Abscesses should never be opened within the vicinity of the flock.³

Draining abscesses and flushing with 1-3% iodine solution or 2% chlorhexidine can speed the elimination and healing of the local, peripheral node. Systemic infection is not altered by this practice. Complete surgical removal is a further treatment option, but requires general anesthesia and a node that can be excised widely in a location that allows for complete skin closure following excision. This practice is often reserved for pet or show animals as it proves economically unfeasible for commercial flocks.

Intra-lesional treatments with 10% formalin or tulathromycin (Draxxin®) have been described.^{22,23} These treatments involve aspiration of the abscessed node with a large bore needle followed by repeated flushing and finally insertion of the treatment solution. These treatments are off-label and should only be performed by a veterinarian having a valid client-animal relationship so that appropriate slaughter withholdings can be established. These treatments are usually reserved for treatment of the individual animal rather than mass therapy.

Identification of infected animals and quick removal from the flock is the most effective method of control.³ The housing environment should remain free of sharp, protruding objects that can serve as a source of skin injury and therefore spread of the bacteria. All docking, castrating, tattooing and shearing equipment should be cleaned and disinfected between animals, especially after using on animals showing clinical signs. Animals with open and draining abscesses should be isolated or culled immediately. Special attention should be paid at shearing time as hidden abscessed nodes can be inadvertently opened by the shears and those contaminated clippers serve as a good source of infection.

Animals with poor body condition should be suspected of systemic CLA infection especially if history of previous external lymph node abscessation exists. Vaccination is available for sheep. The vaccine is typically used in flocks where CLA is endemic. Vaccination can reduce the incidence of abscesses in a flock by more than 70% but will probably not solely result in disease eradication in a flock.²⁰

Flock Control Program for Caseous Lymphadenitis³

- Quarantine new flock additions for 30 days to observed for enlarged lymph nodes
- Identify and cull suspects
- Palpate lymph nodes
- Evaluate individual animals with hemolysis synergistic inhibition test
- Isolate all affected animals
- Cull or treat and cull
- Disinfect housing and equipment with which affected animals had contact
- Disinfect all equipment used on all animals (shears, foot trimmers)
- Necropsy dead animals, especially those with unexplained weight loss
- Perform slaughter checks to assess for disease
- Vaccinate to reduce incidence in endemic flocks
- Vaccinate lambs at time of tail docking
- Vaccinate all replacement lambs and kids two or three times between 6 weeks and 6 months of age
- Vaccinate rams and ewes about 4-6 weeks before lambing

(adapted from Gessert ME: *Proceedings of the 1998 Symposium on Small Ruminants for the Mixed Animal Practitioner Western Veterinary Conference*, 1998, Las Vegas, NV.)

Other Wasting Diseases

Other chronic wasting diseases of ewes include: dental and oral problems, gastrointestinal parasites, liver flukes, *Actinobacillus* infection, and internal abscesses other than caseous lymphadenitis.

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PERFORMANCE OF KATAHDIN-LACAUNE CROSSBRED EWES

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Introduction

For a dairy sheep operation a wool-less sheep would be desirable for several reasons. First, when using East Friesian ewes or East Friesian crossbred ewes shearing is often done twice a year in order to keep them clean for a sanitary collection of the milk but then, because of the resulting shorter fleece, the value of the wool is very much reduced. Another reason is the less than adequate adaptation of woolly dairy sheep to hot and humid climates of the South and South East US where a hair sheep would be preferable. Therefore the idea of creating a dairy breed with little or no wool is appealing. The Lacaune breed, widely utilized in the South Central part of France for Roquefort production is a good milk producer and has very little wool located mostly on the back leaving the head, neck, underbelly and legs fairly bare. Unfortunately, the Lacaune breed is rare in North America and its multiplication limited. The hair sheep Katahdin on the other hand is abundant and is becoming very popular because of its easy care lamb production, tolerance to internal parasites and resistance to elevated temperatures as well as high humidity. The (commercial) milk production of the Katahdin is, however, limited. A small crossbreeding trial between the Lacaune and the Katahdin was started in 2007 at the Spooner Research Station to see if the crossbreds animals would be suitable for commercial milk production while keeping all the attributes of the hair sheep.

Animals used

Twelve Katahdin ewes (9 adults and 3 ewe lambs) as well as two rams were purchased from a reputed Katahdin breeder in South West Wisconsin. In the fall of 2007 those ewes were exposed to one Lacaune ram. At the same time 25 high grade Lacaune ewes (some having a small percentage of East Friesian blood) were exposed to one Katahdin ram. The Katahdin ewes raised their lambs for 60 days while the lambs of the Lacaune ewes were raised on milk replacer and their dams put at milking shortly after lambing (DY1 system). In the fall of 2008 and 2009 the same Katahdin ewes were again exposed to the same Lacaune ram. The ewes raised their lambs for 30 days and put at milking (DY30 system). F1 ewes born in 2008, 2009 and 2010 were exposed either to a Lacaune ram or to a Katahdin ram in order to produce backcrosses (3/4KL, 1/4Ka and 3/4Ka, 1/4L). Backcrosses ewes were bred either by dairy rams or terminal rams.

The number of animals used in this trial is very small involving only 12 Kathadin ewes, and 2 rams and only 25 high grade Lacaune (some having a little East Friesian blood) and 1 high grade Lacaune ram. The results have to be taken with caution but can provide interesting indications for producers desiring incorporate the Katahdin breed in their dairy operation.

Shedding

The pure Katahdin ewes shed their winter coat completely during the course of the spring. The Lacaune ewes, which grow a fairly heavy coat of wool-hair mix for the winter, need to be shorn in the spring. In F1 ewes, as shown in the following pictures, the shedding is very variable from one individual to the next. None however really need to be shorn if not for an aesthetical reason. Backcrosses to Lacaune or Katahdin are very bare and do not need shearing at all.

Reproduction performance

The reproduction performance of the original ewes and their crossbreeds are shown in Table 1 for adult ewes and for young ewes put at breeding at 7-8 months of age. The prolificacy of the Katahdin ewes is remarkable with 2.3 lambs born per ewe lambing. The prolificacy of the F1 ewes is in between the Lacaune and Katahdin and the prolificacy of the backcrosses is close to the purebred which had to be expected. The number of lambs born per ewe put at breeding, a combination of fertility and prolificacy is quite high in all genotypes although somewhat lower in the Lacaune breed.

