

*Proceedings of the 20<sup>th</sup> Annual*

**DAIRY SHEEP  
ASSOCIATION  
OF NORTH  
AMERICA  
SYMPOSIUM**



**November 4 - 7, 2014  
Chehalis, Washington, USA**



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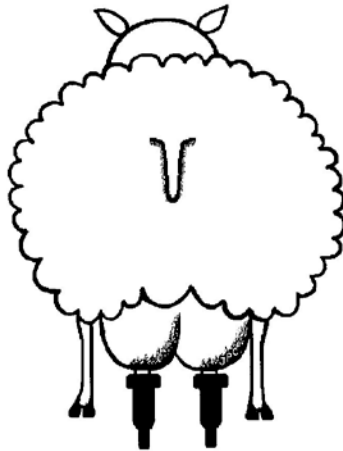
***DAIRY SHEEP ASSOCIATION OF  
NORTH AMERICA SYMPOSIUM***

November 4 - 7, 2014

Red Barn Studios  
Chehalis, Washington, USA

**Organized by:**

Dairy Sheep Association of North America (<http://www.dsana.org/>)



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(top to bottom)

Learning the milking routine early, Willapa Hills Farmstead,  
Chehalis, Washington, USA

Dairy ewes on high desert range in eastern Oregon, Terry Felda,  
Ione, Oregon, USA

Wild flower on range in eastern Oregon, Terry Felda, Ione,  
Oregon, USA

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## Program of Events

### Tuesday, November 4, 2014

**Advanced Cheese Making Course**, Black Sheep Creamery, 345 Bunker Creek Road, Chehalis, Washington (additional registration fee) – Gianaclis Caldwell, Artisan Cheesemaker and Author, Pholia Farm Creamery, Rogue River, Oregon, USA

### Wednesday, November 5, 2014

8:00 a.m.     **Registration**, Red Barn Studios, 207 Goff Road, Chehalis, Washington, USA

8:45 a.m.     **Welcome**, Michael Histon, President, Dairy Sheep Association of North America, New Windsor, Maryland, USA

9:00 a.m.     **Grazing Management: Principles and Rules of Intensive Grazing** (Choose between 1 of 2 concurrent sessions)  
Dr. Woody Lane, Livestock Nutrition and Grazing Consultant, Lane Livestock Services, Roseburg, Oregon, USA

9:00 a.m.     **Hands-On Beginning Cheesemaking** (Small additional fee; Choose between 1 of 2 concurrent sessions)  
Gianaclis Caldwell, Artisan Cheesemaker and Author, Pholia Farm Creamery, Rogue River, Oregon, USA

10:30 a.m.    **Break**

10:45 a.m.    **Continued - Grazing Management: Principles and Rules of Intensive Grazing** (1 of 2 concurrent sessions)  
Dr. Woody Lane, Livestock Nutrition and Grazing Consultant, Lane Livestock Services, Roseburg, Oregon, USA

10:45 a.m.    **Continued – Hands-On Beginning Cheesemaking** (Small additional fee; 1 of 2 concurrent sessions)  
Gianaclis Caldwell, Artisan Cheesemaker and Author, Pholia Farm Creamery, Rogue River, Oregon, USA)

Noon           **Lunch and Keynote Speaker**  
Clint Krebs, Sheep Producer, Krebs Livestock Company, Ione, Oregon, USA and President, American Sheep Industry Association, Englewood, Colorado, USA

1:30 p.m.     **Grazing Management: Individual Grazing Plans**  
Dr. Woody Lane, Livestock Nutrition and Grazing Consultant, Lane Livestock Services, Roseburg, Oregon, USA

3:00 p.m.     **Break**

3:30 p.m.     **bioTRACK – A Record Keeping System for Dairy and Meat Sheep**  
Terry McNeely, Ruminant Lead, BIO, Guelph, Ontario, Canada

**Wednesday, November 5, 2014 (continued)**

- 4:30 p.m.     **Wednesday Educational Program Ends**
- 6:00 p.m.     **A Culinary Celebration of North American Artisanal Sheep Milk Cheeses**  
Cheese, wine, and hard cider reception open to all symposium attendees.

**Thursday, November 6, 2014**

- 8:30 a.m.     **Registration**, Red Barn Studios, 207 Goff Road, Chehalis, Washington, USA
- 9:00 a.m.     **One-on-One Feedback and Reviews on Your Cheeses** (sign-up at the registration desk for a time)  
Gianaclis Caldwell, Artisan Cheesemaker and Author, Pholia Farm Creamery, Rogue River, Oregon, USA
- 9:00 a.m.     **Extend the Grazing Season with Irrigation, New Forages, and Renovation**  
Dr. Woody Lane, Livestock Nutrition and Grazing Consultant, Lane Livestock Services, Roseburg, Oregon, USA
- 10:00 a.m.    **Break**
- 10:30 a.m.    **Continued - Extend the Grazing Season with Irrigation, New Forages, and Renovation**  
Dr. Woody Lane, Livestock Nutrition and Grazing Consultant, Lane Livestock Services, Roseburg, Oregon, USA
- Noon         **Lunch**
- 1:00 p.m.     **Milk Quality and Dairy Hygiene**  
Gianaclis Caldwell, Artisan Cheesemaker and Author, Pholia Farm Creamery, Rogue River, Oregon, USA
- 2:15 p.m.     **Management of Large Sheep and Goat Dairies in Europe**  
Yves Berger, Sheep Researcher - Retired, Spooner Agricultural Research Station, University of Wisconsin-Madison, Spooner, Wisconsin, USA
- 3:15 p.m.     **Break**
- 3:30 p.m.     **Research Update from the Spooner Agricultural Research Station**  
Dr. David L. Thomas, Professor, Sheep Management and Genetics, Department of Animal Sciences, University of Wisconsin-Madison, Spooner, Wisconsin, USA
- 4:30 p.m.     **Thursday Educational Program Ends**

**Thursday, November 6, 2014 (continued)**

6:30 p.m.     **Banquet and Annual Meeting of the Dairy Sheep Association of North America** (separate fee for the banquet)  
Jeremy's Farm to Table Restaurant, 576 W. Main Street, Chehalis,  
Washington, USA

**Friday, November 7, 2014**

8:00 a.m.     **Farm Tours and Other Activities**, Leave in private cars from Holiday Inn  
Express, Chehalis, Washington, USA

**Black Sheep Creamery**

Brad and Megan Gregory, 345 Bunker Creek Road, Chehalis, Washington,  
USA

**Lunch**

**Willapa Hills Farmstead & Artisan Cheese**

Stephen Hueffed and Amy Turnbull, 4680 State Route 6, Chehalis,  
Washington, USA

**Dairy Ewe Nutrition**

Dr. Michael L. Thonney, Professor, Ruminant Nutrition, Department of  
Animal Science, Cornell University, Ithaca, New York, USA

4:00 p.m.     **Return to Holiday Inn Express, Chehalis, Washington and Symposium  
Concludes**



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

# PRINCIPLES AND RULES OF INTENSIVE GRAZING

Woody Lane  
Lane Livestock Services  
Roseburg, Oregon, USA  
www.woodylane.com

## Opening A Door

Spring in Douglas County, Oregon: the hills are a vibrant, rich green, as green as the fabled Irish countryside, and the valleys are filled with a lush carpet of grass and clover growing at 80 lbs. per day or more . . .

Huh? Isn't forage growth measured in inches? Well . . . not here, not during the grazing season. Inches are too imprecise; inches don't give us information about forage density, maturity, or carrying capacity; and inches can't be applied to anywhere else. Also, animals eat *pounds* of feed, not inches. *Pounds* are the numbers we need for good grazing decisions. So let's look at forage management in a new way — by the numbers.

Whenever we want to formulate a grazing plan for a specific paddock, *before we put the animals on it*, we should always do one thing first — we should estimate how much forage is really out there. This is not hard. Just take a sample (or a few samples, as defined by your time and energy). Here, we use a simple wooden frame, two feet long and one foot wide (inside diameter). We place the frame on the ground and cut off everything inside it with a pair of hand-shearing blades. Right to the ground. Then we weigh the sample, dry it in a regular oven or microwave until it is dry, and weigh it again. We stop drying it when its weight stabilizes, which occurs after a few hours in a warm oven (but not too hot and not overnight), or after an initial 5-minute period in a microwave plus successive 2-minute periods. Remember to put an open glass of water in the microwave. A tip: first warn the rest of the family about your intentions. The fragrance of drying forage should not catch them by surprise.

Our sample gives us the total amount of forage dry matter in two square feet. For example, if our dried sample weighs 0.16 pounds (we may actually use a gram scale, convert to pounds, and correct for the weight of the paper bag. Everyone does it slightly differently), this equates to 0.08 lbs/square foot ( $= 0.16 \div 2$ ). This is a nice value but not really very useful, unless we are raising a herd of slugs. But since an acre contains 43,560 square feet, we can convert this number to a total dry matter per acre of 3,485 pounds ( $= 43,560 \times 0.08$ ). Now *that's* a number that we can use.

It's a good beginning. Now we must adjust this value for the realities of grazing, because we never let our animals eat *all* the grass in a paddock, not unless we want to batter our fields into a desert. Generally, we open a gate, allow the animals into a paddock, and then pull them off when they graze it down "low enough." This leftover "residual forage" is the amount remaining when the animals leave.

So now we have a fundamental equation for grazing: *the amount of forage available to our grazing livestock is the difference between the total forage and the residual forage*. This amount is called, not surprisingly, the “*available forage*.” Therefore, good grazing management is quite simple: we just need to measure the total mass, decide on the residuals, and let the sheep and cattle do the rest. There are, of course, a *few* other details . . . but we’ll get to some of them later.

Let’s return, for a moment, to our much-maligned height measurement, because height is what we see. In New Zealand, where farmers have made a few zillion measurements on forage height and mass, they’ve devised a general rule-of-thumb for their type of pasture: the lowest inch of forage contains approximately 1,000 pounds of dry matter per acre, and every additional inch contains 500 pounds (translated from the metric). Now don’t rush off to take those height measurements just yet — remember *that those numbers apply only to a very specific type of pasture managed in a very specific way*. Those numbers were derived from well-managed New Zealand pastures composed of perennial ryegrass and white clover, pastures which are very dense, heavily fertilized, and intensively grazed.

Frankly, very few pastures in North America are like that. Our pastures often differ in forage species, grazing management, and fertilizer use. The New Zealand rule-of-thumb, however, gives us a handle, a rough idea about a possible relationship between forage height and forage mass.

We’ve checked the accuracy of this relationship here in Douglas County, in western Oregon. Many of our improved pastures seem to average 800/300 — that is, 800 pounds in the first inch and 300 pounds for every inch above that. Eight inches of forage clearly means different things in different places: 4,500 pounds/acre on lush New Zealand-type pastures and 2,900 pounds/acre on many local pastures.

Why? Well, our local pastures contain more than perennial ryegrass and white clover. They also contain orchardgrass, tall fescue, bentgrass, subclover, foxtail, and an occasional thistle or two — and these species have different growth forms than perennial ryegrass. Also, we haven’t fertilized our pastures as heavily or grazed as tightly as many New Zealand farmers, so our swards aren’t as dense. This 800/300 relationship is only a general average, however, and there is quite a bit of variation. Some pastures probably range from much less than that up to, in the very best swards, nearly 1000/500.

So what does this mean? Simple. Pasture weights give us information about forage density and growth. Weight (mass) values allow us to discuss pasture management intelligently with *anyone* in the world and learn from *their* management. For example, if I hear that a successful Irish sheep farmer puts his lactating ewes onto a perennial ryegrass paddock at 3,500 lbs/acre and aims for a residual of 1,200 lbs/acre, I know exactly what he did. I also can assess his management in terms of my own pastures.

And more than that — with those weight numbers, I can infer how he managed his livestock, what grazing options he faced in that paddock, and how that sward may respond to the next grazing cycle. Compared to that, inches, ahem, just don’t measure up.

## Animals And Acres

In every grazing workshop, someone asks, “How many sheep can I put on my pasture?” Or “How much space does my flock need for grazing?” Or “How long can my flock graze in a 10-acre field?”

These are really all variations of the same question. Let’s discuss two principles of pasture growth and then describe a method for calculating a reasonable answer.

Principle #1: Forage grows in stages. When grasses and clovers first come out of the ground, the tiny plants spend their time and energy collecting sunlight, transporting sugars down to the roots, and constructing more solar panels, which we call leaves. Because young plants only have a couple of scrawny leaves, this process takes time. Once enough photosynthetic machinery is in place, however, the carbohydrate assembly line kicks into high gear. Then, with enough sunlight and root-supplied nutrients, these plants make lots of sugars and protein, build more leaves, and grow profusely. Finally the forage plants become tall enough to shade out their lower leaves, which die. New plant growth then just about equals senescence, so the net effect is little or no additional high quality tissue. From a graziers perspective, those plants may be healthy but the pasture is actually gaining very little nutritional mass.

These stages, or “phases,” are called *Phase I, Phase II, and Phase III*. For any pasture, we can identify the phase by measuring the amount of dry matter in an acre. As I described last month, pasture height is not the best measure of growth. We really need to describe a pasture in terms of pounds of dry matter. Pastures with less than 1,000-1,200 lbs/acre are in Phase I. Pastures containing more than 3,500-4,000 lbs/acre are usually in Phase III. Everything in between is Phase II.

These are rough estimates, of course. Different types of pastures have different numbers. Height can be misleading. Species that specialize in prostrate growth — like Kentucky bluegrass, Gala grazing brome, and some varieties of white clover, birdsfoot trefoil, and perennial ryegrass — contain more of their biomass in the lower inches of growth than upright forages like tall fescue, orchardgrass, and Ladino clover.

Phase I is a preparatory phase, a lag phase. Plants in Phase I are highly nutritious, but their growth is very slow. Phase II is the grow-like-gangbusters phase. Plants in Phase II are large and robust and still have high nutritional value. Phase III is the inefficient, too-tall-for-good-grazing phase. Hay is almost always Phase III forage. But the initial questions were about grazing, which is definitely not the same as making hay.

In a system of sustainable, controlled grazing, we’d ideally like to keep our pastures oscillating between the high and low ends of Phase II. If possible, we should put animals into a paddock *just before* the plants reach Phase III and take them off *just before* the plants are reduced to Phase I.

Principle #2: My “Five Day Rule”: Don’t keep animals in a tightly fenced paddock for more than five days. Reason? Because grazing animals eat the most delectable forages first. Consider

some of the new, improved forage varieties — bred for palatability and quick growth. Five days after they are munched, if given water and nutrients, these plants will begin to send out new shoots. These are *precisely* the forages that we want in our pastures. But if our sheep are still inside that paddock, what do you think that they will eat? Animals spend all day searching for those new shoots. Yummy! But re-defoliating plants so quickly puts them under severe stress, which ultimately exerts a steady selection pressure *against* the very species that we want to encourage. The answer is really simple: move livestock *before* they can eat those new shoots.

Now the main question: how large an area for our sheep? Let's approach the problem in discrete, logical steps: How many sheep are in the mob? How much do they weigh? How much do they eat (dry matter intake – DMI)? And how much forage dry matter is available for grazing? Then we match the answers, find a balance, and stir in the 5-day constraint.

Our hypothetical flock consists of 25 adult Targhee ewes and their month-old lambs, mostly twins. Let's guess that the ewes weigh approximately 175 pounds. A reference table in the SID Sheep Production Handbook lists an expected DMI at 6.6 lbs, which is 3.8% of their body weight. But that DMI is based on feeding some grain. In reality, I would expect that ewes on pasture would consume (and also stomp and soil) approximately 5% of the body weight, or maybe even 6%. Let's use 5% for this example, which means that the total daily DMI of the entire flock, including stompage, would be 219 pounds ( $= 25 \times 175 \times 0.05$ ).

On the pasture side of the equation, our field contains smooth brome, orchardgrass, and white clover, with 2,800 lbs of total dry matter per acre. We'd like to move the sheep off the pasture at the low end of Phase II, so let's decide to leave a residual of 1,200 lbs. By subtraction, therefore, our pasture contains 1,600 lbs of available dry matter. If our ewes use 219 lbs/day, one acre of this pasture will last the flock 7.3 days ( $= 7$  days, 7 hours, 20 minutes, and 30 seconds). This is longer than our 5-day rule. One acre, therefore, is clearly too large.

In five days, our sheep would use 1,095 lbs of DM ( $= 5 \times 219$ ), which is available from 0.68 acres of pasture. But if we wanted to move our sheep after only 3 days (more reasonable) and still leave 1,200 pounds of residual, then our flock would need only 657 lbs of DM ( $= 3 \times 219$ ), which equates to only 0.4 acres. For a three day movement, that's where we could put our fence.

Pasture management: fire up the calculator, move fence, and watch the sheep graze. But one word of warning: although your attention may be focused on pasture weights and grazing areas, just remember that before you move the electric fence, first turn it off.

## **Regrowth**

When I teach my producer course on pasture management and get to the topic of grazing, the ranchers ask very practical questions, such as: When should I open the gate to let the animals into a field? When should I move the animals off? How long is too long?

These questions and their permutations may be endless, but the principles they invoke are not. So here, very briefly, is one critical principle of good grazing.

(An important disclaimer: Here I'm talking about *improved* pastures, or at least *improvable* pastures. Grazing livestock in open range country is a different universe entirely.)

*Critical Principle: My 5-Day Rule.* Have you ever carefully watched grass grow? *Really* watched it? Let's say that you have a pasture with good fertility and water, containing forage that has excellent genetics for rapid recovery and high growth rate. After animals graze this forage (or after equipment cuts it) — how many days pass before you can see the little bright green shoots of new regrowth? Hmm. Well, next time look carefully. In my fields, I've seen that bright young regrowth within 4–5 days.

Now let's think about this. If a sheep or goat or cow is still wandering around that field looking for something to eat, and it comes across these bright green new shoots — what will it graze? Will our animal choose to avoid this new vegetation and instead munch on some older grass, or will it happily graze our new shoots and look for more? The answer is obvious.

But let's pursue this concept a little further. When our grazing animals preferentially select these new shoots, they are effectively putting selection pressure *against* the very plants that we *want* in our pasture — i.e. the valuable forage plants that send up new palatable growth quickly after defoliation. In addition, that new regrowth may come from plant reserves, and this type of grazing management systematically lets our animals destroy those reserves before the plants can recover. And if we allow our animals to do this for weeks or months, then the only forages in those fields that will thrive will be plants with slower regrowth and lower palatability, and also awful non-forage weeds like thistles and toxic plants that are *really* less attractive to our livestock.

Hence my 5-Day Rule: *Do not keep animals in a paddock for more than five days.* Fewer days is usually better — but that choice depends on the management details in each farm or ranch. Dairy farmers, for example, move animals twice each day anyway, so for them a 12-hour move makes sense. Graziers with other species of livestock may move animals every 1–4 days based on their specific production system and their strategies for managing time and labor. But never more than five days.

In other words, *we should always protect the forage regrowth in a pasture.* I repeat: we protect the regrowth. As good graziers, we should become fanatical about protecting the regrowth. And a grazing period of five days or less gives us a management tool to do this.

A 5-Day Rule implies lots of things, especially about some traditional approaches to grazing. First, look at any classic textbook on forages — such as the books assigned to university students for their agronomy courses. Those textbooks list all types of grazing techniques, each carefully named and defined (which students must memorize and repeat on exams), like “creep grazing” and “forward creep grazing” and “first-and-second grazing” and “put-and-take grazing” and “multi-species grazing” and others.

But in light of our 5-Day Rule, all these grazing techniques, all this memorized jargon, comes down to this: *animals should be off the field within five days.* Period. It's all about regrowth. No matter which livestock species we use, or how we select their subgroups, or how skillfully we

design the sequences for one subgroup to follow another — the basic axiom is that everyone must be off that field before the plants begin any significant regrowth.

And when we keep this principle in mind, all the various grazing techniques actually become variations of the same theme. Sure, we can graze the lighter animals first and then follow up with heavy breeding stock. Or design a clever creep-grazing system which allows very young stock to graze ahead of their mothers. Or top off a pasture with one mob and then “clean it up” with a follow-up mob. Etc., etc.

Even the popular concept of multi-species grazing falls neatly under the same principle. Start with sheep, follow with cattle. Or start with cattle, follow with chickens. Or start with goats and follow with sheep. Whatever. Just get the last group of animals off the field within five days. The rest are just details and preferences.

Which brings us to the important concept of *set-stocking*. Most folks think they know about set-stocking — that it’s a type of grazing management in which animals are left in a field for a hundred years and they demolish all the forage. While that might be true, it’s not quite the full story. Viewed in the light of our 5-Day Rule, the concept of set-stocking takes on a whole new and insidious meaning. *Set-stocking really means that animals will consume young regrowth.* Which means that set-stocking isn’t only defined by weeks or months on the same field, but rather it can be defined by days — a few extra days that allow animals the opportunity to eat our field’s most valuable forage, its regrowth.

Which means that set-stocking can actually occur on a fertile pasture in only seven days. Which implies that forages can be damaged by leaving livestock on them a few extra *days*, not just the classic weeks or months that most people think.

But, you say, my field is too big! It takes my flock (herd, mob, pod, etc.) at least 14 days to graze all the forage in that field!

Actually, there is a straightforward answer to this problem: *electric fencing*. Set a temporary electric fence across that field to reduce its size. Aim for a size that allows the animals to consume the feed in only 3–5 days.

Where to put that fence? Well, first estimate the available amount of feed in the entire field. Then estimate the amount of feed needed by the livestock per day — as a rule of thumb use a dry matter disappearance of 4-5% of body weight per day. Then position the temporary fence to give the animals  $X$  days of feed, where  $X$  is a number of 5 or less.

In other words, you will *allocate* feed and then set the fence so your animals will harvest that amount of feed in a few days. If you estimate wrongly, you’ll either run out of feed early or have too much feed remaining after five days. In either case, you will have learned about feed allocation, and you will set the fence better the next time. Not bad — a win-win situation. And eventually your forages will thank you for this — because you will have protected the regrowth.

## Principled Grazing

Last month I described one of the bedrock principles of good grazing management — never leave animals in a paddock for more than five days. But my 5-Day Rule is not the only principle of good grazing. This month, I'll discuss three more. (I'll begin with Principle #2, because the 5-Day Rule is Principle #1).

*Principle #2: Stay in Phase II.* Hmmm ... what am I talking about? Does “phase” mean something celestial, as in “phase of the moon”? Do I mean that perhaps graziers should only graze when the moon is full? (Don't laugh — I've seen equivalent statements seriously espoused on the Internet). No, I'm talking about forage growth and how we describe and manage it.

Forage growth follows a predictable S-shaped curve, and the three parts of that curve are called *Phase I*, *Phase II*, and *Phase III*. Think of a graph in which the Y-axis is “forage yield” and the X-axis is “time”. From left to right, a forage growth curve slopes upwards in a sinuous shape that mildly resembles a stretched-out “S” (“sloping upwards” means that the amount of forage increases with time — hopefully, a reasonable assumption).

The section of the curve near the bottom left is *Phase I* — which is the slowly-rising part of the curve when forage growth is slow because the plants only have a few leaves to capture sunlight. The forage is probably shorter than 3 inches, which on many pastures translates to less than 1,000 lb dry matter (DM) per acre. The next section of the curve rises steeply — the long, nearly-vertical shank of the S. This is *Phase II* — when forage growth is exploding. The pasture contains enough vegetation to capture vast amounts of sunlight, and the leaves manufacture lots of carbohydrates and proteins to create additional plant tissue. Finally, the third section of the curve is the top of the “S” which begins to flatten out. This is *Phase III*. During this period, many of the bottom leaves in the sward stop functioning and only the top leaves are effectively capturing sunlight. Although the forage is still adding more vegetation mass each day, the amount *per day* is considerably less than during the steep part of the curve. Phase III contains the highest total forage yield, which may be nice for putting hay in the barn, but the slower forage growth means that less and less additional DM accumulates each day.

So ... the principle “*Stay in Phase II*” means that animals should only graze a paddock when the forage is in Phase II. Which, in essence, defines livestock movement on the farm. Ideally, a good grazer introduces animals into a paddock when the forage is at the *top* of Phase II, and then removes those animals when the forage is at the *bottom* of Phase II. While, of course, always obeying the 5-Day rule. The animals are then moved to a different paddock which is at the top of Phase II. And this timing continues throughout the grazing season, from paddock to paddock and back again. In other words, a grazer always stays in Phase II.

Why the big deal? A couple of reasons. First, because Phase II is the most efficient part of the growth curve. By harvesting Phase II growth, a grazer systematically takes advantage of the least-cost part of the growth curve — the part of the curve where the most amount of forage has accumulated in the fewest number of days. In contrast, Phase III growth is less efficient because it takes more days to accumulate forage. And Phase I growth is a *very* expensive place to graze because there is very little growth on a daily basis.



Here's a second compelling reason: the nutritional value of Phase II forage is excellent. Truly excellent. Phase II forage consists of almost entirely vegetative young leaves. Crude protein levels of Phase II forage are at least 14% and often higher than 20%. Energy levels are also delightful — at least 68% TDN or higher — high enough to support excellent animal performance without grain supplementation. In today's world of expensive grain and high fuel costs, Phase II forage is a grazier's economic secret.

In terms of practical field measurements, the “top” of Phase II is approximately 3,000 lb DM of forage per acre, depending on the type of forage and time of year. Phase II “bottoms out” at approximately 1,000 lb DM per acre.

Which brings us to this next principle:

*Principle #3: Leave enough residual.* Generally this means moving the animals when the paddock still contains approximately 1,000 lb DM per acre — which is conveniently the bottom of Phase II. *Residual* is the amount of forage remaining when the animals leave the paddock. *Leaving too little residual means that the animals have grazed down into Phase I, which puts* some of those grazing days in the inefficient slow-growth section of the growth curve. Grazing into Phase I also means that the forage plants will need 7–14 *additional* days to get to the bottom of Phase II, which effectively adds those days to the recovery period. Which means that, instead of cycling livestock back into a paddock in 20 days, we'll need to wait 30–35 days. Or longer if the growing conditions are not ideal.

Consider what this means to the entire grazing season. Let's say that you would like to cycle your animals through a paddock four times during a growing season. But because of insufficient residual, you lose 10 days each cycle. This means that over the course of a growing season you will have lost 30 grazing days in that paddock because you've had to wait for inefficient Phase I growth. Essentially, you've lost one full grazing period in that paddock. Multiply by the number of paddocks, and you're beginning to talk real money.

But leaving enough residual forage means you must move animals when the paddock still contains a couple of inches of lush green feed! Oh, the temptation... It takes some discipline to walk away from a couple of inches of nutritious forage. And I can say from my own experience that it's not easy, at first. But trust me — it works. And it doesn't take long to see that it's truly worth it.

And finally, *Principle #4: Water and minerals move with the animals.* A good grazier designs a paddock system to maximize forage growth and then puts animals in those paddocks to harvest that growth. Water and minerals are supplementary items that should follow the animals into every paddock, into every grazing cell — not the other way around.

This principle seems very simple, but it often entails some radical changes in design and tradition. The paddocks on many farms are often designed around *existing* water supplies — access to a stream, walking to a central corral or barn, etc. It's the same with large, stationary mineral feeders. But these designs encourage animals to move away from their main grazing

areas and congregate in small, central locations. From a grazier's perspective, this can cause lots of problems: areas of deep mud or heavily pugged pasture, damaged stream banks and riparian areas, badly overgrazed and undergrazed areas in paddocks, piles of accumulated manure near a barn, loss of soil fertility from pastures, etc. Basically, allowing our livestock to obtain water and minerals from centralized areas means that we can't properly manage forage growth. In other words, we lose control of our intensive grazing system.

Good graziers learn to supply water and minerals to all the grazing cells. They lay hoses and pipes under fence lines, with risers everywhere. They use small drinking tubs because animals don't have to walk far to get to them. They design portable mineral feeders that one person can easily haul or sled each time the animals move. And they may even bury their mainline water pipes to strategic branch points.

Yes, it's clear to me that good grazing *is* a principled activity.

# BEGINNING CHEESEMAKING

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## Summary

Making cheese is, at its most basic level, a way to both preserve the nutrients of milk for a season when milk is not available. But for the dairy farmer it is also a way to increase income and satisfaction. Learning to make basic, fresh cheeses is a skill that can be accomplished by anyone with the desire to do so. No matter the type of milk, these simple cheeses can be made with ease and are desirable for both home use and for resale – when regulatory requirements are met. The two recipes here will introduce you to two of the most primary means of making cheese – acid and heat coagulation and slow coagulation by acid producing bacteria.

## Ingredients

**Milk:** Sheep's milk is one of the most precious for making superior cheeses. Its high component content and quality of fat and proteins give a superior yield and flavor profile. But any high quality milk can be used for the recipes included here.

**Cultures:** All of these recipes included that require cultures can be made using store bought buttermilk with live active cultures. Use 1-2 Tablespoons per gallon of milk. The recipe instructions call for starter cultures from cheese supply companies.

**Rennet:** Rennet is a coagulant used in making cheese. The only recipe here that uses rennet is Fromage Blanc. It is included in the packets from some companies, but can be added separately if buttermilk or other starter culture (without included rennet) is used.

**Salt:** Choosing a good quality salt, such as sea salt, will add flavor. Iodized salt should be avoided for most cheese recipe types. Salt adds flavor, but also stops the acidification of the cheese, and is an important part of shelf life.

**Other:** Citric acid, vinegar, lemon juice are used in “added acid” cheeses. They all add equal quality acid, but will also add their own flavors.

## Equipment

**Thermometer:** I like the inexpensive dial type that you can buy at any grocery store.

**Pots and utensils:** Should be stainless steel (non- reactive to acids). You can use your home cooking pots and utensils.

**Cheesecloth:** aka. Butter muslin, is a fine weave cloth that allows the liquid portion, the whey, to run out but keeps the curd in the cloth. Grocery store cheesecloth is really gauze and

will not usually work. For very fine curd cheeses such as fromage blanc, a very fine cloth will work – even a pillow case.

### **Paneer (or Queso Blanco) – Acid plus heat coagulation**

Ricotta, paneer, queso blanco and many other cheeses in the world are made using heat and the addition of an acid, such as vinegar. These are quick, easy and very versatile cheeses. Ricotta, a soft texture curd cheese, is made using the same steps that follow, except a lower temperature (about 185F) when the acid is added, and no pressing.