Growth of lambs

The growth of lambs, shown in Table 2 is good and very similar between F1 and backcrosses. Their average daily gain from birth to 60 days of age is around 227 g per day (.5 lb) for all genotypes. It is lower than the average daily gain of the Spooner flock of 340 g per day (.75 lb/day) for the same period. The livability of the F1 lambs is quite good (95% and 86%) while backcrosses and contemporary Lacaune lambs are more prone of dying at a young age with a livability of only 70% to 76%. The weights of F1 and Katahdin at first mating at 7 month of age are all above 45 kg (100 pounds) which is sufficient to ensure a good conception rate at an early age.

Milk production

The Katahdin ewes that were purchased in 2007 had a very wild disposition and were not put at milking their first year at the station. After raising their lambs the Katahdin ewes were returned with the main flock hoping that they would calm down and become tamer. This did not happen and milking the Katahdin ewes during their second year proved to be a challenge. The F1 ewes born from Lacaune dams had a much better disposition while the F1 ewes born from Katahdin ewes still had a wild streak.

The milk production of all groups is given in Table 3. Only ewes with a lactation of more than 20 days were included. The Lacaune ewes shown in the table are the ewes that were used to produce the F1s and were put at milking shortly after lambing (DY1 system). The milk production of the high grade Lacaune ewes in first and subsequent lactations (207 liters or 472 pounds and 308 liters or 700 pounds respectively) is well in the norm of the Lacaune breed. The percentage of fat and protein in the milk is also a good representation of the breed. The pure Katahdin ewes produced only 13 liters of milk (30 pounds) in the DY30 system and were milked for only 35 days. The small amount of milk obtained shows a very poor adaptation of those

animals to a dairy situation. Only one Katahdin ewe proved to be suitable for milking with a good temperament and a decent milk production of 219 liters or 500 pounds in 211 days over 3 lactations. F1 ewes, however, produced around 100 liters (228 pounds) in 109-145 days during their first lactation. In their second and third lactation they produced more than 200 liters (456 pounds) in 185 days. The percentage of fat and protein is only marginally lower than the high grade Lacaune. Backcrosses to Lacaune ($\frac{3}{4}$ Lacaune, $\frac{1}{4}$ Katahdin) have a higher production at their first lactation but similar production at their second lactation than F1s. Backcrosses to Katahdin ($\frac{3}{4}$ Katahdin, $\frac{1}{4}$ Lacaune) seem to produce only slightly less milk. In all groups there is a large variation of production between individual animals.

Conclusion

The good shedding of Katahdin-Lacaune crossbred ewes avoiding the trouble of shearing, combined with a decent growth of lambs and a sensible commercial milk production indicate that those animals could be acceptable in a low input and easy care system where the maximum milk production is not the goal. Heat and parasite resistance will add to their attraction for producers in the South and South East of the United States. Producers, however, need to be warned that because of the small number of Lacaune in North America the only way to create those animals would be by starting with a flock of Katahdin ewes. Because of the large variation between animals not all F1s will be suitable for milking and a certain amount of culling will need to be done.



Lacaune ewe



Katahdin ewes



F1 1/2Katahdin, 1/2Lacaune



F1 1/2Katahdin, 1/2Lacaune



3/4Lacaune, 1/4Katahdin



3/4Lacaune, 1/4Katahdin

Table 1. Reproductive performance of Lacaune, Katahdin and crossbred ewes

	Lacaune	Katahdin	50Ka,50L	50L,50Ka	>50L,Ka	>50Ka,L
Adults						
# at breeding	25	31	13	17	13	2
# lambed	22	26	11	15	13	2
# lambs born	42	60	24	31	24	4
Fertility	88%	84%	85%	88%	100%	100%
Litter size	1.91	2.30	2.18	2.07	1.85	2.00
Lambs born /ewe at breeding	1.68	1.94	1.85	1.82	1.85	2.00
Ewe lambs						
# at breeding			12	27	24	6
# lambed			9	24	20	5
# lambs born			16	49	33	9
Fertility			75%	89%	80%	83%
Litter size			1.78	2.04	1.65	1.80
Lambs born /ewe at breeding			1.33	1.81	1.38	1.50

Table 2. Growth of Katahdin-Lacaune crossbred lambs

	Lacaune (contemp.)	50Ka,50L	50L,50Ka	>50Ka,L	>50L,Ka
Weight at birth	5 kg 11.05 lb	5 kg 11.05 lb	4 kg 8.8 lb	4.3 kg 9.5 lb	4.4 kg 9.7 lb
Weight at weaning (30 days)	13.7 kg 30 lb	12.6 kg 27.7 lb	11.5 kg 25.4 lb	11.6 kg 25.5 lb	12.4 kg 27.2 lb
Weight at 60 days	18.4 kg 40.4 lb	20 kg 44 lb	17.7 kg 39 lb	19.1 kg 42 lb	17.3 kg 38 lb
ADG Birth-60 days	219 g .48 lb	251 g .55 lb	228 g .50 lb	246 g .54 lb	214 g .47 lb
Survival to 60 days	76%	95.2%	86%	73%	70%
Weight at 1 st mating (7 months)	47.3 kg 104 lb	53.6 kg 118 lb	52.7 kg 116 lb	45.5 kg 100 lb	57.8 kg 127 lb

Table 3. Milk production of Lacaune, Katahdin and crossbred ewes (\pm Standard Deviation)