#### **Ingredients**

- 1 gal whole milk
- About 3/4 cup lemon juice or vinegar (white or cider)
- Pure salt, about ¼ tsp

#### **Equipment**

- Stainless steel pot
- Ladle
- Colander
- Cheese cloth

#### **Procedure**

1. Place milk in pot, and using direct heat, and stirring constantly, bring milk to 195 to 200°F.  
*Tips: When using direct heat, it is very easy to scorch the milk. Use a heavy-bottomed pot, and stir constantly but gently. The milk may foam and look as if it is ready to boil. As the temperature nears the goal, the rate of increase will slow.*
2. Add acid slowly, stirring gently until curd separates, leaving yellowish whey.
3. Let set uncovered for 5 to 20 minutes.
4. Ladle curds into cheesecloth-lined colander. Drain for 10-30 minutes
5. Using a spoon, gently stir and work curd until it is smooth and even in texture. Then stir in ¼ teaspoon salt or to taste. If cheese is to be used soft, it is done at this stage. Simply use or transfer to a sealable container, and store in the fridge for up to about a week. If it is being used as a slicing or grilling cheese, proceed to the next step.
6. With the curd still in the cheesecloth, push and form the mass into the center of the cloth. Then close the cloth by gathering the corners together and gently twisting them to form the curd into a compressed mass. Place the cloth-wrapped ball on a smooth surface, and press gently down to form a disc about 1.5 inches (4 cm) thick and as even in circumference as possible. Open the cloth, and pat the curd ball a bit to smooth the top. Then fold the cloth, one corner at a time over the curd, making it as smooth as possible. Wrap any excess so it is tucked under the mass, forming a tightly closed packet.
7. Place the packet on an inverted plate in a larger bowl or container. Place another upside-down plate on top of the packet, and set a bowl or pan on top of the plate. I like to use a heavy cast iron skillet. The total weight at this point should be about 3 pounds (1.5 kg). After 10 minutes add 3 more pounds of weight. Press for a total of 1 hour. Chill overnight.

8. This cheese can be grilled, fried, etc as it will not melt. It can also be flavored and frozen for use later.

### **Fromage Blanc** (when made from goat's milk it is often called chevre)

Simple, lactic acid coagulated cheeses such as fromage blanc are related to yogurt but use different bacteria and are drained (unlike most yogurts). These cheeses take longer to make, but also have a longer shelf life. They can be frozen and flavored, making them very versatile. The commercial producer can make them months ahead and store them frozen until the market is in need.

### **Ingredients**

- 1 gallon milk
- Fromage Blanc packet from cheese supply OR starter culture such as Flora Danica, Buttermilk AND 1 drop double strength rennet diluted in 2 Tb non-chlorinated water.
- Pure salt (without any additives)

### **Equipment**

- Stainless steel pot and double boiler or set in sink of hot water
- Ladle
- Colander
- Cheese cloth or draining bag (use a sterilized pillow case if you want)

### **Procedure**

1. Warm milk to 86-90F using a double boiler or carefully on direct heat
2. Remove from heat and add prepackaged culture or add Flora Danica type culture stir well then add rennet mixture
3. Place in warmer (I use an ice chest with a couple of towels inside) to hold temperature at 70-80 F
4. When  $\frac{1}{4}$  to  $\frac{1}{2}$  inch of whey covers top it is ready, usually about 12-14 hours
5. Drain in cloth for 4-8 hours to desired texture
6. Salt to taste and place in fridge.

# **BIOTRACK: A RECORD KEEPING SYSTEM FOR DAIRY AND MEAT SHEEP**

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## **Background**

Livestock record keeping is a necessary part of farm business analysis and improvement. Traditional paper based or home designed spreadsheets are commonly used but limit the ability for aggregate and readily exchanged industry data. With agricultural industries building more dynamic value chains to meet market demands, a web-based strategy has become a comprehensive solution. In 2011 the Ontario Sheep Marketing Agency (OSMA) partnered with BIO to make the necessary program changes to the bioTrack program that would provide this web-based program for their producers.

BIO is a not for profit farmer co-operative that resulted from the privatization of livestock improvement programs, previously managed by the Ontario Ministry of Agriculture. The web-based bioTrack program was originally designed in collaboration with the Ontario Cattlemen's Association, for the beef industry. With the main program platform built and performing well for the beef industry, OSMA was able to provide a customized sheep program for their producers at a fraction of the original development costs. BIO has also developed the bioLinks program, for small to medium sized processors, that is being utilized by cheese makers for inventory, tracking and sales. Bridging bioTrack and bioLinks provides full data control and analysis for direct to market value chains.

Dairy shepherds are able to use all the bioTrack program functions designed for lamb production, as well as lactation and conformation trait analysis. Management functions include events for breeding, ultrasound, birth, growth, health, traceability, sales and expenses. Most flock events and editing are able to be done with a Smartphone or tablet, thus replacing paper and multiple data entry duties. Genetic evaluation data for flock evaluation is automatically submitted to national organizations and results returned to producer accounts each week. Program updates are released twice per year and incorporate traits and functions that producers identify as important for day to day flock management and analysis.

Industry benchmarking and objective genetic improvement has proven to be a successful model for the dairy cow industry. Aggregate industry data would also facilitate strategic research and project evaluation, with flocks wishing to contribute to the betterment of their industry. The dairy sheep industry has seen growing demand for their milk products and will need to build sustainable production going forward. A web-based program provides a dynamic method of producer's use of hardware technology for data collection into and industry wide improvement strategy. Finding the best genetics and management practices for profitable production will enable current and future shepherds to continue meeting consumer demand for the long term...

## EXTENDING THE GRAZING SEASON WITH IRRIGATION, NEW FORAGES, AND RENOVATION

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### Something New Under The Sun

There *are* some new things under the sun. At least in the world of forages. And they are definitely under the sun. Graziers around western Oregon are using some very interesting forages. Let's take a short tour. I'll cover each species with one or two paragraphs. It will be like a wine-tasting expedition — interesting selections laid out on a counter, with just enough of each to whet your palette.

Let's start with one of our most common forages — Annual Ryegrass (ARG, *Lolium multiflorum*). One thing you should know about ARG: annual doesn't always mean annual. I'm not splitting legal hairs here. Although many ARG varieties sold on the market, they all fall into two main types. The first type is the *true* annual — plants that go to seed within twelve months of planting, regardless of when the seed is put into the ground. These varieties are called *Westerwold-type* ARG, after the Westerwolde region of Holland where they were first developed. Westerwold plants always set seed at the end of their first spring. Just what you'd expect from an annual grass.

The second type of ARG is the *Italian-type*, also known as *Italian Ryegrass*. These plants won't go to seed unless they first experience a winter period, a phenomenon called *vernalization*. If we plant Italian Ryegrasses in the fall, they will go to seed in the following spring or early summer, just like the Westerwold varieties. But here's the real benefit of the Italian Ryegrasses: if we plant them *in the spring*, they won't go to seed *until the following spring*, which means that those plants will spend their entire first summer as lush, high-quality, vegetative leaf. One seeding, eighteen months of forage. Not bad.

Another use of ARG is as a training tool. ARG is very easy to grow — its seed will sprout even when broadcast onto open ground, and the plants will out-compete many weeds. ARG responds to good fertility, provides lots of forage, and recovers beautifully from defoliation. And its seed is usually cheaper than its perennial cousins.

In short, ARG is a great learning grass. (Actually, it's a great grass even when we really know what we're doing, but for learning, it can't be beat). We just broadcast 30–50 pounds per acre, add plenty of fertilizer, especially N, step back, and watch it grow. The resulting dense swards give us fine opportunities to learn grazing skills, like allocating feed, designing grazing cells, and setting up a grazer's wedge. All without the onus of committing to a set of perennial species. If things don't work out — like we discover that moving fence is not our cup of tea, or that we just want to wait another year before deciding about a permanent pasture — ARG is just an annual, and it will go away at the end of the season.

Another annual forage that's making waves here is Sorghum-Sudangrass (*Sorghum bicolor*). Although not exactly a new concept, it's regaining popularity as a grazing forage instead of just for hay. This same species also produces sorghum grain (also known as *milo*), but here I'm describing the specialized forage varieties. Sorghum-sudangrass is a C-4 (warm-season) grass, like corn, and it only grows during the summer. We plant it in late spring or early summer. It grows particularly well on irrigated ground, but since it's very drought tolerant, it also can provide a good amount of green forage on non-irrigated ground (our rains usually end in June). A good stand can yield more than 4 tons (DM) per acre under the right conditions, with multiple grazings throughout the summer. And the new *brown-midrib* varieties are more digestible than the older varieties. True, sorghum-sudangrass can potentially cause toxicities of cyanide and nitrates, but we minimize these risks by only grazing plants at least 18-inches tall and also watching the nitrogen and frost conditions carefully.

Let's switch to perennials. One sweet story that I've told before is about the new high-sugar varieties of Perennial Ryegrass (PRG, *Lolium perenne*). Originally bred in Wales, these forages are now available commercially here. Their main advantage is the higher levels of soluble sugars in their leaves, which translates to increased microbial efficiency in the rumens of animals grazing high-protein forages. This is most important for high-producing animals. And since higher sugar levels also help the fermentation process, it's easier to make good silage from these forages. We've also noticed one high-sugar PRG variety doesn't go dormant during midsummer as quickly as other PRG varieties. Nothing scientific here — just initial observations by good graziers.

Here are two oddball plants more familiar to most folks as salad herbs rather than as forages: chicory and plantain. Although these species are usually considered weeds, both are perennials with taproots. New Zealand plant breeders have created leafy varieties of each that can be exceptionally valuable forages.

Chicory (*Cichorium intybus*) has been around longer, since 1985 in New Zealand and the early 90s in North America. Chicory is that stemmy plant with pretty blue daisy-like flowers you see along roadsides. Two improved varieties are *Puna* and *Forage Feast*, but new cultivars are beginning to hit the market. Soft leaves, high palatability and nutritional quality, excellent regrowth, good winter hardiness. Graziers use chicory widely in New Zealand and increasingly around North America. But we've observed in the wet Pacific Northwest that chicory is too dormant in the winter to provide much winter growth, and its tendency to bolt in the summer can severely reduce its forage value. So it's fallen out of favor for a different herb that does much better here.

That would be Narrowleaf Plantain (*Plantago lanceolata*). The improved varieties *Tonic* and *Lancelot* have only recently been released in North America. Mature plants show fast regrowth, good summer production, and excellent persistence. Plantain is very aggressive at seeding, and its swards thicken nicely over the years. Nutritionally, plantain is similar to chicory, but agronomically we've found it better suited for our climate. Plantain grows during our mild winters, so it gives us some forage during that critical time — but that lack of winter dormancy translates to high winter-kill in regions with sub-freezing winters, like the rest of North America.



Plantain's poor winter survival means that you won't read much about it in the national press, but here this plant is finding its way into many of our pasture renovations.

Finally, we have the new forage brassicas. The *Brassica* genus contains species like turnips, rape, kale, swedes, cabbage, rutabaga, cauliflower, kohlrabi, and broccoli. Many farmers around the country are familiar with turnips, which are usually planted for a one-time grazing in the late fall or winter, although a leafy variety called *Tyfon* has been available for many years.

Ranchers around here, however, are using some new forage brassicas that are truly impressive. Plant breeders created them by crossing turnips, kale, and rape. These hybrid brassicas are aggressive, easily-grown plants that can withstand severe water stress and provide high-quality forage for multiple grazings. All are annuals, although they have lasted for 14 months in some fields. Graziers either plant them alone or in combination with other short-lived forages such as sorghum-sudangrass, vetch, or an annual clover. We've also used them to eliminate troublesome weed grasses such as foxtail. By planting a field to forage brassicas, we can keep that field in grazing production throughout a season while we periodically spray it for emerging weed grasses. After the season, we can then reseed that field with the grass species that we desire.

Well, that's all the space we have this month. We're also trying some other intriguing forages around here, like *Gala* Grazing Brome, Faba Beans, Crabgrass, and Teff (teff? Isn't that a type of plastic? No, it's a warm-season grain crop from Ethiopia). Not to mention two promising but rather unusual species — *Graza* Forage Radish and something called Quackgrass. But let's not go there just yet.

## **Filling Holes**

A couple of years ago, I wrote here about some interesting forages that we grow in western Oregon. Italian ryegrass was a big deal, and so were Sorghum-Sudangrass and the new high-sugar varieties of Perennial Ryegrass. Things have evolved since then, and I'd like to bring you up to date. Forages that we're using here may very well begin turning up in other places soon.

First some background: Western Oregon lies on the rainy, west side of the Cascade Mountains and enjoys a mild maritime climate. Rain falls between October and June — 30+ inches in the Willamette Valley, up to 80 inches in the surrounding hills and along the Pacific coast. Summers are warm and bone dry. We have two main growing seasons — a short one during the fall after the rains start, and then the long spring which supports a tidal wave of forage growth. After the rains end in May or June, all fields turn parched yellow until fall, unless there is irrigation. Winters are wet and usually mild. How mild? Here's a perspective: we don't bury our pipes. The bottom line is that, with irrigation and good winter management, we can actually grow forages 365 days a year.

Our typical improved pastures contain orchardgrass, perennial and annual ryegrass, endophyte-free tall fescue, and weeds like bentgrass and various foxtails. For legumes, we generally use white clover, subclover (subterranean clover — a winter annual), and more and

more, red clover. (For brevity, this month I won't list all the formal Latin species names. Brevity makes easier reading).

We can grow a lot of forage here, but it's seasonal. As we like to say, anyone here can grow forage in March, April and May. The trick is to grow feed during the tough months when the alternatives of stored feed are very expensive.

But we are fortunate: A hundred years of university research has demonstrated one irrefutable fact — that sheep and cattle and goats have legs. They can walk to their feed and graze it. Our task, therefore, is to find ways of providing feed for those legs — to use growing forages to fill calendar “holes” that otherwise would need to be plugged with expensive hay or silage.

So how are we doing this? Here are some of the newer forages we now routinely use to fill the holes:

We are perhaps most excited about the new forage brassicas. *Brassic*as are in the large mustard family which includes turnips, rape, kale, swedes, cabbage, radish, Brussel sprouts, horseradish, and watercress. Actually, no one here is growing horseradish for sheep, although that *would* be an interesting use of prepackaged flavors. Also, I'm not referring to the new varieties of bulb turnips which are often discussed around the country. These varieties are indeed more leafy than the older turnips, but they still have large bulbs that look like, uh, turnips.

No, the plants we are excited about are the *hybrid forage brassicas*. These are leafy high-yielding plants designed for multiple grazings. They are all annuals although they can sometimes last 15 months or so. An early hybrid brassica was *Tyfon* — a cross between a stubble turnip and Chinese cabbage. *Tyfon* gave one or two regrowths in the summer, which was an improvement over the bulb turnips, but we have much better varieties now. Like *Winfred*, a cross between turnip and kale, and *Hunter* and *Pasja*, which are crosses between turnip and rape. And there are others. These come up quickly, provide grazing in 45 days after seeding and then again and again every 30 days or so, as long as there is enough moisture.

We also use a surprise brassica: the new *Graza Grazing Radish*. This is no run-of-the-mill garden variety radish. *Graza* is a complex hybrid between a vegetable garden radish, a seaside radish, and cabbage. *Graza* comes up fast and keeps going. It has taken this area by storm.

Hybrid brassicas serve us in three ways. Firstly, these plants provide lots of high-energy, high-protein feed for our most productive animals. The leaves contain much higher levels of protein than the starchy bulbs, and these hybrids are nearly all leaf. Secondly, we can plant these brassicas into a field we want to renovate, spray out noxious grass weeds multiple times, and still keep that field productive throughout the season. Then afterwards, we can plant a good grass/clover seed mixture into a clean field free of unwanted grasses. And thirdly, as these brassicas are annuals, they help break the cycle of internal parasites, which reduces our need for anthelmintics.

Another major new forage for us is *Plantain* — but not the small weed everyone sees in their lawns. We use an improved leafy variety of Narrowleaf Plantain (*Plantago lanceolata*) called *Tonic Plantain*, although other commercial varieties are now beginning to hit the market. Big upstanding leaves, soft like lettuce, extremely high quality and extremely palatable, and a deep taproot (Plantain is a herb similar to chicory). A perennial, Tonic Plantain grows in a wide range of soil pH and moisture conditions, and it will spread year after year. Its aggressive seed can even be broadcast on top of the ground and trampled in. Many ranchers now include it in their seed mixes for mixed pastures. Plantain especially fills two feed holes — it provides winter feed because it does not go dormant in the cold months, and it responds brilliantly to good soil fertility and competes with our best forages like annual ryegrass.

You might ask, why not *Chicory* (*Cichorium intybus*), which is a popular forage herb in other parts of the country? Two main reasons. Chicory (*Puna* is the original commercial variety) goes dormant during the winter. While winter dormancy helps it survive cold winters in other parts of the continent, winter dormancy means no winter feed here. Also, chicory generally likes to bolt during the heat of the summer, which makes its summer management complex. In contrast, plantain has neither of these drawbacks.

In past articles, I've discussed *Italian Ryegrass*, and I'll mention it briefly again because it's so important. Italian Ryegrass, which is a type of annual ryegrass, can act like a biennial when planted in the spring. Normally, annual ryegrasses go to seed in their planting year, but if we plant an Italian Ryegrass in the spring, it will grow vegetatively through its first year and only go to seed in its *second* summer. That gives us one full spring and summer of lush, high-quality leafy growth plus a second season. The seed is also relatively inexpensive compared to perennials. We use the Italian Ryegrasses quite a bit, because its biennial impermanence often fits a rancher's plans for a field better than anything else.

Another new forage we use is *Gala Grazing Brome* (*Bromus stamineus*). Originally from Chile and bred by New Zealand scientists for yield and persistence, Gala is a perennial grass that produces a low, dense sward excellent for intensive grazing and hard use. It also grows well in both the winter and the hot summer — two of our primary feed holes. Gala likes well-drained soils and good fertility. Some ranchers here have maintained Gala in their fields for more than ten years, even after trampling those fields as sacrifice areas. More and more ranchers are beginning to include it in their renovation plans.

I'll just mention a couple of other forages we currently use:

*Red River Crabgrass* (*Digitaria ciliaris*), an improved, leafy variety of the southern crabgrass. A warm-season self-seeding annual with potential for explosive summer growth and good persistence, we are just trying it out on some commercial pastures. Also *Big Trefoil* (*Lotus pedunculatus*), a relative of the common Birdsfoot Trefoil, but this species has rhizomes and can grow in our heavy, wet soils of low pH. Another intriguing forage is *Persian Clover* (*Trifolium resupinatum*), a winter annual legume that also grows well in wet soils of low pH. Yes, western Oregon has a lot of heavy wet soils with low pH. Persian Clover interests us because it flowers quite late and thus can provide vegetative growth into the early summer. And last but certainly not least, *Reed Canarygrass* (*Phalaris arundinacea*), which grows in wet soils *and* sandy soils,

responds incredibly well to fertilizer, and spreads aggressively with extensive rhizomes. Unfortunately, Reed Canarygrass can also outgrow most management, and it has gained a dismal reputation for low palatability and poor nutritional quality. But good management can overcome these problems. We are working on ways to manage Reed Canarygrass properly so we can use it where wants to grow.

If forages are our tools, and we have holes to fill, it's good to have a toolbox with lots of good tools.

## **The Money Pit**

Ah ... May.

Spring bright and green, warm sunshine, birds singing, and a young person's thoughts turn to ... renovating pastures. (What *exactly* did you expect in an agricultural magazine?) Of course we think about pastures, and in the spring, we should evaluate all our fields. Let's say that we decide that one field is not "doing well," and that perhaps we should make some changes, like planting a new seed mix. So what's a good pasture mix for sheep? Whoa! Renovation is expensive, sometimes more than \$100/acre. Before we begin plowing money into the ground, literally, maybe we should stop and carefully consider some things about this field. Afterwards, of course, we can cheerfully throw money wherever we want.

The first thing we should ask ourselves is what do we want *to do* with this field? Graze it? Make hay or silage? Both? I'm talking about the bigger picture — how does this field fit into our whole farm system? Let's take this even further: Do we even *like* making hay, or would we rather shift to a full-time grazing system, minimize stored feeds, and purchase the extra hay? Also, will this field be permanent pasture or only part of a long-term crop rotation? If the latter, maybe we would want to use it for green manure during its final year. And how much flexibility do we anticipate in case we want to change management in a year or two?

Tough no-nonsense questions. And we really want no-nonsense answers — *before we spend a penny*. These answers set the big picture. They'll guide our choice of seeds — annuals or perennials or short-term perennials (like endophyte-free tall fescue or perennial ryegrass, or a biennial like red clover), varieties that grow tall for making hay or low and dense for grazing. If we think that we may shift to Management Intensive Grazing (MIG) in a couple of years, we may not want to plant a defoliation-sensitive species like timothy or smooth brome.

Now let's turn our attention to the soil — soil type, drainage, slope, aspect (facing which direction), tree cover, flooding potential, etc. These can indicate which forage species may thrive, which may not, and when the field should be used or left alone. For example, a poorly-drained, east-facing field will be colder than the rest of the farm, and its growth will start later in the spring. We wouldn't want to depend on this field for early-season forage or for anything that requires heavy equipment. Will our field receive water throughout the growing season, either from rain or irrigation? A dependable summer water supply does not jive with a forage that goes dormant in midsummer heat, like perennial ryegrass.

Then, of course, there is soil fertility — nutrient levels, limitations, and history of fertilizer application and hay crop production. Why the dual history? Because fertilizer means adding nutrients to the field, and hay means hauling those nutrients away.

And to understand our soil's fertility, we *must* take a soil test. In fact, I wouldn't *begin* to think about spending money until I studied a recent soil test. *Recent* means within the past 3-4 years. Without a soil test, we would be like a doctor attempting to treat a patient without a medical chart of temperature, blood pressure, and drug history.

Many laboratories report a bare minimum set of fertility values, namely pH, P, K, organic matter, and perhaps a liming recommendation. That's really not enough. We should also get information about soil magnesium, calcium, the *cation exchange capacity* — including the proportion of the CEC taken by each of those minerals — and also something called *buffer pH*, which tells us how an acidic soil will react to various amounts of limestone. Many commercial laboratories provide this information at reasonable prices, so look around.

How do we intend to graze this field? Set-stocking, or some version of rotational grazing, or full-blown MIG, where we adjust the internal fence lines and stocking density throughout the year? No single forage will excel in *all* these grazing systems, and some species will assuredly die out in some systems.

Notice one question I *haven't* asked: “What's a good seed mixture for sheep?” (or cattle, or llamas, or whatever). That's the usual question that many producers initially ask, but it's not as relevant as it sounds. *All* forages provide high nutritional quality during certain parts of their growth. *All* forages will work for sheep under certain types of management conditions. It's just up to us, as managers of the field, to choose the right conditions.

From an animal perspective, we are interested in forage intake, palatability, physical attributes that may interfere with intake, and of course, health risks. Forages may indeed differ in palatability, although not as much as their reputations when they are young and vegetative. We really need to know about the *extreme* species — forages at the *extreme low end* of the palatability scale, like the older varieties of tall fescue and reed canarygrass, or at the *extreme high end* of the scale, like puna chicory. Forages at either extreme can become problems in a mixed-species pasture, because without careful management, they will either take over the pasture or disappear from it. On the physical side, some forages like reed canarygrass can quickly grow too tall and rank for animals to consume. And some forages, such as grazing corn, may cause tiny facial abrasions that can increase the risk of eye problems. Everyone, it seems, knows about health risks like bloat, endophyte, alkaloids, and estrogens. (Just spend two hours on the Internet).

So, if we want to renovate, what do we plant? Or — dare I say this — should we plant anything at all? If a field is not “doing well” under our current management system, then, before pouring money into renovation, why not first try changing our management? We can apply fertilizer and lime, change stocking density, sharpen our grazing skills, and see what happens. If a year passes and we only have more moss in the field, then, well, we *do* need some new seed.

But here's the corollary: even if we renovate, *we still must change our management*. A field is a complex ecosystem, and the plants growing there now are plants that have thrived under our recent management. Even *no* management is a type of management. So, if we renovate a field by spending money on seed, equipment, and fertilizer, but if we don't change our management, then after a few years, what do you think will be growing in our field?

Otherwise, that field will truly become a money pit.

## **Water Breakthroughs**

Now that the growing season is drawing to a close, let's look at a "what if?" — let's look at irrigation.

I know, irrigation can be a pain. It can be expensive and time-consuming. But in the West we accept it as a way of life, even for pastures and hay fields. If we want improved forage during our dry months, we must add water. Alternatively, we can hope that rain will fall, though in the West that is generally not a very good strategy. But in the East and Midwest and South, water generally comes from the sky fairly regularly (except when it doesn't). Either way, most farmers in these areas think of supplementary irrigation as an expensive luxury, especially for pastures. They would only consider such an investment for high-value row crops, and many university spreadsheets and budgets support this conclusion. But maybe we should rethink this conclusion for pastures. The last ten years have seen a revolutionary change in irrigation. Some new equipment is seriously changing the options and finances about using water, especially for pastures.

[Major disclaimer: I am not a company salesman. I don't make a penny by describing this stuff. It's just that this equipment works exceedingly well. It's influenced a lot of operations on the West Coast, and I think it's something we should all know about.]

I'm speaking, of course, of the K-Line system for pasture irrigation. Haven't heard of it? Well, I'm sure you can find sales brochures on the Internet, but I'll give a brief description here.

The K-Line system consists of flexible, tough, low-density plastic water hoses that can be dragged across the ground. Every 40–50 feet along the hose is a plastic pod that kind of looks like a crockpot, with a sprinkler nozzle inside the pod. Hoses can be up to 400–500 feet long containing 8–10 pods. One end of the hose is attached to a source of mainline water, and water is pumped through the hose like any other piped irrigation system (in contrast to, say, flood irrigation). The hose is shifted every 12 or 24 hours. It's incredibly easy to move these hoses — just hook up an ATV (all-terrain vehicle) to the far end of the hose and drag it to the next position in a crisscross pattern over the field.

The K-Line system was originally designed by a farmer on New Zealand's South Island who was trying to create a better and cheaper way of irrigating his pastures. The equipment is manufactured in New Zealand by RX Plastics Ltd. There are many irrigation agents around this country who carry and sell it. In fairness, I must add that K-Line is not the only pod irrigation

system in existence. There are other competing pod systems available commercially, at different prices, but this is the one I am most familiar with.

One compelling advantage of a pod system is speed. A person riding an ATV can move all the hoses in thirty minutes. Yes, *thirty minutes*. You can move every hose in the system while riding the ATV, at a good speed, and you don't need to turn off the water. This is delightful on a hot summer day, although on a cool morning, you might want to wear rain gear.

The ease of shifting hose is actually a very big deal. It's all about labor and time. Finding and keeping good labor on a farm is a challenge. Many farm families rely on their children to do chores, but when the kids leave the farm, then what? It's getting harder and harder to finding reliable workers willing to move 40-foot irrigation pipes twice each day, especially in the hot sun. But asking someone to ride an ATV for less than an hour and get a bit wet on a hot summer day — well *that's* a fun job. And instead of spending three hours each summer day moving irrigation pipe, it takes less than an hour to shift hoses. Saving two hours each day for 90 summer days — that's a lot of hours that can be used for other things.

These pods also have other benefits. The K-Line system runs at relatively low water pressures — around 45 psi — which requires a smaller pump and puts less stress on the fittings. The pods sprinkle the water gently, like a spring rain, which improves infiltration into the soil and reduces puddling and runoff. If the farmer has enough pods to allow shifts (called “sets” in irrigation lingo) of 24 hours rather than 12 hours, the longer irrigation period essentially eliminates the problem of wind shear — which occurs when a prevailing 20 mph wind blows the airborne irrigation water constantly in one direction, resulting in some areas that receive too much water and some areas that receive little or no water.

Another big plus is that the K-Line system is expressly designed for *pastures*, unlike the big irrigation guns and pivots. The pod system can be customized for fields of all sizes and shapes. Since short hoses can be created by using only a few pods, hose length can be adjusted to match the layout of any field, even irregularly-shaped fields or small fields. Dragging the hose across a pasture does not damage grasses or legumes, and hoses can even be safely dragged across annual forages such as brassicas, corn, and sorghum-sudangrass when the plants are short.

There is one caveat, however: cost. A pod system is not the least expensive irrigation system available. The initial cash outlay is a serious investment. But this system's design flexibility, low water pressure, and savings of labor and time put it in a class by itself.

But enough sales pitch. You can find much more on the Internet or with any agent. I really want to speculate about what this system can mean for pastures...

In regions where producers rely on natural rainfall, summer water usually comes in the form of thunderstorms. Although these storms may be exciting events, I would not call them dependable, at least not from an irrigation standpoint. Thunderstorms can drop too much rain or not enough; their path through the county can be spotty; and their timing may leave something to be desired. The rain often falls so hard that there is runoff and pooling. And every year is different, so we never know what is around the corner. But since this situation is normal in many

areas, we generally shrug and live with it and hope for the best. It does give us something to talk about.

But *what if* we knew that we had dependable water throughout the growing season? How would that change our options?

For example, if the spring was particularly hot and dry, we could apply water early to pastures so they would not dry out, or to a new planting of grass and legumes so the seedlings get a good start and establish a thick stand of forage, or to summer annuals like sorghum-sudangrass so they consistently provide huge yields.

How would a dependable supply of water change our options for planting different types of forages? High-producing annuals like brassicas and sorghum-sudangrass would become more reliable — there is less risk of losing an expensive planting or getting a small yield. The famous “summer slump” of Kentucky Bluegrass — no more. We could obtain midsummer yields from alternative cool-season perennials like tall fescue and orchardgrass. We could depend on legume pastures to finish lambs and beef during the summer. And in some fields we might consider planting warm-season perennial grasses like the bluestems and switchgrass to take advantage of their specialized summer growth. And if we grew more forage in the summer, how would that impact our need for stored feed during the rest of the year, or our decisions about obtaining feeder lambs or stocker cattle to graze that summer growth? Basically, we might open doors that we never looked at before.

The West has depended on irrigation since the first settlers broke the sod. Every state west of the Missouri River has an intricate web of laws and regulations and customs that govern water — who owns it; who uses it; how much can be used; when it can be used. But in the East and Midwest and South — well, it’s a lot easier to put a pump in the nearest stream and start pumping. And finally we have an irrigation system specifically designed for our pastures.

This K-Line System is about money, of course. And risk. And opportunity. But this scenario hadn’t existed in the past. Now we have this new pod system. Maybe it’s time we look at irrigation in a new light.



# MILK QUALITY AND DAIRY HYGIENE

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## Summary

The collection of high quality milk for fluid use or for making cheese is the guiding principle when designing and setting up the dairy. By understanding the importance of each aspect of collecting high quality milk, the right choices are more likely to be made. While many guidelines are given by regulatory agencies, this paper will help you understand the reasoning for these guidelines and also how to apply them to your own situation.

## The Four Principles for Quality Milk

Milking hygiene; proper chilling and storage; prevention of cross or post contamination; and herd health are the cornerstones of quality milk production.