	Lacaune	Katahdin	50L,50Ka	50Ka,50L	>50L,Ka	>50Ka,L
1st lactation						
Weaning syst.	DY1		DY1	DY30	DY1	DY1
# of lactations	14		23	5	21	3
Total milk (liters)	207 \pm 68		108 \pm 50	89 \pm 84	134 \pm 56	87 \pm 51
(pounds)	472 \pm 155		246 \pm 114	203 \pm 191	306 \pm 128	198 \pm 116
Days in milk	182 \pm 36		145 \pm 56	109 \pm 77	145 \pm 40	116 \pm 52
Avg. Fat %	6.1 \pm .52		5.82 \pm 1.42	5.31 \pm 2.11	6.02 \pm .61	4.93 \pm 1.82
Avg. Prot. %	4.97 \pm .48		4.67 \pm .99	4.53 \pm 1.7	4.94 \pm .51	4.17 \pm 1.25
2nd + lactation						
Weaning syst.	DY1	DY30	DY1	DY1	DY1	DY1
# of lactations	95	8	18	7	11	4
Total milk (liters)	309 \pm 96	13 \pm 9	196 \pm 75	217 \pm 102	210 \pm 79	198 \pm 50
(pounds)	705 \pm 219	30 \pm 21	447 \pm 123	495 \pm 233	479 \pm 180	451 \pm 114
Days in milk	208 \pm 40	36 \pm 11	184 \pm 54	187 \pm 70	177 \pm 27	200 \pm 22
Avg. Fat %	6.6 \pm .79	6.09 \pm 1.48	6.37 \pm .84	6.18 \pm .63	6.08 \pm .78	5.77 \pm 1.13
Avg. Prot. %	5.27 \pm .54	5.22 \pm 1.4	5.16 \pm .46	5.16 \pm .29	5.01 \pm .51	4.95 \pm .47

PARASITE CONTROL IN DAIRY SHEEP

Susan Schoenian
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Introduction

Internal parasites are a common health problem in sheep. The severity of the problem varies by geographic location and production system. Dairy ewes may be at high risk due to the stress of lactation. Dairy sheep lambs are more susceptible because of early weaning.

Many species of internal parasites can infect sheep. *Haemonchus contortus* (barber pole worm) is usually the most pathogenic. The barber pole worm is a blood-sucking roundworm that causes blood and protein loss in the host. Anemia (pale mucous membranes) is the primary symptom. Edema (bottle jaw) may also be observed. Sudden death is not uncommon, especially among young lambs.



There are several other roundworm species (e.g. *Trichostrongylus* spp. and *Teladorsagia*) that can impact the health of small ruminants. These are usually part of mixed infections with the barber pole worm, but unlike the barber pole worm, they are less likely to cause death. Production loss and digestive distress (diarrhea) are their more common symptoms and their effects are additive to the barber pole worm.

Tapeworms (*Monezia* sp.) are the only parasites that are visible in the feces. They are usually of little consequence, even in lambs. In fact, there is little research to support treatment for tapeworms. Liver flukes can be a problem in some geographic locations. A snail or slug serves as the intermediate host, and anemia is a symptom. It is difficult to diagnose lungworm infection in live sheep, as symptoms are similar to other disease conditions affecting the respiratory system.

Sheep are an abnormal host for the meningeal worm (***Paralaphostrongylus tenuis***). While the meningeal worm generally causes little damage to its natural host (white tail deer), when a sheep (or other abnormal host) ingests the intermediate host (terrestrial snail or slug), the parasite crosses the blood-brain barrier and causes damage to the central nervous system. Symptoms may start as simple limp or weakness in the hind quarters and escalate to complete paralysis. There is no known “cure,” but treatment protocols recommend high doses of anthelmintics and anti-inflammatory drugs.

After the barber pole worm, coccidia (*Eimeria* sp.) is probably the most costly internal parasite affecting sheep, especially lambs. Coccidia are single-cell protozoa that damage the lining of the small intestines, thereby affecting nutrient utilization. Coccidiosis is characterized by poor performance, ill-thrift, weakness, and diarrhea. Sub-clinical disease is probably the most costly.

As compared to stomach worms, different drugs are necessary to control coccidiosis. It is recommended that a coccidiostat (lasalocid or Decoquate) be included in the starter ration for lambs. A coccidiostat may also be included in the milk replacer diet. Clinical coccidiosis is treated with amprolium (Corid) or sulfa medications, both of which require extra-label drug use by a veterinarian.

While a simple fecal egg flotation (performed by most veterinarians) can differentiate among major egg types (Strongyle vs. tapeworms vs. coccidia), a larval culture must be done to determine the species of strongyle (round) worms present. The lectin staining test is a new test than can be used to determine the proportion of barber pole worm eggs in a sample.

A different fecal flotation media is needed to identify liver flukes. While lungworm larvae can be sometimes recovered in the feces, diagnosis is usually post-mortem. Since the sheep is a dead end host for the meningeal worm, no eggs are passed in the feces. Diagnosis is usually based on symptoms and case history.

Integrated parasite management (IPM)

Unfortunately, there is no simple way to control internal parasitism in small ruminants. What works on one farm may not work on another. What works one year may not work the next. There are variations ((including seasonal) in parasite life cycles. Sheep breeds and individuals vary in their ability to tolerate parasite infections.

Parasite control is further limited by the effectiveness of the anthelmintics (or dewormers). Over time, the repeated use of anthelmintics has allowed worms to develop resistance to the drugs. In some cases, a drug may not be effective enough to prevent production loss or death. Drug resistance varies by farm and is based on past anthelmintic use. Resistance tends to be more of a problem in regions that experience longer periods of warm, moist weather.

Effective parasite control usually requires an array of management practices that collectively serve to minimize the need for anthelmintic treatment. In fact, anthelmintic treatment should be seen as the last line of defense against worm parasites. While some years require more frequent

anthelmintic treatments, the need for frequent treatments should serve as a sign that management practices need to be altered to minimize treatment needs.

The most common method of non-pharmaceutical parasite control is rotational grazing. There are no set recommendations for pasture rest and rotation. The number of animal units, the length of the grazing period, and the duration of the rest period all impact the level of pasture contamination and the disease challenge. There are also seasonal differences to consider.

The use of safe pastures can minimize the amount of infective worm larvae that sheep ingest. A safe pasture is a pasture that is “free” from infective worm larvae. A pasture that has not been grazed for the previous 6-12 months by sheep (and/or other small ruminants) is considered to be a safe pasture for sheep. Newly-cultivated pasture is considered to be clean, as are pastures in which a hay or silage crop has been removed. A pasture that has been rested for several months, while lower in contamination, is not considered to be a safe pasture.

Mixed or multi-species grazing has been shown to decrease parasite loads in small ruminants and other livestock. While sheep, goats, and camelids are infected by the same worm species, cattle and especially horses are affected by different parasites. Thus, sheep that ingest worm larvae that infects cattle and horses will not be affected. At the same time, cattle and horses will help to remove the worm larvae that causes clinical infection in sheep. Multi-species grazing also improves forage utilization, as sheep and cattle have complimentary grazing behavior.

Forage type is another factor which influences internal parasitism. Some forages (e.g. *Sericea lespedeza*) contain condensed tannins (or other compounds) which have been shown to disrupt parasite life cycles, thereby reducing fecal egg counts and the need for frequent anthelmintic treatment. Sheep which browse or graze forbs or mixed swards tend to ingest fewer infective worm larvae than those which graze predominately grass pastures.

Grazing height is another important aspect of pasture management. Overgrazing (overstocking) is the primary cause of worm problems. As approximately 80 percent of worm larvae is found in the first two inches of plant growth, livestock should not be allowed to graze below 3-4 inches. Since worm larvae favor moisture, delaying grazing until after the dew has lifted in the morning may help to reduce the amount of infected larvae that are ingested.

Animals reared in confinement or dry lot usually experience fewer parasite problems. This is because grazing is the vector by which sheep ingest infective worm larvae. Zero grazing generally lacks a source of infection or re-infection. Housing sheep at night will reduce the amount of pasture contamination. Coccidiosis can still be a problem in confinement, especially if the pens are overstocked and the conditions are not sanitary.

Nutrition is an important aspect of parasite control. Animals in better body condition and on a higher plane of nutrition are better able to withstand the effects of parasite infection. Increasing protein levels to ewes in late gestation has been shown to decrease fecal egg counts. Nutritional supplementation makes the most sense when pasture or forage quality is low.

Genetics probably offers the best long-term solution to internal parasite control in small ruminants. There are two traits to consider: resistance and resilience. Parasite resistance is when an animal is able to prevent (or limit) parasite infection. It is quantified by fecal egg counts (eggs per gram of feces), which are an estimate of the worm load that an animal is carrying.

Parasite resilience is when an animal is able to remain healthy and productive, despite carrying a worm load. For the barber pole worm, it is quantified by packed cell volume (PCV), which is a measure of the percent of red blood cells in whole blood. FAMACHA© (eye anemia) scores are used to estimate packed cell volume. Dag scores and body condition scores are other important evaluation criteria for parasite resilience. Parasite resistance is a moderately heritable trait and is usually positively correlated to resilience.

There is significant variation in parasite resistance and resilience among sheep of different breeds or types. Hair sheep, of tropical origin, tend to be more parasite resistant than conventional woolled sheep. The Florida or Gulf Coast Native is a woolled breed with demonstrated resistance to internal parasites.

Of more importance to dairy sheep producers, there is also considerable difference among sheep of the same breed. According to the 80:20 (or 70:30) rule, 20 percent of the animals in a flock or herd are responsible for 80 percent of the pasture contamination. Culling animals which have consistently high egg counts and/or frequent need for anthelmintic treatment will go a long way towards reducing future parasite problems on a farm.

Anthelmintics

While numerous drug formations are available for purchase and use in sheep, there are only three chemical families which offer a unique mode of action. The three groups are 1) benzimidazoles; 2) nicotine agonists; and 3) macrocyclic lactones. Resistance to one drug is likely to result in cross resistance to another drug in the same family. Drug rotation should always be among families not individual drugs.

The benzimidazoles (white drenches) are the oldest anthelmintic family. They include fenbendazole (Safeguard® and Panacur®), albendazole (Valbazen®), and oxybendazole (Synantic®). Benzimidazoles are the only family with efficacy against tapeworms. Albendazole is labeled for the control of adult liver flukes. Widespread resistance has been reported in benzimidazoles.

The nicotinic agonists include two groups of anthelmintics. Levamisol (Prohibit®) is classified as an imidazothiazole, whereas morantel (Rumatel®) and pyrantel (Strongid®) are classified as tetrahydropyrimidines. For many farms, levamisole remains the most effective dewormer. However, it has a narrower margin of safety as compared to other anthelmintics.

The newest group of anthelmintics (though not so new anymore) is the macrocyclic lactones, composed of two sub-groups: avermectins and milbimycins. Ivermectin (Ivomec®) and doramectin (Dectomax®) are classified as avermectins, whereas moxidectin (Cydectin®) is a milbimycin. The macrocyclic lactones differ from the other anthelmintic families because they

have some effectiveness against external parasites, especially nasal bots. Persistent activity is another characteristic of the macrocyclic lactones.

Widespread resistance has been reported among the avermectins, especially ivermectin. While moxidectin will initially kill ivermectin-resistant worms, resistance is likely to develop quickly with frequent use of the drug.

When worm populations are resistant to all available drug families, a short-term strategy is to use anthelmintics from two or three chemical families. Combination treatments have been shown to have a synergic effect.

A new anthelmintic with efficacy against worms that are resistant to the currently available drugs may eventually become available to U.S. sheep producers. Monepantel (Zolvix®) represents a new chemistry and mode of action.

At the present time, no “natural” products (e.g. garlic and DE) have been scientifically proven to be consistently effective at killing worms (i.e. reducing fecal eggs and improving packed cell volume). Producers who use natural products should continue to monitor animals for signs of clinical parasitism and the need for deworming with an anthelmintic. Considerable research is being conducted in the area of natural anthelmintics and bioactive forages. Perhaps, the use of natural “anthelmintics” may serve to reduce the number of animals requiring treatment.

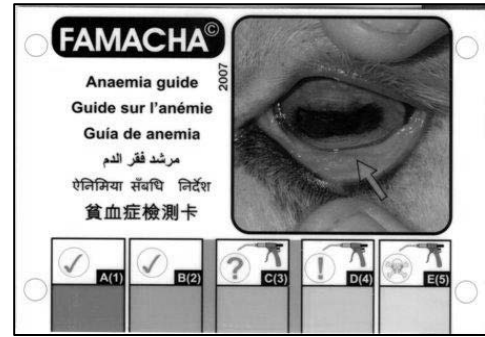
On the other hand, various scientific studies have demonstrated the effectiveness of copper oxide wire particles (COWP) as an anthelmintic for the barber pole worm. In order to use COWP as a dewormer, the cattle dose of the commercial product (Copasure®) must be repackaged into smaller doses for small ruminants. COWP should only be given to sheep showing clinical signs of barber pole worm infection (i.e. anemia and/or bottle jaw). Repeated doses could predispose sheep to copper toxicity. Some inspectors may allow COWP for use in certified organic production.