## Milking Hygiene

- Animal Cleanliness in parlor
  - Animals should be fairly clean when entering the parlor
- Udder health
  - SCC, CMT
  - Teat inspection, orifice and skin surface
- Parlor cleanliness and air quality
  - Parlor air is being pulled into most milking systems, the area must be designed to limit dust from pens and paddocks from entering
  - Parlor must be easy to clean and maintain for the same reasons
- Teat preparation
  - Approaches vary and new theories are being researched as to the best approach, especially when collecting milk for raw milk cheesemaking
  - Key elements: Proper stimulation before milking to prevent orifice damage, removal of contaminated foremilk, reduction of bacteria on teat surface, and milking with udder, skin, and hands of milker dry
- Milking techniques
  - Ensure workers know proper technique for hand and machine milking – no slipping or slurping, proper takeoff, proper position on teat
  - Use of gloves with proper procedures for disposal, replacement, cleaning

- Milking equipment condition and cleanliness
  - Close inspection with each use for residues, damage, etc
  - Replacement schedule for each part, hose, inflation, ect
  - Verification of water pH, water temperature, and chemical combination that will work effectively

### **Chilling and Storage**

- Choosing equipment that provides rapid chilling to 40F or lower to just above freezing
  - During lag phase of bacterial growth, after lag double population every 15-20 min.
  - To limit psychrotroph growth – spoilage and pathogens
- Once chilled, it should stay chilled!
  - Ensuring chilling during bottling
  - Ensuring temperature stability during transport
  - Ensuring raw milk customers understand importance

### **Cross and Post Contamination**

- Milk is at high risk for cross and post contamination during collection and after
  - Chores related to other livestock, such as managing hogs, poultry
  - Microbes in gut, and therefore feces, and from other sources, including humans
  - Other products in processing area, such as eggs, meat, spices
  - Once in the hands of the consumer

### **Herd Health and Nutrition**

- Healthy milk comes from healthy animals eating a proper diet
  - Design dairy to properly store feed to preserve quality
  - Include adequate feed stations so that all animals have access
  - Design and maintain healthy paddocks and grazing areas
- Emotional stress causes loss of production and susceptibility to diseases
  - Design facilities to allow animal movement that prevents stress
  - Include adequate water, feed, and supplement stations so that lower ranking herd members have access
  - Train workers to understand the mentality of “prey” animals in general and the species you have in particular
- Physical Stress reduces production and makes animals prone to illness and disease
  - Similar to above, physical stress can be from things such as having to fight for positions at watering stations, etc; having to walk to far to feed, shade, resting areas, and so on. Design facilities to anticipate these situations as best as possible.

- Closed Herd is the ultimate goal for the prevention of diseases – particularly those that are zoonotic.
  - Design facilities to accommodate adequate replacement stock
  - When new animals must be brought in, provide proper quarantine housing
- Herd testing for diseases transmitted in milk is required in most states and should be monitored regardless
  - Provide equipment and set-ups for securing of animals for blood draws, TB testing, and other maintenance tasks such as hoof trimming

### **Using Microbiological and Sensory Testing to Monitor Quality**

- On Farm Testing
  - Lactofermentation
  - Shake and Sniff
  - PetriFilm – milk and environment with Quick Swabs
- Outside Labs
  - Certified, reportable
- Understanding what the results mean and what to do about them

### **Basic Milk Quality Tests Parameters**

- SCC- Somatic Cell Count
  - Regulatory limit 750,000, but goal for bulk should be closer to 300,000
  - Monitor individual animals monthly at minimum with CMT or equivalent
- SPC- Standard Plate Count (also called Aerobic Plate count)
  - Goal Less than 1,000? Some debate about number
  - Regulatory limit 300,000
- Coliforms
  - Less than 10
- E. coli
  - Goal zero (less than 1)
- Staph
  - Ideal less than 10

## **LARGE SHEEP AND GOAT DAIRIES IN EUROPE**

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Most of the small ruminant dairies (sheep or goats) throughout the world are flocks of 20 to 500-600 does/ewes. However, as it happened with dairy cows, some producers are now seriously envisaging increasing the number of animals to a few thousands. The management of such large dairies is certainly extremely complex and one would wonder if it could even be possible to make it work. A few of those dairies already exist in Holland (goat) and in Spain (sheep). I had the chance of visiting one large goat dairy in Holland and 3 large sheep dairies in Spain. What follows is only a synopsis of my visit to those farms. I do not pretend of having seen everything or even understood all the complexities of the different phases of very intensive management.

### **Schajjk, Holland**

The farm has 10000 goats on two different sites. The site we visited has 3 huge buildings 100 meters long and 32 meters wide housing 2,000 goats each. Four pens of 500 goats with 2 feeding alleys in between pen giving an area of 1.12 square meter per goat which might be a bit smaller than the American standard of 1.35 square meter needed for sheep. The goats are milked 3 times a day in a 180 stall rotary parlor (780,000 euros or \$1,000,000). We witnessed the milking of 2000 goats in 1 hour and 10 minutes by 1 milker and 1 helper. The milking is extremely rapid but does not seem to be always performed correctly with milking cups falling off before time.

The farm also includes 4 milk silos to receive milk from 20 other smaller farms for consolidation of milk shipments to France, Italy, Greece and Germany.

Most of the goat are on a 365 day lactation with some having longer lactations. Management includes one kidding a year per goat with continuous lactation and no drying off period and therefore no colostrum formation. Kids are removed right after birth and raised on milk replacer on the farm for 2-3 days before being shipped to another farm for contract rearing. Average production per goat is about 980 kg of milk at 4.2% butter fat. Milk is sold at .50 euros /liter (\$.30/pound).

All feed and bedding (straw, 1500 tons needed per year) are purchased. TMR consists of corn silage, ryegrass silage and premix. All goats are fed and new fresh bedding blown in 3 hours by one man only. The total labor force of the farm is 8.

Because of its impressive cleanliness, its high level of hygiene and apparent well-being of the 6000 goats, I am encourage in the idea that it is possible to have a large number of animals and having them looking very good and apparently content.

**Buildings with 2000 goats each**



**2000 goats waiting to be milked**



**500 goats per pen with feeding alleys**



**Milking in a 180 stall rotary parlor**



## **Cerromonte, Spain**

Cerromonte is located near Avila at San Pedro del Arroyo. Cerromonte has a total of 5300 ewes with 3800 ewes being milked. The farm covers a surface area of 12 hectares and employs 15 people including the manager and office staff. All ewes are electronically identified with ruminal boluses and managed with the Delaval Alpro software. The ewes are milked in 2x50 parallel rapid exit parlor twice a day. The large number of ewes in the parlor (100) did not appear to be very advantageous. The loading time is longer and some ewes are done milking before the last units are put on.

All ewes are of the Lacaune breed originally from France. The total production of those ewes is 370 kg per lactation. Because of an accelerated lambing management of 1.4 lambing per year the total yearly milk production is 520 kg. The somatic cell count is fairly high at 500,000 cells/ml but typical of Europe. Prolificacy is 1.6 giving a yearly lamb production of 2.2 lambs/ewe/year. Lamb mortality is high with only 55%-60% survivability in the early years and up to 75%-80% in 2011 and 2012.

The management is of 5 lambing periods during the year with a mating of no more than 25 days occurring 60 days postpartum followed by echography 35-50 days later to allow rebreeding of open ewes with another group, a lactation of 210 days and a dry period of 35 days. The short dry period is very interesting. Fernando Hernandez, the manager of the farm, along with his colleagues have published in the **Journal of Dairy Research** (2012, **79**, 352-360) an illuminating article on the influence of the dry period length on reproductive performance and productivity of Lacaune dairy sheep under an intensive management system. The article concludes that 30 to 60 days is the optimal dry period length for Lacaune sheep under intensive management.

All lambs are raised on milk replacer with cow colostrum fed via stomach tube 4 times during the first 24 hours. Lamb rearing area was set up as an afterthought as a whole building inside of a building. The difficulty of artificially raising the lambs did not seem to have been planned ahead.

Ewes are in complete confinement and fed a TMR of different composition according to the stage of production. The feeding system is with conveyor belts which permit less equipment traffic in the barn and more room for animal housing. This is the typical feeding system found in the Roquefort area in France. However at Cerromonte, the barns are 105 meters long and 30 meters wide housing a total of 1920 ewes each with only one mid transversal feeding alley 7.5 meters wide. Removing feeding alley and feeding conveyor belts the housing area is of 1.11 m<sup>2</sup>/ewe which is too low. The recommended surface area per ewe in the USA is 1.35-1.5 m<sup>2</sup>/animals (Sheep Housing and Equipment Handbook, Midwest Plan Service, Ames, Iowa). Animals looked crowded with acute feet problem. With the same surface area, the goats in Holland did not seem crowded which is certainly due to a somewhat lower body size and a lack of wool.

Altogether I was not very impressed by the overall well-being of the animals. However:

- The intensification of the production cycle is of high interest and permits to reach a higher level of production that I did not think possible. The management of this system is complex and certainly difficult to maintain efficiently. Is it really sustainable on a long term?
- The feeding system appears to be of some interests allowing for less space taken by feeding alleys. However the cost of 300 Euros/meter (\$402/meter) might be prohibitive.

- The overall investment is about 800-1000 euros (\$1000-\$1300) per animal which seems to be the norm in Europe.

**Buildings at Cerromonte**



**Lacaune ewes**



**50 ewe rapid exit parlour**



**Systematic use of the Sagi hook**



**Lambs on milk replacer**



**Milk mixing machine**



## Pago Los Vivales, Spain

Pago los Vivales is located near Zamora. Pago los Vivales has exactly the same type of management and production cycle as Cerromonte, resulting in the same amount of milk produced per ewe and per year and the same amount of lambs per ewe and per year. Pago los Vivales has 3300 ewes with 2100 at milking. Half of their animals are of the Assaf breed and half of the Lacaune breed. The Assaf produces a little less milk with less fat and protein. The farms is composed of 4 barns ( 2 ½ used for lactating ewes, ½ for rams and dry ewes and 1 for lamb rearing and young stock), 1 milking parlor and holding area and 1 cheese plant.

The fundamental differences between the two farms are:

- A milking parlor relatively smaller 2x36 which seems to be slightly more efficient.
- A relatively better lamb rearing area.
- A feeding system based on dry feed allowing for bin storage and auger distribution through the whole farm. The quality of the feed is certainly more under control and more consistent. Very little space is taken by the auger system. The ewes appeared to be in excellent body condition.
- A creamery that utilizes all the milk produced by the farm. Three or 4 different types of cheeses are produced and cured 4, 8 or 12 months. The cheeses are sold on the national market. The added value from the cheese is very important for the profitability of the farm. The total cost of the creamery alone with curing room was 1.5 million euros (\$2 millions) for a maximum capacity of 56,000 liters of milk per week, the limiting factor being the amount of cheese that is possible to store in the curing room.



**Buildings of Pago los Viales**



**Lambs on milk replacer**



**2x36 rapid exit milking parlor**



**Feedlot and dry ewes**



**Lacaune and Assaf ewes in barn**



## Los Francos, Spain

“Los Francos” is located near Placencia and has approximately 3800 ewes. Contrary to Cerromonte and Pago los Viales which are corporate owned, Los Francos is owned and operated by a father and son. The enthusiasm of the son in showing his operation was obvious and translated in the quality of his animals. Again, the farm uses the same management and production cycle as the other two but produce most of its feed and bedding on 1000 hectares. The buildings are older and set in no particular order with additions and remodeling. The newer building (Roquefort area style) felt poorly ventilated. Although the animals seemed to be somewhat crowded they looked very good with no apparent feet problem. The milking parlor was a rapid exit 2x24 GEA subway system which I had never seen before. The parlor is built on 2 levels. On the lower level are all the electronic, automatic take off system, pulsators etc... and on the main level is the milking parlor per se. This subway system permits to keep everything very clean.

The lamb rearing is done on another site at the other end of the village. All lambs looked amazingly good due to the good care given to them which is reflected by a low mortality (7% total between birth and sale at 11-12 kg). The replacement stock was also looking very good.

The farm purchases fresh and frozen Lacaune semen directly from France and artificial inseminate about 200 ewes every other year for the production of their own rams.

### Lacaune ewes at Los Francos



**Milk hoses going to lower level**



**Electronic sorting gate**



**Lower level of milking parlor**



**Ewes being sorted after milking**



**Nice lambs**



## Conclusions

Intensively managing large number of dairy ewes (or dairy goats) is certainly possible. Managers and workers need to have extensive knowledge of dairy sheep. Milking all year around is a must for the operation to be economically sound. Lambing needs to be simplified as it is being done now at the Spooner Research Station (University of Wisconsin-Madison).

- Extremely clean
- All ewes electronically identified and controlled everyday and automatically sorted on a need basis.
- Production of 370 kg of milk (840 lbs) per lactation
- Milking period of 210 days starting just after birth
- Dry period of 35 days
- Mating period of 25 days starting 60 days after lambing
- 5 matings periods per year
- Accelerated lambing (1.4 lambings/ewe/year)
- Average milk production of 518 kg (1180 lbs) **per year**
- No lambing jugs, simplified lambing
- Ewes going to milking directly after birth
- All lambs raised artificially directly from birth with all colostrum tube fed.

## MILKING INTERVAL AND OTHER SHEEP RESEARCH PROJECTS AT THE UNIVERSITY OF WISCONSIN-MADISON

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### Milking Intervals

**Background.** Dairy ewes produce relatively small amounts of milk at each milking relative to dairy cows and dairy does. Therefore, it is very important to have an efficient milking system that results in the maximum amount of milk produced per unit of labor. Good parlor design and milking routine are both very important for fast throughput of ewes at each milking. Most flocks are milked twice per day at approximately 12 hour intervals during the majority of the lactation period. Increasing or decreasing the milking interval from the normal 12 hours may be another method to improve the economic efficiency of milk production.

The alveoli are the milk secreting units of the udder. The alveoli are bag-like structures with an inner lining of epithelial cells that secrete milk into the inner cavity or lumen of the alveoli. The milk then moves through small ducts connected to the alveoli into larger ducts and eventually into cavities in the udder gland and teat known collectively as the “cistern”. Therefore, milk within the udder of dairy ruminants can be divided into two fractions: the cisternal fraction, which has already been transferred from the alveoli to the cistern during the intermilking interval and is immediately obtainable at the time of milking without oxytocin release and milk ejection, and the alveolar fraction, which can be removed from the udder only if oxytocin is released and milk ejection occurs (McKusick et al., 2002).

Large differences between dairy species exist with respect to the proportion of total milk that can be stored within the cistern. For example, following a normal milking interval of 12 to 14 hours, the dairy ewe and goat can store up to 75% of the total milk volume within the cistern (Marnet and McKusick, 2001), whereas the cisternal fraction in dairy cattle accounts for approximately 20% of total milk volume (Pfeilsticker et al., 1996). Dairy ewes may be more amenable to longer milking intervals than dairy cows because they have larger cisterns, relative to their udder size, capable of storing larger volumes of milk between milkings than do dairy cows. However, large differences between dairy sheep breeds in the size of their udder cisterns and in the proportion of total milk that is cisternal milk has been reported (Rovai et al., 2008) so some dairy sheep breeds and individuals within breeds with larger than average cisterns may be more adaptable to a longer milking interval than breeds or individuals with smaller cisterns.

### Results from Previous Milking Interval Studies at Spooner

**16-Hour Milking Intervals from Mid-Lactation.** A trial was conducted at the Spooner Station in 2001 to determine if the milking interval could be extended from 12 to 16 hours

starting in mid-lactation without a significant drop in milk yield (McKusick et al., 2002). Forty-eight third lactation East Friesian crossbred ewes were utilized. Twenty-four ewes were kept on the 12 hour milking interval (12H, milked daily at 6:00 a.m. and 6:00 p.m.), and 24 ewes were switched from the 12H interval on an average of day 90 of lactation to a 16 hour milking interval (16H, milked at 6:00 a.m. and 10:00 p.m. one day and at 2:00 pm. the following day and then repeating). Lactation performance was measured through day 180 of lactation.

During the 90-day treatment period, 16H ewes produced about 28% more ( $P < .05$ ) milk at each 6 a.m. milking than 12H ewes, and there was no difference between treatments in the total amount of milk produced. The percentage of fat and protein and somatic cell count was not different between the two treatments. From mid- to late-lactation, it appears that dairy ewes can be milked at 16 hour intervals, reducing the number of milkings by 25%, without a decrease in milk production.