Deworming

In the past, sheep and lambs were dewormed at regular intervals with little regard for the necessity of treatment of the individual animal. Due to the widespread development of drug-resistant worms, this strategy is no longer recommended. Nor is it recommended that treated animals be moved to a clean pasture.

Instead, it is recommended that prophylactic treatments be replaced with therapeutic treatments. In other words, only animals displaying clinical signs of internal parasitism should be given an effective anthelmintic. Exceptions to this rule would include treatment of pregnant ewes to counter the periparturient rise in worm eggs and treatment of newly acquired animals with multiple drugs to prevent the introduction of drug-resistant worms to the farm.

The FAMACHA® system is an effective method of monitoring barber pole worm infection in small ruminants and identifying the animals that require deworming. A FAMACHA® card depicts varying levels of anemia. A treatment recommendation accompanies each eye anemia score. The Five Point Check® is an expansion of the FAMACHA® system that includes evaluation criteria for animals with FAMACHA® scores of 3 (no treatment recommendation), as well as other parasites, such as coccidia and the scour worms. The five evaluation points are: 1) eye, FAMACHA® score; 2) jaw, bottle jaw; 3) back, body condition score; 4) hindquarters, dag score; and 5) nose, nasal bots.



Another valuable diagnostic tool is fecal egg counting (EPG). While not a good diagnostic test for a single animal, fecal egg counts help to quantify the level of pasture contamination. They can also be used to determine the effectiveness of anthelmintic treatments. The fecal egg count reduction test (FECRT) involves taking a fecal sample at the time of anthelmintic treatment and 7 to 14 days later. An effective treatment should reduce fecal egg counts by 95 percent or more. Severe resistance exists when fecal egg counts fail to decrease by more than 60 percent.

A DrenchRite test (or larval assay) can also be used to determine the effectiveness of anthelmintics. Unlike the fecal egg count reduction test, the DrenchRite test determines drug effectiveness for all drugs using the same pooled fecal sample. It is difficult to effectively control internal parasites if the efficacy of the anthelmintics is unknown.

Sheep should always be dosed orally with drench formulations of anthelmintics. Oral drenches clear the animals' systems faster and have shorter withdrawal periods, whereas injectable dewormers leave a residual which accelerates the development of drug-resistant worms.

A syringe with a long metal nozzle should be used to deliver the drug over the tongue into the esophagus. Depositing the drug in the animal's mouth may stimulate the sucking response, which could cause the drug to by-pass the rumen (and be less effective). Dosing should be based on accurate weights. When using an automatic drench gun, the dosage should be set for the heaviest animals in the group (not the group average).

Anthelmintics which lack FDA approval for use in sheep may not be used without prior approval of a licensed veterinarian. Only a veterinarian is allowed to use drugs extra-label. Extra-label constitutes any use of a drug which is not indicated on the product label, i.e. different species or class, different dosage, or different route of administration.

None of the anthelmintics currently FDA-approved for use in sheep (Valbazen®, Prohibit®, Ivomec®, or Cydectin®) have been labeled for lactating dairy ewes. Nor has a milk withdrawal period been established. Thus, dairy sheep producers must work with their veterinarian to establish safe milk withdrawal periods.

All of the approved anthelmintics may be administered to pregnant ewes with the exception of albendazole (Valbazen®) which should not be given during the first 30 days of pregnancy or within 30 days after ram removal.

Be sure to visit the web site of the American Consortium for Small Ruminant Parasite Control at www.acsrpc.org, controlworms.org, wormcontrol.org, or wormx.org. The web site contains more detailed discussion of the topics in this manuscript.

FARM TOUR I: EVERONA DAIRY

**Pat Elliott, Owner
Everona Dairy
Rapidan, Virginia, USA**

Background

Everona Dairy has been a licensed producer of farmstead, artisanal, raw milk, and aged sheep cheese since 1998. Since there was little commercial sheep cheese production prior to 1990, we are one of the earlier producers and still the only sheep cheese producer in Virginia.

We feel very fortunate to have started when we did. Pat was, and is, a country physician, and had worked in the sheep barn at Michigan State University while getting her undergraduate degree and an MS in genetics. After she bought a Border collie puppy, she soon realized she needed some sheep for the dog. That was in 1992. A couple of years later she brought Dell, a trained, imported Border Collie from Wales, and finally it occurred to her that perhaps you could milk sheep –they are mammals, right? It sounds so naïve now!

That decision was the beginning. The original aim was to pay for the hay! We didn't know that there were more sheep milked in the world than cows. Nor did we know that sheep milk is the premium milk for cheese making as far as taste. After some searching for milking sheep, we added three ewes from Diane Kaufmann in Wisconsin and three milking Shropshires ewes and a ram from New Zealand through Annette Menhennett to the 10 Dorsets we had for the Border Collies. Then we found out about and began obtaining a series of excellent purebred rams from Peter Welkerling, a well-known Canadian breeder and proponent of dairy sheep, who lived north of Wisconsin in Canada. They were progeny from Dutch and German imports by Peter and proved to sire very high producing ewes. We purchased rams of his breeding for several years until we had a 95% -97% purebred herd which we have continued as a closed herd 1998.

Current Management Plan

Everona Dairy is a family dairy with three general divisions –production of milk, production of cheese, and marketing.

Son Brian Wentz is farm manager, daughter-in-law, Carolyn, is the cheese maker, and Pat Elliott is the marketing and business side of Everona. Emily Cross assists in all areas! Jason is our new marketing person, and Paula Stewart is everyone's secretary and first contact! We also have two milkers and several part time persons.

The Farm: Production of Milk

We are proud to do official DHIA testing and, perforce, we maintain our own sheep registry, there being no national registry yet in the United States. We have the highest or one of the highest milk production. Breeding stock is sold on the basis of the mother's production. We sell only lambs less than one year. We milk around 200 sheep, depending on the time of year and do

year round milking, drying sheep off on an individual basis depending on production. A number of ewes milk through or are dry only the last month of lactation. This practice allows us to give year round jobs to the milkers and to maximize production.

We keep a ram with the ewes and many ewes take advantage of this, producing a second lambing each year. We have practiced only natural breeding and have found many of our Friesians will breed freely year round –one I remember produced 8 lambs in a few days under 2 years! Ewe lambs are breeding at 5-6 months and have their first lamb(s) at a year. We prefer to do our maximum lambing in late December through February this practice gives us greater year round production and freedom from flies at lambing. Disadvantages of winter lambing are that ewes need closer monitoring to prevent losses of new lambs from chilling and that newborns need a heat lamp or other ways to keep them warm.

We practice day 1 weaning to bottle after colostrum and hand feed all lambs in pens of 10 so we can monitor intake closely to eliminate bloating and monitor health. We gradually add whey to the milk replacer. We do not dock or castrate males and feed them separately from the ewe lambs, depending on their planned use.

Emily Cross, our lamb mother, is responsible for most of the sales of breeding stock –she carefully monitors and records each lamb’s health and correlates records with the milk production of its mother and other relatives this information is available to prospective buyers of breeding stock. Incidentally, all our animals are pretty friendly since they are handled (and talked to) a lot!

The Creamery: Production of Cheese

The cheese is the focal point of our operation. Carolyn and her helpers usually make the cheese as soon as the morning milking is finished. We have developed about 40 kinds of cheeses to meet people’s individual tastes and desire for “something new”. Our new creamery with a viewing window from the store to the make room, with underground “caves” beneath it has made the process smoother for her.

Sanitation and cleanliness are the biggest focus in the creamery, taking precedence over everything else. We are inspected regularly by the state and Carolyn is a daily vigilante on everything from milk quality on to the finished product that goes out the door. We are proud of her excellent cheeses, of the prizes she has won and the way the creamery looks. We also enjoy her coming up with new cheeses –she comes in with a “here, try this” --customers always like something new!

Besides the cheeses, we make other items to serve with cheese—membrillo, butter crackers, lamb charcuterie.

Cheese Sales: Office and Marketing

We sell all over the United States to distributors, wholesalers, restaurants, wineries, and individuals including a number of farmers markets. Marketing is through visits, phone contact,

email, social media, newsletters, our web site, demonstrations, talking! Word of mouth and sampling are two of the best methods! Most cheese is sold as whole wheels though we vacuum pack cheeses for the retail market.

Pat (owner), Paula (secretary), sometimes Emily, are the people you talk to for information and when ordering. We handle all the details involved in getting the cheese to the right place on time, advertising, information, etc., It is the 3rd leg of a farmstead operation that keeps a close eye on the whole process from lamb to cheese consumer.

We are always interested in sharing what we have learned. You can call anytime with questions! The phone number for Everona Dairy is 540-854-4159, the email is Everona@hughes.net

FARM TOUR II: SHEPHERDS MANOR CREAMERY

**Colleen and Michael Histon, Owners
Shepherds Manor Creamery, LLC
New Windsor, Maryland, USA**

Shepherds Manor Creamery has been an eight year project in the making and a dream for most of our entire married life. Michael and I moved from the suburbs of Washington, D.C. to Mt. Airy in 1989. Our children, Anne Marie and Matthew were only 5 and 6 at the time. We had absolutely no agricultural background. But it was our dream to live in the country and raise our children in a better atmosphere than suburban life had to offer, to give them the challenge of possibly possessing an active role in 4-H life to the extent of wherever it would lead. We, at the time had no idea the direction this exposure would take us!

We contacted our local extension office and made contacts with farmers who had market sheep wherein we purchased our first 4-H projects. We went on to raising market lambs, breeding meat lambs, market steers, breeding heifers, and market pigs. Over the years our children were very active in their 4-H clubs and in FFA in High School. They were genuinely enriched by this background and we remained in Mt. Airy for 21 years on a modest 2 ½ acre farmette.

Over the years, the benefits we gained, and our children gained, and the others whose lives we influenced, became the fuel we needed to begin such an almost mind boggling adventure! Most everyone in our circle of life could not comprehend this idea that we were proposing!

In 2004, Michael and I travelled to St. Helena, California, a small town 30 minutes outside of Napa Valley where my sister lived. We visited a farmer's market and Michael spoke with a local farmer and cheese monger that day. They discussed market lambs and farming in general. The cheese monger told Michael that he should consider selling all our meat lambs and going into the sheep dairy business. He said that the United States imports 99% of its sheep's milk cheese and there would be quite a market for the product! As a matter of fact, he vowed to buy every bit of cheese we would produce! We tossed the idea around on the airplane ride home but quickly put it away. Unbeknownst to me, though, Michael kept the thought in his mind and started doing some research. We had always talked about how neat it would be to own a cow dairy but we just couldn't manage the thought of milking 365 days a year or the financial burden of not growing up in the business and inheriting a way to finance this type of farm.

Two years later, we visited my sister again and went to the same farmer's market with the same farmer and cheese monger still selling products...only to have the cheese monger recognize Michael and yell out to him from across the way "Hey, are you milking those sheep yet?" This time he offered Michael six different types of sheep's milk cheese to sample, explaining the differences. The plane ride home this time led to a much more serious discussion regarding the ideas and once again Michael did more research on the subject.