Initially, the drawbacks to this milking system appear to be the different milking routines between adjacent days and the necessity of a late night milking every other day. However, the routine can actually result in improved quality of life due not only to a reduced number of milkings but also to the actual milking times. Many people have social activities for themselves or their school-age children in the late afternoon or early evening. Milking twice-daily with the evening milking at 5:00 or 6:00 p.m. is disruptive to these social activities, but the 16 hour milking interval allows you to engage in these late afternoon or early evening activities either after a 2:00 p.m. milking or before a 10:00 p.m. milking. For some people, the 16 hour milking interval during mid- to late-lactation may be a viable option.

***Once-Daily Milking from Mid-Lactation.*** The above trial indicated that U.S. dairy ewes could be milked at 16 hour intervals (3 milkings in 2 days) from mid-lactation without a reduction in lactation milk yield. The logical next step was to see if ewes could be milked only once-daily (24 hour interval) from mid-lactation without a large decrease in milk production.

A trial was conducted at the Spooner Station in 2013 to determine the effect of once-daily milking starting in mid-lactation on milk yield (Thomas et al., 2013). Seventy-two crossbred East Friesian-Lacaune ewes in their second to seventh lactations were selected for the trial from the larger flock of milking ewes. All 72 ewes had been milked twice-daily from less than one day after lambing to the start of the trial at an average of 100 days of lactation. On the test day one week before the start of the trial, the 72 ewes produced an average of 6.0 lb. of milk.

The ewes were divided into 3 similar groups of 24 ewes each and the following treatments were applied starting on June 4, 2013: 1) Control – continued to be milked twice-daily, 2) 7/1 – milked once per day in the morning, and 3) 6/1 – milked once per day in the morning except not milked at all on Sunday. All 72 ewes entered the parlor twice a day during the milking times of the entire flock to receive their grain supplement, but only the control ewes were milked at each milking. The treatments were administered through August 9, 2013 (total of 67 days). Before milking on a Monday morning in July 2013, blood samples were collected from all ewes and analyzed for lactose content. A high blood lactose content would indicate leakage of milk into the blood system due to increased leakiness of mammary tight junctions between the blood supply and the milk-producing epithelium. From August 9 through 20, 2013, all ewes were

milked twice-daily to determine if once-daily milking had any effect on subsequent milk production. After August 20, 2013, the entire flock was switched from twice-daily to once-daily milking until the end of milking on September 28, 2013.

The control and 7/1 ewes had consistent, small decreases in milk production as lactation progressed, which was expected. The 6/1 ewes, however, had large swings in daily milk production with highs on Mondays after not being milked on Sundays followed by a large drop on Tuesdays and gradual increases from Tuesdays through Saturdays. By August 20, and after 11 days of twice-daily milking of all ewes, daily milk production of the three groups was similar.

There was no significant difference in milk yield between the ewes milked twice daily (Control) and ewes milked once-daily (7/1) during the 67 days of the experiment (241 vs. 232 lb., respectively). This study indicated that East Friesian-Lacaune ewes of the types found in North America can move from twice-daily to once-daily milking at mid-lactation (at approximately 100 days post-partum) with a large savings in milking labor and an insignificant drop in milk yield.

Milking once-daily except not on Sunday (6/1) resulted in a significant decrease in total milk yield of 18% compared to once-daily milking (7/1) (232 vs. 189 lb., respectively). The labor savings from one less milking per week cannot compensate for the financial loss of an 18% decrease in milk yield in most flocks. In addition, the large drop in milk yield on Tuesday following the very high yield on Monday suggested that increased pressure in the udder from the large amount of milk accumulated from after the Saturday milking until the Monday milking may be causing some short-term stress to the udder that required a few days for recovery. This was confirmed by the blood lactose levels, which were significant higher on the Monday before milking in the 6/1 ewes compared to both the control and the 7/1 ewes. However, the somatic cell counts were similar among treatments, indicating that once-daily milking treatments were not resulting in an increase in udder infections.

***Three Times Daily Milking in Early Lactation.*** We conducted a study in 2000 at the Spooner Station comparing three-times-a-day milking (3X) (milking at 6:00 a.m., noon, and 6:00 p.m.) with twice-daily milking (2X) (milking at 6:30 a.m. and 5:30 p.m.), and the results were published in the Proceedings of the 6<sup>th</sup> Great Lakes Dairy Sheep Symposium (de Bie et al., 2000) held in Guelph, Ontario.

A total of 125 mature East Friesian crossbred ewes were utilized during the first 30 days of lactation. After day 30 of lactation, all ewes were milked twice-a-day. All lambs were weaned from their dams within 24 hours after parturition, and ewes were immediately assigned to a milking treatment. During the 30-day treatment period, 3X ewes produced a total of 29 lb. more ( $P < .05$ ) (+15.2%) milk than 2X ewes (220 versus 191 lb.).

#### **2014 Milking Interval Study – Proposed “Optimum” Milking Interval Schedule (H. Stellrecht, R. Burgett, D. Thomas)**

The above previous studies showed that U.S. dairy ewes produced more milk with 3-times-a-day milking in early lactation and similar amounts of milk during late lactation when milked

once-daily compared to ewes milked twice-daily throughout. These results suggest that an “optimum” milking interval schedule to minimize milking labor while not decreasing, or perhaps even increasing, lactation milk yield may be a schedule that milks ewes 3-times-a-day in early lactation, followed by twice-daily milking in mid-lactation, and finishes with once-daily milking during late lactation. A study was conducted at the Spooner Station in 2014 to evaluate this milking interval schedule.

Seventy-two East Friesian-Lacaune dairy ewes from 3 to 8 years of age were randomly assigned to two milking interval treatments as they lambed in 2014. Ewes lambed from January 20 through February 5, were separated from their lambs immediately after giving birth, and joined the milking ewes in the parlor at the very next milking after giving birth. The 2X treatment group (n = 36) was milked twice-daily (5:00 a.m. and 5:00 p.m.) during the entire study period (average lactation length = 208 days). The 3-2-1X treatment group (n = 36) was milked 3-times-a-day (at the start of the morning milking of the rest of the flock, noon, after the afternoon milking of the rest of the flock) during early lactation (first 40 days of lactation), milked twice-daily with the entire flock (5:00 a.m. and 5:00 p.m.) during mid-lactation (middle 98 days), and milked once-daily with the entire flock (5:00 a.m.) at the end of lactation (last 70 days).

Three ewes were removed from the trial (two 2X ewes and one 3-2-1X ewe) due to mastitis, and their data was excluded prior to statistical analysis. During the 208 days of the trial, daily milk yield was measured on 21 separate test days spaced at 7 to 14 day intervals throughout the trial period. On each test day, a milk sample was taken and submitted to a commercial laboratory for determination of % milk fat, % milk protein, and number of somatic cells per milliliter of milk (somatic cell count - SCC). Estimates for each ewe of lactation yields of milk, fat, and protein during each period (early, mid, and late lactation) were obtained by averaging yields from adjacent test days, multiplying by the number of days between test days, and summing all the resulting estimated yields between test days within a period. Estimated total lactation yield of each ewe for milk, fat and protein was the sum of the estimated yields during each period. Percentage fat and protein was calculated as the estimated weight of fat or protein divided by the estimated weight of milk within each period and over the entire lactation. Somatic cell counts from each ewe were averaged within a period and for the entire lactation prior to analysis. The data were analyzed with a general linear model that included the effects of treatment (2X or 3-2-1X), age of ewe (3, 4, or 5 and greater years of age), and number of lambs born (1, 2, or 3 and greater) nested within age of ewe.

Lactation traits for the two groups are presented in Table 1. The last two rows of Table 1 indicate that there were no significant differences between the two milking interval systems for total lactation performance for any of the traits analyzed, i.e., the entire group of ewes in the study averaged approximately 860 lb. of milk, 57 lb. of fat, and 42.5 lb. of protein and had average SCC of approximately 100,000/ml. The 2X ewes made this production with 416 milkings (2 milkings per day x 208 days) whereas the 3-2-1X ewes made a similar production with 386 milkings [(3 milkings per day x 40 days) + (2 milkings per day x 98 days) + (1 milking per day x 70 days)] for a 7.2% reduction in the number of milkings for the 2X system compared to the 3-2-1X system.



However, the 3-2-1X ewes under-performed relative to expectations in both early and late lactation based on our previous research studies. During early lactation when the 3-2-1X ewes were milked three-times-a-day, they tended to produce 9.9% more ( $P < 0.10$ ) milk than the 2X ewes that were milked twice-daily, but our previous study with three-times-a-day milking in early lactation resulted in a 15% increase over twice-daily milking. During late lactation when the 3-2-1X ewes were milked once daily, they tended to produce 11.9% less ( $P < 0.10$ ) milk than the 2X ewes that were milked twice-daily, but our recent study conducted in 2013 with once-daily milking in late lactation resulted in a similar milk yield compared to twice-daily milking.

While the results of this study did not confirm previous research, it does demonstrate that dairy ewes with relatively high milk production potential can adjust relatively well to different milking interval schedules without a decrease in lactation milk yield and with a possible savings in milking labor.

Table 1. Least squares means  $\pm$  standard errors for lactation traits of ewes milked twice-daily (2X) or 3 times daily in early lactation, twice-daily in mid-lactation, and once-daily in late lactation (3-2-1X).

Treatment	Lactation traits					
	Milk yield, lb.	Fat, %	Fat yield, lb.	Protein, %	Protein yield, lb.	SCC, log <sub>10</sub>
<u>Early lactation (40 days)</u>						
2X	205.2 $\pm$ 9.8 <sup>d</sup>	7.33 $\pm$ 0.18 <sup>c</sup>	14.9 $\pm$ 0.75	5.14 $\pm$ 0.06	10.5 $\pm$ 0.46 <sup>b</sup>	4.80 $\pm$ 0.12
3-2-1X	225.5 $\pm$ 9.0 <sup>c</sup>	6.91 $\pm$ 0.16 <sup>d</sup>	15.6 $\pm$ 0.68	5.19 $\pm$ 0.06	11.6 $\pm$ 0.42 <sup>a</sup>	4.68 $\pm$ 0.11
<u>Mid-lactation (98 days)</u>						
2X	442.4 $\pm$ 21.1	6.32 $\pm$ 0.10 <sup>d</sup>	27.7 $\pm$ 1.37	4.81 $\pm$ 0.07	21.1 $\pm$ 0.93	4.93 $\pm$ 0.08
3-2-1X	455.5 $\pm$ 19.2	6.54 $\pm$ 0.09 <sup>c</sup>	29.6 $\pm$ 1.24	4.87 $\pm$ 0.06	22.1 $\pm$ 0.85	4.94 $\pm$ 0.07
<u>Late lactation (70 days)</u>						
2X	207.7 $\pm$ 11.3 <sup>c</sup>	6.33 $\pm$ 0.17 <sup>b</sup>	13.1 $\pm$ 0.72	5.02 $\pm$ 0.11 <sup>c</sup>	10.3 $\pm$ 0.55	5.23 $\pm$ 0.09
3-2-1X	183.0 $\pm$ 10.3 <sup>d</sup>	6.82 $\pm$ 0.15 <sup>a</sup>	12.4 $\pm$ 0.65	5.25 $\pm$ 0.10 <sup>c</sup>	9.6 $\pm$ 0.50	5.27 $\pm$ 0.08
<u>Entire lactation (208 days)</u>						
2X	855.2 $\pm$ 38.6	6.56 $\pm$ 0.10	55.7 $\pm$ 2.53	4.94 $\pm$ 0.07	41.9 $\pm$ 1.73	5.00 $\pm$ 0.08
3-2-1X	863.9 $\pm$ 35.1	6.69 $\pm$ 0.09	57.6 $\pm$ 2.30	5.03 $\pm$ 0.06	43.3 $\pm$ 1.57	4.98 $\pm$ 0.08

Pairs of means with a different superscript are statistically different: <sup>a,b</sup> $P < 0.05$ , <sup>c,d</sup> $P < 0.10$ .

### Caseous Lymphadenitis (H. Stellrecht and R. Burgett)

**Introduction.** Caseous Lymphadenitis (CL), or sometimes known as cheesy gland, is a prevalent disease in the goat and sheep industry. CL varies from flock to flock from 0% to 90% prevalence within flock (Windsor 2011). It is a disease that creates abscesses on or near the lymph nodes on the body, but there is also a possibility of abscesses occurring on internal organs. Internal abscesses are more common in sheep, whereas external abscesses are more common in goats. The external abscesses are commonly located on the lymph nodes of the animal; for instance, on the head or neck. There can also be some found around the lymph nodes of the legs

and shoulders. Visceral abscesses are located mainly on the lungs of the animal, but can be found on other organs as well. It can be associated with “Thin ewe syndrome”; with internal abscesses being associated with rapid loss of body weight and body condition regardless of plane of nutrition.

Caseous Lymphadenitis is caused by the bacterium *Corynebacterium psuedotuberculosis*. It is a gram-positive, rod-shaped, aerobic or facultative anaerobe. This bacterium can enter the body either through the respiratory system or through an open wound on the body. *Corynebacterium psuedotuberculosis* has the possibility of surviving on wool, wood, bedding and other products for several weeks at a time. It can also live in the environment (dirt, straw, grass) for up to 8 months.

Caseous Lymphadenitis has the ability to be zoonotic. There are very few reported cases of CL in humans (less than 30 in literature), with no fatalities recorded (Azevedo, 2006). There have been cases in Australia where shearers have reported abscesses on their necks similar to those of CL's. Rupturing an abscess during shearing and having the bacterium enter the human body through an open wound causes these reports. CL can also be passed to the human through raw milk. In one case, a patient was infected, but had no known contact with farming equipment or livestock. The conclusion was made that he contracted CL by regularly drinking raw goats' milk (Baird and Fontaine, 2007). Therefore, it is highly recommended to pasteurize milk before consuming or processing it into dairy products.

**Testing.** Commonly, sheep producers inaccurately diagnose CL in their flock solely by the prevalence of external abscesses. However, several other pathogens are usually cultured including various strains of Staphylococci, Streptococci, and *A. pyogenes*. Additionally, ewes may be harboring the bacteria in internal abscesses or have external abscesses that have ruptured and healed but are still capable of spreading the disease. A more definitive diagnosis can be obtained by testing all or a representative sample of the flock. The test used is a synergistic hemolysis-inhibition (SHI) test, which detects the concentration of antibodies for *C. pseudotuberculosis* in the blood and your local veterinarians should be consulted for testing procedures. Because the test identifies antibodies, once a ewe has been vaccinated, she will always test positive which makes monitoring progress more challenging.

**Treatment.** There is no known cure for CL in sheep or goats. In order to reduce or eliminate the prevalence in a flock or herd, producers can test and cull all individuals with a positive test. However, as prevalence rates have been reported of over 60% of individuals testing positive in flocks, this may not be economically feasible. Also, the accuracy of the SHI test for CL is 98+2% with both false positives and false negatives being possible. The SHI test has a very low specificity, with the specificity being between 10 and 33% (Alves et al., 1987; Alves et al., 1986). Managing positive and negative ewes separately is also a possible control measure but nose to nose contact and sharing of facilities must be avoided which is not feasible for most sheep and goat producers. A vaccine is commercially available (a formalin inactivated preparation and CSL vaccine, CSL453), and has been found to be 95% successful in preventing a sheep from contraction CL. A clostridial-CL vaccination, Glavanac™6 shows a 93% prevention rate (Cameron et al 1999). Also, as stated previously, vaccination in the flock eliminates the ability for further testing.