In the spring of 2008, Michael and I travelled to New Jersey and visited one of the largest sheep dairies on the East Coast. We purchased a few ewe lambs in May from Pat Elliott to start

with, knowing we needed a larger flock eventually. We still lived in Mt. Airy and at this point knew we had to find a real farm. We contacted Tom and Laurel Kieffer in Wisconsin after a Google search found me emailing them and Tom responding to my inquiry right away. We made a plan to purchase a used 5th wheel truck, borrow a friend's trailer, and drive to Wisconsin over Labor Day Weekend (18 hrs each way). It was a crazy plan and it almost worked. On the way home on Sunday we broke down three times in this newly purchased truck and ended up with the last breakdown three hours from home and hiring two separate tow services, one for the truck and one for the trailer! I honestly could not believe this was happening to us, but as I sat on a curb, at the last breakdown shaking my head asking why...Michael could only say that this was a test, a test that if we got through this challenge, we could make it through anything! Well, we were challenged time and time again and we made many more road trips over the following months...a trip to view and then a very long day trip to Pennsylvania to disassemble and load a cow cheese dairy setup, another weekend trip to Vermont to view and then again to purchase, disassemble, load, and bring home a small sheep dairy cheese setup. The truck broke down once again on the way out of Vermont with the dairy equipment and stranded us for a few hours but we made it home just a little later than we planned! It was not an 18 hour trip turned into 38 hours with a load of sheep in 90 degree heat! We actually took it in stride after what we had previously endured! But I vowed that day to never leave Maryland again in that truck! We travelled to Vermont the following Jan and Feb for two full weeks of classes at the VIAC and then again overnight to Tennessee to purchase a ram. Each time the opportunity arose that fit our immediate and future needs for the dairy, whether educational or for equipment, it became just second nature to say here we go again...another road trip!

That first winter the sheep were housed in our backyard for 8 months, lambing out the following spring, with really wonderful neighbors supporting our efforts! We rented property around the corner and spent that winter putting up fence and building a lean-to building. We moved the ewes with their lambs in May to the property. It was quite a relief!

We purchased the farm in October of 2009 and spent 2 ½ months working on the interior. We moved on January 2, 2010. Our lambs, however, remained back in Mt. Airy until we were finally able to bring them to the farm in March of 2010. We were please to finally have them on the farm to lamb in their new home! It was then time for the dairy to evolve!

Michael and I designed the layout of the building. We had to build it in two sections as our Mt. Airy house had not sold yet with the Real Estate market and the economy being in a difficult position. So we contracted for the shell of the dairy and did the interior ourselves. We hired a plumber, electrician, and refrigeration person. It was a very slow process.

We lambed in March of 2011 but we were not finished the dairy building until mid May. So the lambs remained with their mothers until that time, approximately 2 -2 ½ months. We began milking but only once per day for the whole summer. I made 200 wheels of cheese. We did not receive our license to produce and sell cheese until August. With only one month left of the season and very little milk, I produced only a few wheels to actually sell, but it was a good start! The greatest moment was the evening we tasted the first aged slice of our Tomme Cheese. It looked and tasted just like we had hoped!

This year, 2012 has been our first true season. We once again lambed in March but still left the lambs with their mothers for 30 days. We separated 20 the first week, 10 each week thereafter till we had 50 in the parlor, milking twice per day. Cheese was made in the evening and weekend days. Michael and I still work full time jobs! Each day began at 3 am with me going back down to the house at 5:30 to shower and make the hour commute to work. I came home each day at 4:00, making cheese every three days and doing affinage on the other two. I ended this year's season with 500 wheels of cheese. I added a new product to the farm - sheep's milk soap. We found that there was a bit of milk wasted after each milking and instead of allowing it to go down the drain we captured it for soap making. I have made approximately 750 bars of soap.

Keeping the farm chores up this year has been quite the challenge as well, but we have managed with perseverance. It seems that there is never enough time! The best we can do is repair only that which hinders the production of our products or affects the life of our flock. The rest, we have learned will wait till season's end!

Marketing the cheese has been a slow process as well mainly because of time restraints! But it is evolving day by day. We have visited local wineries, some restaurants, given lectures, and conducted tours. The word is getting out... so I am confident it is only a matter of time!

We are still learning many lessons as we go along. The biggest lesson this year has been the importance of high quality feed for our milking ewes. There is a huge difference in the quantity of milk a ewe produces on high quality protein feed vs. lower quality protein feed.

We have been asked to share our story from time to time. I have been approached by young and eager men and women looking to consider this business asking my thoughts and advice. Michael and I have survived despite the many obstacles we have faced, from government regulations to a difficult economy, to low personal capital, to challenges of raising animals, to weather conditions, to multiple locations raising our flock, to just about everything! We have learned every lesson the hard way. So when approached by someone who wants to consider this business, my comment is simply this: if you are willing on a 20 degree day in the pouring down rain to stand outside soaking wet and freezing cold with frostbitten hands and wet feet, cleaning a pen or feeding your sheep or doing whatever is necessary to shepherd your flock, then you have the passion and tenacity it takes! Your battle is three quarters won and I say yes you can do this too!

Today, with so much behind us now, so many obstacles tackled, so much accomplished, we are reaping the rewards of that circle of skeptics that no longer flourishes around us! Instead we find people's heartfelt praise. We have appreciated all of the help we received along the way. We have given a lot to this venture, but we did not do it alone! We are grateful for those who, although wondered if we would ever really meet our goals, have been with us, and helped meet each challenge along the way, and who now beam smiles of seeing this monumental undertaking at its completion!

We praise the farmer for his hard work, his drive for a lost occupation, an occupation of only a few percent of the world's population, responsible for feeding the rest of the people who

inhabit this earth! Farming is a hard, but enriching lifestyle. It is not glamorous and it is not popular, but it is self rewarding and it brings the very core of one's human self back to the very essence of our natural existence. Our city friends live life in cars, office buildings, on cell phones, in front of televisions and on computers... We, on the other hand walk the path of a quieter existence, noticing the sunrise when we come out of the parlor at daybreak, hearing the birds, seeing the dew on the grass, listening to the sounds of our content lambs as they rest in the barn...and another day moves forward...

Michael and I look forward to a bright future, working side by side, tending our flock, making great cheese and educating the young and old! It takes passion and drive to continue forward, to persevere, and to succeed! The more mistakes we make, the more lessons we learn, the better we become.