***CL infection and production of the Spooner flock.*** To our knowledge, the effects of CL on ewe production in a milking flock have not been analyzed. In flocks managed for meat and fiber production, CL has been shown to cost the meat industry in Australia \$A12-15 million per year. Even though there haven't been any extensive tests, Australia claims that CL also has an adverse effect on their wool production (Baird and Fontaine, 2007). In order to define the economic impact of CL on the milking flock at the Spooner Agricultural Research Station, a study was designed to analyze the relationship between CL infection status of all individual ewes and body weight, body condition score, total milk yield, daily milk yield, length of lactation, lamb birth weight, and culling rate. Blood samples were collected from all lactating ewes on July 28, 2014 (n=247) and analyzed for infection status of CL.

Presented in Table 2 are the numbers of ewes of each age that were negative and positive for CL. Of the 247 total ewes tested, 45 (18.2%) were infected with CL. It is evident from Table 1 that the infection rate becomes higher as ewes age. Only 3.9% of the youngest ewes (~ 17 month-old yearling ewes) were infected whereas 60.9% of the oldest ewes ( 6 – 8 years of age) were infected. The highly significant regression of percentage of positive ewes on ewe age estimates that the percentage of infected ewes increases by 10.6% percentage units each year. Obviously, continual exposure to *C. pseudotuberculosis* over time results in higher rates of infection.

Table 2. Distribution of CL negative and positive ewes by age of ewe.

CL status	Ewe age, years						Total, n
	1	2	3	4	5	6+	
Negative, n	74	49	30	22	18	9	202
Positive, n	3	5	6	7	10	14	45
Total, n	77	54	36	29	28	23	247
% positive	3.9	9.3	16.7	24.1	35.7	60.9	18.2

Regression of % positive on ewe age = +10.6% per year,  $P < 0.01$ .

To date, only very preliminary analyses have been conducted on this data to determine if there is any indication of a relationship between CL infection and performance. On the day that blood samples were taken from the ewes for analysis of CL status, they were weighed and condition scored. These ewes are currently nearing the end of their 2014 lactation, and test day milk yields taken once each month were available from early and mid-lactation. These data are presented in Table 3.

There were no significant differences between negative and positive ewes for any of the traits presented in Table 3. These data suggest that CL infection had no effect on body weight, BCS, or milk production of dairy ewes in 2014. However, these data require further analysis, and the young ewes need to be monitored over several years to determine if there are any differences in

culling rates and/or lifetime production between ewes infected early in life and their uninfected flock mates. Annual testing will take place in future years to determine the time of infection.

Table 3. Least squares means  $\pm$  standard errors for performance traits of CL negative and positive ewes

CL status	Traits				
	Body wt., lb.	BCS <sup>1</sup>	Test day milk yield, lb.		
			1 <sup>st</sup> test	2 <sup>nd</sup> test	3 <sup>rd</sup> test
Negative	170.2 $\pm$ 1.68	2.7 $\pm$ 0.06	5.3 $\pm$ 0.13	4.5 $\pm$ 0.11	4.3 $\pm$ 0.10
Positive	168.7 $\pm$ 3.19	2.6 $\pm$ 0.11	5.4 $\pm$ 0.26	4.7 $\pm$ 0.21	4.4 $\pm$ 0.19

<sup>1</sup>BCS: 1 = very thin, 5 = very fat.

### Ovine Progressive Pneumonia in Non-Dairy Sheep (T. Murphy, T. Taylor, D. Thomas, M. Maroney, and K. Nelson)

**Background.** Ovine lentiviruses (OLV) are found throughout the majority of sheep producing countries in the world. The ovine progressive pneumonia (OPP) virus is a strain of OLV common to North American sheep operations. In fact, 36% of U.S. sheep operations sampled in 2001 had at least one infected sheep, and 24% of the sampled sheep tested positive for OPP (APHIS, 2003). Similar to the human immunodeficiency virus, the OPP virus is a retrovirus that persists in infected sheep over their lifetime with no existing cure or preventative vaccination protocol.

As its name suggests, OPP affects the respiratory system of infected animals which causes difficulty in breathing in severe cases. It can also have degenerative effects on basic nervous system functions and motor control. However, the most common symptoms of OPP in the ewe are a loss of body condition and hardening of the tissues of the udder (APHIS, 2003).

The economic impact of OPP infection on production traits is poorly understood with, oftentimes, conflicting results. Some studies have reported that OPP negative ewes (NEG) have higher fertility and heavier litter weaning weights than positive ewes (POS) (Keen et al., 1996). Other studies have found no effect of OPP infection on lamb and wool production traits (Gates et al., 1978; Huffman et al., 1981; Dohoo et al., 1987; Snowden et al., 1990). One report actually found an increase in reproductive efficiency in POS ewes (Huffman et al., 1981). Conflicting results are likely due to differences in production setting, management intensity, and accuracy of the testing protocol among experiments.

In a given flock with a prevalence of OPP POS animals, many ewes will continually test NEG despite having constant contact with POS ewes over their productive lifetime. Such observations led scientists at the U.S. Meat Animal Research Center (USMARC), Agricultural Research Service, U.S. Department of Agriculture in Clay Center, NE to conduct a genome-wide association study to determine if any genomic regions may explain susceptibility or resistance to OPP. The researchers were able to find one significant region of DNA near the ovine gene *TMEM154* which codes for a transmembrane protein. This particular transmembrane protein is

thought to play a role in granting/denying a virus access to the cytoplasm of a cell. The researchers identified several mutations that code for differences in the amino acid structure of the TMEM154 protein, and hence, function of the protein (Heaton et al., 2012). These mutations are arranged in several haplotypes, and the most common were named haplotypes 1, 2, 3, and 4 (Heaton et al., 2012) and were found in their studied populations at frequencies of 0.77, 0.08, 0.13, and 0.02, respectively. It was determined that haplotypes 2 and 3 were dominant to haplotype 1 for incidence of OPP infection and that sheep with one or more copies of haplotype 2 or 3 were 2.85 times more likely to be infected with the OPP virus than sheep without haplotype 2 or 3 (Heaton et al., 2012).

The objectives of this study were to determine the prevalence of OPP infection in the purebred Hampshire (H) and Polypay (P) flocks of the University of Wisconsin-Madison and to test the findings of USMARC on the relationship between *TMEM154* haplotype and OPP status.

**Ewe management.** The ewes (n = 188) in the present study were housed at the University of Wisconsin-Madison Arlington Agricultural Research Station. They were intensively managed year-round. They grazed improved pastures during the growing season and were housed indoors during the long winter period. Ewes lambed indoors under close supervision with most lambings occurring during the winter (January – March) and some lambings occurring in the autumn (September – November). All animals were managed under protocols approved by the Institutional Animal Care and Use Committee (IACUC) of the University of Wisconsin-Madison, College of Agricultural and Life Sciences.

**Data.** Ewes were tested for OPP infection between April 2011 and December 2013. OPP POS ewes were generally not retested, but OPP NEG ewes were retested at least once per year. The number of tests per ewe ranged from 1 to 6. Ewes that tested NEG on all earlier tests but POS on the most recent test were classified as POS for OPP infection. Ewes classified as OPP NEG had a NEG result on all tests

Blood samples were collected from each ewe and tested for OPP infection with the Small Ruminant Lentivirus cELISA kit distributed by Veterinary Medical Research & Development (Pullman, WA) at the Wisconsin Veterinary Diagnostic Laboratory (WVDL). The kit's protocol was followed by the WVDL staff and uses a sample inhibition rate of 35%; below this value, a sample was considered NEG and above this level, a sample was considered POS. In addition to serologic testing for OPP infection, blood samples were collected in September 2012 for *TMEM154* genotyping by GeneSeek (Lincoln, NE).

**Statistical analysis.** Simple contingency tables within and across breed were used that arranged ewes according to their OPP infection status (POS or NEG) and whether they were of the diplotype 1,1 or had one or more copies of haplotype 2 or 3. A Chi-square test with 1 degree of freedom determined whether the observed frequency of POS and NEG ewes differed across *TMEM154* haplotypes/diplotypes.

**Results.** The results of the cELISA tests for OPP infection are presented in Table 4. Tests revealed that 55.9% of H and 41.9% of the P ewes were POS. Overall, 46.8% of the Arlington flock tested POS for OPP infection. This is considerably higher than the sample average of 24%

reported by USDA using data from a national survey in 2001 (APHIS, 2003). It should be noted that the dairy flock at the Spooner Agricultural Research Station also has been tested for OPP and is 100% OPP-free.

Table 4. Within and across breed OPP infection status.

Breed	POS, % (n)	NEG, % (n)	Total, n
Hampshire	55.9 (52)	49.0 (50)	102
Polypay	41.9 (36)	58.1 (50)	86
Overall	46.8 (88)	53.2 (100)	188

Table 5 presents the haplotype frequencies from the *TMEM154* genetic tests. Within the H ewes, frequencies were 0.672, 0.221, and 0.108 for haplotypes 1, 2, and 4, respectively. Interestingly, haplotype 3 was not present in the H ewe flock. Within the P ewes, frequencies were 0.890, 0.017, 0.087 and 0.006 for haplotypes 1, 2, 3, and 4, respectively.

A contingency table was set up to group ewes by their OPP status and whether they were diplotype 1,1 or had one or more copies of haplotypes 2 or 3 (Table 6). Overall, 68.2% of diplotype 1,1 ewes were NEG. Conversely, 76.3% of ewes with one or more copies of haplotype 2 or 3 were POS. The Chi-square value of 20.86 was highly significant ( $P < 0.0001$ ) under a one degree of freedom test. Ewes that had one or more copies of haplotype 2 or 3 were 2.45 times more likely to be POS for OPP than the diplotype 1,1 ewes (76.3 vs. 31.2% POS, respectively). These results are in relative agreement with the USMARC study (Heaton et al., 2012) that reported this type of ewe to be 2.85 times more likely to be POS for OPP infection than all other ewes.

Table 5. Within and across breed *TMEM154* haplotype frequencies.

Breed	Haplotypes, frequency			
	1	2	3	4
Hampshire	0.672	0.221	0.000	0.108
Polypay	0.890	0.017	0.087	0.006
Overall	0.771	0.128	0.040	0.061

Table 6. Percentage of OPP positive and negative ewes by *TMEM154* diplotype 1,1 and one or more copies of haplotype 2 or 3.

OPP status	1,1, % (n)	2 or 3, % (n)	Total, n
Positive	31.2 (35)	76.3 (45)	80
Negative	68.2 (75)	23.7 (14)	89
Total, n	110	59	169

The *TMEM 154* haplotype test seems to reveal genetic components that explain a large degree of resistance or susceptibility to OPP. In sheep operations experiencing economic losses due to OPP infection, this genetic test could prove to be a valuable tool. By purchasing diplotype

1,1 rams, a producer can increase the frequency of the less susceptible 1,1 diplotype in the ewe flock. Commercial DNA testing for TMEM154 haplotypes is available from GeneSeek, Lincoln, Nebraska, USA for \$12.00 per animal (<http://www.neogen.com/agrigenomics/Sheep.html>).

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## DAIRY EWE NUTRITION

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### Nutritional Principles

Feed formulation is the art of combining ingredients to meet nutritional requirements of animals. Ruminants have a 4-compartment stomach made up of the rumen, reticulum, omasum, and abomasum or true stomach. The largest compartment is the rumino-reticulum, which contains bacteria and protozoa and functions as a fermentation vat in which fiber is digested. Thus, appropriate feed components are needed for normal ruminal bacteria and protozoa to flourish in order to develop (Warner et al., 1956) and to maintain proper rumen function. Diets for ruminants should, therefore, be formulated to provide: 1) feed components for fermentation by and multiplication of normal ruminal microbes and 2) feed components that are directly digested into nutrients in the true stomach (abomasum) and intestines. The major end product categories of fermentation by ruminal microbes are 1) volatile fatty acids (VFA: acetate, propionate, butyrate), which are absorbed through papillae of the rumen wall and 2) more bacteria and protozoa. The VFA are metabolized by ruminants into glucose and other carbohydrates or used directly as fuel or to synthesize tissues and milk. The bacteria and protozoa are passed to the abomasum and small intestine where they are digested to provide essential amino acids and other nutrients.

Diets should therefore be balanced on measurable **feed components** to supply proportions of digestible nutrients in full-fed animals to optimize milk production. In addition to fresh water, **nutrients** include carbohydrates, lipids, amino acids, vitamins, and minerals.

### Nutrients

The major **carbohydrates** absorbed by ruminant gastrointestinal tracts are volatile fatty acids and sugars. Major volatile fatty acids include acetic acid (vinegar), propionic acid, and butyric acid. Volatile fatty acids are produced by bacteria and protozoa that ferment feed components in the rumen and reticulum parts of the 4-compartment ruminant stomach. Volatile fatty acids likely signal cells in the ruminal wall to maintain and enhance papillae (Warner et al., 1956) that absorb volatile fatty acids into the blood stream. Acetic and butyric acids are important precursors for milk fat formation.

**Lipids** are supplied in feed components or produced by bacteria and protozoa in the rumen. Lipids are absorbed into the blood stream from the small intestine. **Vitamins A, D, and E** are associated with lipids and they or their precursors must be supplied in diets for ruminants. Water soluble **B vitamins** are synthesized by ruminal bacteria and protozoa and normally do not need to be supplied in feed.

**Amino acids** are the units that make up proteins. They are absorbed after feed protein (that escaped ruminal fermentation) or microbial protein is digested in the stomach and small intestine. Microbial protein usually supplies optimal concentrations of the essential amino acids. Feed ingredients with high concentrations of lysine and methionine that escape rumen fermentation sometimes have been shown to improve growth, milk production, and feed efficiency.

Required **minerals** are elements that must be supplied by the diet. Forages and grains often do not contain sufficient salt, calcium, selenium, cobalt, or iodine. Magnesium and sulfur may also be limited. Copper is a required nutrient, but sheep are particularly susceptible to copper toxicity even at levels as low as 15 parts per million. Most diets contain adequate copper. Therefore, except for very special circumstances, copper should not be added to sheep minerals or diets.

### Feed Components

Feed components can be measured or calculated directly (not predicted by regression equations) from measured feed components. Feed components are digestible nutrients or precursors for digestible nutrients. Suggested general levels of feed components are shown in Figure 1, which includes the proportions of each suggested component for production of 0 to 5 (ewes and does) or 50 (cows) kg milk per day.

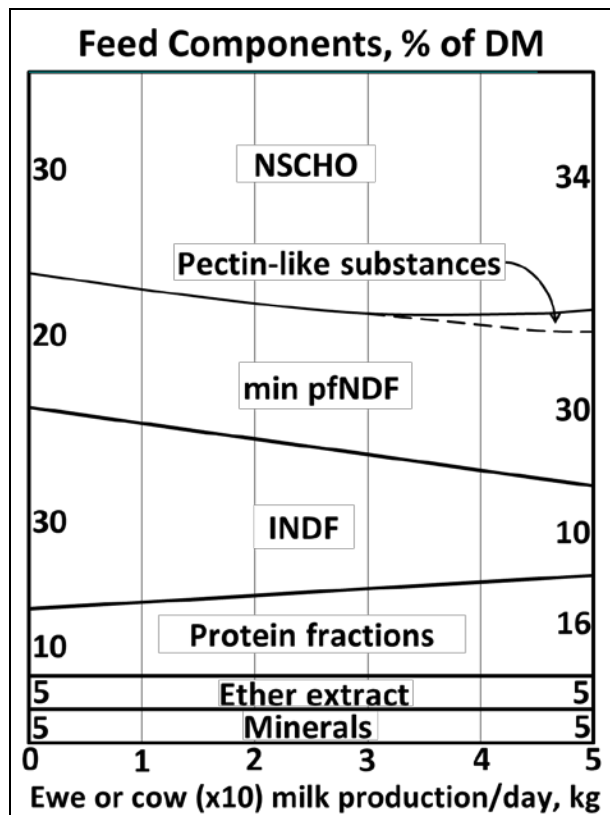


Figure 1. Suggested dietary levels of feed components for lactating ewes, does, and cows (modified from the original of D.E. Hogue).