Colleen

**Recipients of the William J. Boylan Distinguished Service Award
(The DSANA Distinguished Service Award prior to 2009.)**

- 2003 – David Thomas, Madison, Wisconsin, USA – Dairy sheep researcher
- 2004 – Daniel Guertin, Stillwater, Minnesota, USA – Dairy sheep producer
- 2005 –
- 2006 – Pat Elliot, Rapidan, Virginia, USA – Dairy sheep producer and artisan cheese maker
- 2007 – Tom and Nancy Clark, Old Chatham, New York, USA – Dairy sheep producers and sheep milk processors
- 2008 – William Wendorff, Cross Plains, Wisconsin, USA – Sheep milk processing researcher
- 2009 – Yves Berger, Spooner, Wisconsin, USA – Dairy sheep researcher
- 2010 – Eric Bzikot, Conn, Ontario, Canada – Dairy sheep producer and sheep milk processor
- 2011 – Tom and Laurel Kieffer, Strum, Wisconsin, USA – Dairy sheep producers

Locations and Chairs of the Organizing Committees of Previous Symposia

- 1995 – 1st Great Lakes Dairy Sheep Symposium – Madison, Wisconsin, USA
Yves Berger – Chair
- 1996 – 2nd Great Lakes Dairy Sheep Symposium – Madison, Wisconsin, USA
Yves Berger - Chair
- 1997 – 3rd Great Lakes Dairy Sheep Symposium – Madison, Wisconsin, USA
Yves Berger – Chair
- 1998 – 4th Great Lakes Dairy Sheep Symposium – Madison, Wisconsin, USA
Yves Berger – Chair
- 1999 – 5th Great Lakes Dairy Sheep Symposium – Brattleboro, Vermont, USA
Carol Delaney - Chair
- 2000 – 6th Great Lakes Dairy Sheep Symposium – Guelph, Ontario, Canada
Axel Meister - Chair
- 2001 – 7th Great Lakes Dairy Sheep Symposium – Eau Claire, Wisconsin, USA
Yves Berger - Chair
- 2002 – 8th Great Lakes Dairy Sheep Symposium – Ithaca, New York, USA
Michael Thonney - Chair
- 2003 – 9th Great Lakes Dairy Sheep Symposium – Québec, Québec, Canada
Lucille Giroux - Chair
- 2004 – 10th Great Lakes Dairy Sheep Symposium – Hudson, Wisconsin, USA
Yves Berger - Chair
- 2005 – 11th Great Lakes Dairy Sheep Symposium – Burlington, Vermont, USA
Carol Delaney - Chair
- 2006 – 12th Great Lakes Dairy Sheep Symposium – La Crosse, Wisconsin, USA
Yves Berger - Chair
- 2007 – 13th Great Lakes Dairy Sheep Symposium – Guelph, Ontario, Canada
Eric Bzikot - Chair
- 2008 – 14th Great Lakes Dairy Sheep Symposium – Maryville, Tennessee, USA
Claire Mikolayunas - Chair
- 2009 – 15th Great Lakes Dairy Sheep Symposium – Albany, New York, USA
Claire Mikolayunas - Chair
- 2010 – 16th Great Lakes Dairy Sheep Symposium – Eau Claire, Wisconsin, USA
Claire Mikolayunas - Chair
- 2011 – 17th Great Lakes Dairy Sheep Symposium – Petaluma, California, USA
Cynthia Callahan – Chair
- 2012 – 18th Dairy Sheep Association of North America Symposium – Dulles, Virginia, USA
Laurel Kieffer - Chair



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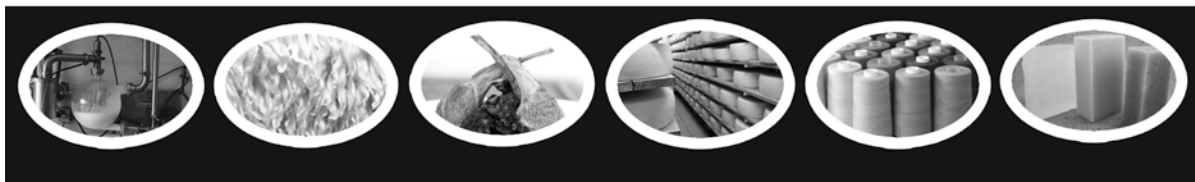
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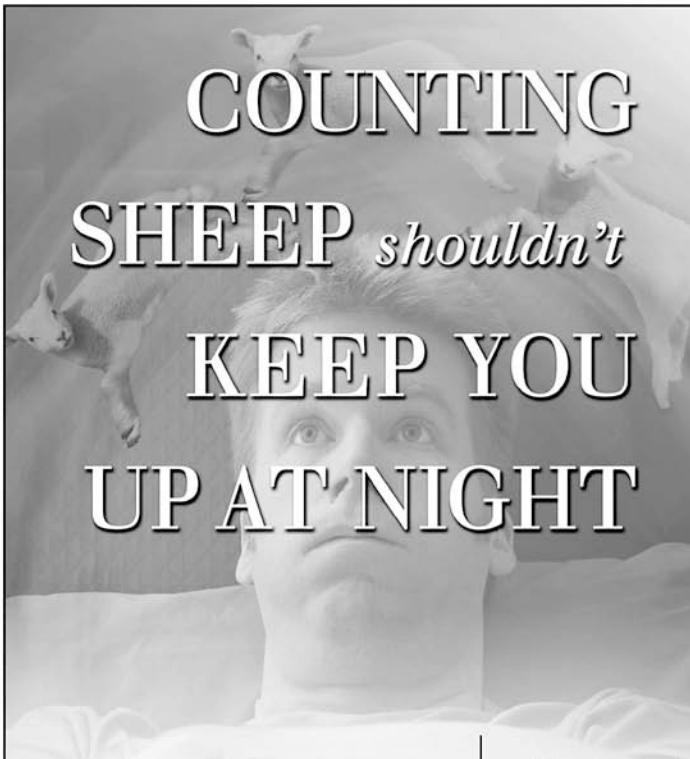
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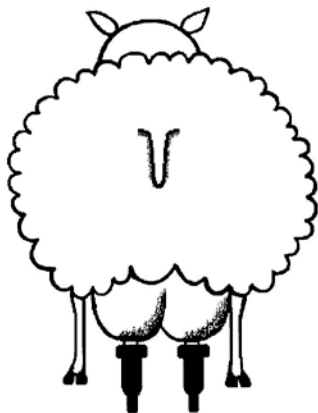


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