**Minerals** include the required elements specified above that are usually limiting in forages and grains. The total concentration of minerals in feed ingredients is measured as ash. The average concentrations in feed ingredients are shown in Figure 1 to be 5% of the dry matter of the diet. Concentrations of nutritionally required minerals can be measured directly by most feed analysis laboratories.

Lipids (fats) are measured as **ether extract**. The average concentrations in feed ingredients are shown in Figure 1 to be 5% of the dry matter of the diet. Vitamins A, D, and E or their precursors are in the ether extract.

Because proteins on average contain 16% nitrogen, crude protein is calculated directly as 6.25 multiplied by the nitrogen concentration. **Protein fractions** make up crude protein. Protein fractions include degradable intake protein (DIP), digested by rumen microbes, and undegradable intake protein (UDIP), which escapes ruminal digestion and is digested in the lower gut. UDIP can contain amino acids that

are limited in microbial protein and may improve feed efficiency (Mikolayunas et al., 2011).

The **INDF**, **pfNDF**, and **NSCHO** components of diets make up the carbohydrates. Neutral detergent fiber (NDF) is measured using the neutral detergent method (Van Soest, 1964). NDF includes cellulose and hemicellulose, which both can be fermented by rumen microorganisms unless the fiber also contains too much indigestible lignin. **INDF** is **indigestible NDF**. INDF can be computed directly by subtracting an estimate of metabolic fecal loss (Van Soest, 1994) from dry matter indigestibility. **pfNDF** is **potentially fermentable** (digestible) NDF; the concentration of NDF that can be digested by an animal consuming at a maintenance level of intake. (Digestibility of NDF declines as intake increases because rate of passage through the gut is faster, leaving less time for digestion.) Non-structural carbohydrates (**NSCHO**) include sugars and starches. **Pectin like substances** ferment like NDF and are therefore included in the pfNDF even though by analysis they will be in the NSCHO fraction of the feed.

From the point of view of diet formulation, it is satisfying that the sum of minerals, ether extract, protein fractions (crude protein), INDF, pfNDF, and NSCHO sum to 100% of individual feed ingredients or diets. pfNDF and NSCHO, along with ether extract and sometimes crude protein, are digested and provide absorbed nutrients that can be metabolized to provide energy. Energy is not a nutrient, however, and these feed components have important non-nutritive roles beyond providing absorbed nutrients. Therefore, instead of balancing on energy, it is important to balance diets for carbohydrate components while providing minimum levels of digestible dry matter.

### Non-Nutritive Effects of Carbohydrate Fractions

A meta-analysis of experiments to define the minimum NDF requirements of growing lambs (Hogue, 1993; Hogue, 1994; Hogue and Jabbar, 1991; Thonney and Hogue, 2007) showed that the source of NDF had a major effect upon feed intake. When included at high dietary concentrations, NDF from low digestibility oat hulls reduced intake while NDF from highly digestible soy hulls increased intake.

A designed lamb growth experiment was conducted using 40 raised expanded metal floor pens with 2 lambs per pen in a 10-diet experiment (Figure 2) to confirm the results of the meta-analysis. The objective was to quantify the responses for intake, digestibility, and growth rate to diets across the widest possible range of potentially-fermentable NDF (pfNDF, FNDF at maintenance intake) and INDF values.

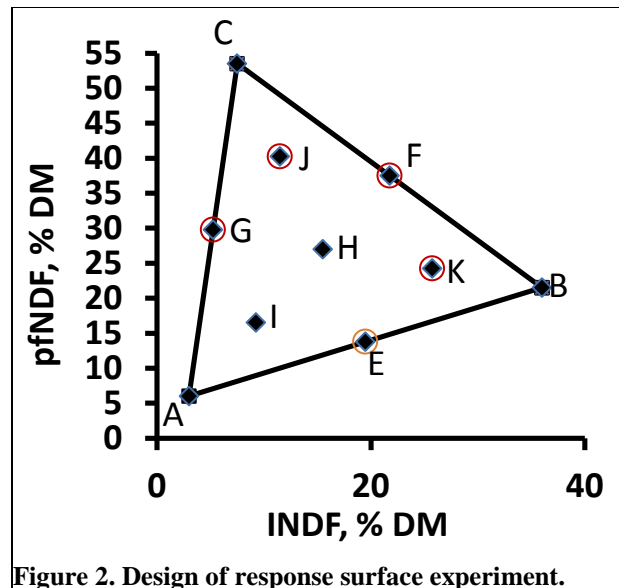
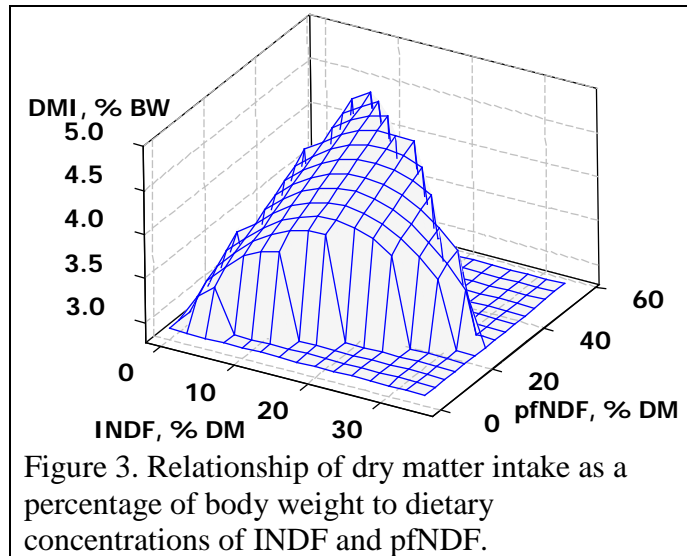


Figure 2. Design of response surface experiment.

As INDF increased, dry matter intake first increased to a maximum at 17% of dietary INDF and then it declined (Figure 3). As pfNDF increased, dry matter increased continuously at any level of INDF (Figure 3). This result is extremely important because the milk production of lactating ewes is highly dependent upon the amount of digestible feed they can consume. Two example trials with lactating ewes demonstrate this effect.



### ***Feeding Ewes with Triplet Lambs***

These feeding trials (Hogue, 1994) were carried out to determine if a diet with sufficient pfNDF would allow high production ewes to consume enough feed to prevent weight loss in early lactation. Hay consumption was restricted to the amounts shown in Table 1.

Total feed intake was much higher than the NRC (1985) expected dry matter intake of 6 lb for ewes rearing twins during early lactation. In fact, the total DMI of ewes in trial 2 was almost 7% of body weight. Furthermore, although

digestibility data were not available, the available digestible dry matter in this trial most probably exceeded that anticipated by the NRC (1985). Instead of losing weight, the ewes all gained weight while their triplet lambs gained rapidly and at maximal rates in trial 2. This demonstrated that, if the diet is formulated properly so that intake is not limited, then it is not obligatory that ewes be in negative energy balance during early lactation.

**Table 1. Observed feed intake and body weight gains of triplet-rearing ewes and their lambs.**

Item	Trial 1 (30 days)		Trial 2 (41 days)	
<i>Ewe feed intake</i>				
Hay	2.0		3.3	
Pellets <sup>1</sup>	6.9		7.6	
Total	8.9		10.9	
<i>Daily gain</i>				
	n	lb/day	n	lb/day
Ewes	8	0.29	14	0.55
Lambs	23	0.49	42	0.71
3 lambs		1.47		2.13

<sup>1</sup>High Energy Lamb Pellets, Agway Inc., Syracuse, NY. A key ingredient to improve intake was 20% soy hulls.

### ***Effect of potentially fermentable fiber on feed intake and digestibility by lactating ewes (Schotthofer, 2007)***

The objective of this MS thesis experiment (Schotthofer, 2007) was to evaluate the effect of pfNDF on feed intake, lamb growth, and milk production of highly productive lactating ewes. Twenty-one sets of ewes with either twin or triplet lambs (2.7 lambs per ewe) were penned

individually in elevated, expanded metal floors less than 1 week after lambing and assigned at random to diets (7 ewes per diet) that contained 15, 25, or 35% pfNDF (Table 2). The experiment lasted 6 weeks.

Feed intake and ewe weight changes are shown in Table 3. Feed intake and weight increased with increasing pfNDF, with the most dramatic increase from 15 to 25% pfNDF. For all diets, the DDMI were much higher than the 2007 NRC maintenance intake levels of 1.05 kg per day.

**Table 2. Diet ingredients.**

Ingredient	Percentage of dietary pfNDF		
	15	25	35
	% in diet dry matter		
Corn grain	47.2	29.2	13.1
Corn gluten feed	44.0	44.0	40.7
Soy hulls	---	18.5	38.6
Limestone	4.4	3.9	3.2
Vegetable oil	2.2	2.2	2.2
Vitamin-mineral premix	2.1	2.1	2.1

Growth rates for lambs that completed the experiment are shown in Table 3. For each diet, the average starting number of lambs per ewe was 2.7. By the end of the experiment, 3 of the 57 lambs had died and others were removed and raised artificially because some ewes lacked sufficient milk. At the end of the experiment, ewes fed the diet with 15% pfNDF had many fewer lambs than ewes fed

the diets with higher pfNDF. Growth rates were dramatically higher for lambs that were suckling ewes fed the 35% pfNDF diet.

**Table 3. Growth and DM intake of ewes and individual lambs.**

Item	Diet pfNDF			SE	<i>P</i> value	
	15%	25%	35%		15% vs 25 & 35%	25% vs 35%
<b>Ewes</b>						
n	7	7	7			
Initial weight, kg	57.7	62.9	61.8	2.56	0.228	0.765
Final weight, kg	56.7	66.8	66.2	3.58	0.038	0.905
Daily DMI, g	2,148	2,971	3,456	186.5	<0.001	0.082
DMI, % BW	3.7	4.6	5.3	0.23	<0.001	0.042
ADG, g/d	-30	93	105	50.7	0.052	0.874
Gain/feed, g/kg	-31.0	31.6	31.7	32.2	0.057	0.997
<b>Lambs<sup>1</sup></b>						
Lambs/ewe <sup>2</sup>	1.7	2.3	2.4	0.32	0.114	0.753
Initial weight, kg	4.3	4.4	4.6	0.29	0.628	0.562
Final weight, kg	11.6	11.4	14.2	0.89	0.324	0.013
ADG, g/d	174	167	229	18.0	0.246	0.007

<sup>1</sup>For lambs that completed the 6-week experiment.

<sup>2</sup>Each diet began with five sets of triplets and two sets of twins (2.7 lambs/ewe).

Keeping the ewes with their lambs in small pens caused udder problems. Lambs over-suckled the ewes, resulting in sores around the base of the teats. As a result, most of the ewes were treated for mastitis. Thus, although milk was measured during the fourth week of lactation over a 3-hour period, the high somatic cell counts and large variations in milk yield reflect problems

with mastitis. They are presented in these proceedings in Table 4 and Table 5 as the only known data on the effect of pfNDF on milk yield and composition.

Table 4. Milk yield, extrapolated from 3-hour milking data to represent 24-hour milk yield, and milk composition.

Diet	Milk yield, g	Milk fat, %	True protein, %	SCC x 1000	MUN, mg/dL	CP, %	Lactose, %	Total solids, %
15% pfNDF	2,663	10.2	5.37	7,312	23.2	5.03	4.58	20.8
25% pfNDF	3,120	6.38	4.23	4,812	21.6	4.43	5.42	16.9
35% pfNDF	3,589	7.14	4.37	1,253	26.2	4.56	5.44	17.7
SE	563.1	1.002	0.6233	2,704	1.523	0.5580	0.4010	1.177
<i>P</i> value:								
15% vs 25%,35%	0.329	0.009	0.154	0.213	0.694	0.445	0.082	0.018
<i>P</i> value:								
25% vs 35%	0.564	0.583	0.870	0.364	0.034	0.863	0.981	0.609

Table 5. Milk composition yield.

Diet	Milk fat, g	True protein, g	Crude protein, g	Lactose, g	Total yield, g
15% pfNDF	235	120	120	138	513
25% pfNDF	211	147	148	182	561
35% pfNDF	275	163	164	196	654
SE	58.63	28.33	28.34	35.59	119.8
<i>P</i> value: 15% vs 25%,35%	0.911	0.363	0.289	0.231	0.502
<i>P</i> value:					
25% vs 35%	0.429	0.654	0.682	0.771	0.576

Obviously, the high SCC – particularly for the ewes fed the 15% pfNDF diet – make interpretation difficult. Although nonsignificant, milk yield and all components except fat increased with increasing pfNDF (Table 5). Cannas et al. (1998) studied the relationship between MUN levels and dietary protein levels. They reported an MUN level of 17.0 mg/dL associated with a dietary CP level of 16.6% and an MUN level of 22.3 mg/dL associated with a dietary CP level of 18.8%. The diets for this experiment contained CP levels around 17%, but the MUN levels averaged between 21.6 mg/dL and 26.2 mg/dL (Table 4); higher than would be expected. Perhaps this can be attributed to the high level of DMI, which resulted in higher protein intakes.

Total solids are usually 17.5% of sheep milk (Pulina et al., 2002). The 25% and 35% pfNDF diets resulted in milk solids similar to normal composition. The fat yield from ewes fed the 15% pfNDF diet may be higher than that of the 25% pfNDF diet because there were higher incidences of udder infections at the time of milking in ewes fed the 15% pfNDF diet, causing the milk components to be more concentrated with low yields.

The upper threshold for SCC in uninfected mammary glands of sheep ranges from 260,000 to 1,580,000 cells/mL (McDougall et al., 2001). The SCC levels for ewes in this experiment reflect

mastitis. While it is therefore difficult to make solid conclusions about the effects of diet on these milk production data, the numbers of lambs reared and their growth rates (Table 3) support the conclusion that the higher feed intakes of ewes fed diets higher in concentration of pfNDF resulted in increased milk yield over the 6-week experiment.

## **Feed Formulation**

### ***Forage***

High quality forage is the basis for dairy ewe diets. Because digestibility of forage declines about 0.5 percentage units per day after late April (Reid et al., 1959), early harvesting is important. Ewes that graze intensively managed pastures with frequent rotations by definition will consume high quality forage. Forage in early spring pasture, however, may be so high in water and so low in pfNDF that dairy ewes may not be able to consume enough dry matter; particularly pfNDF. In that case, supplemental high quality grass hay or a forage supplement high in pfNDF is desirable.

Preserved forage is needed for animals during winter in northern latitudes. Drying weather for making early-cut hay often is limited in rainy areas west of the Cascades in Washington and Oregon and in most areas of the eastern US. Often, the best way to preserve early cut forage in those areas is to ensile it. Many dairy sheep flocks are too small to remove sufficient forage daily from silage bunks to keep the silage face from spoiling. The best alternative is to preserve haycrop silage in wrapped bales (baleage).

Most dairy ewes require forage supplements to maximize milk production. Whether maximum milk production should be the goal depends upon price of supplement ingredients, farmer goals, and marketing options. For example, both organic and non-genetically modified organism (GMO) claims require that all feed ingredients be from non-genetically engineered sources. Grass-fed only claims do not allow grain to be fed.

### ***Complete mixed diets***

An example of a complete mixed diet to maximize milk production for dairy ewes based upon high quality haycrop silage (15% crude protein, 36% pfNDF) is shown in Figure 4. The custom premix (Figure 5) was included at about 1% of the dry matter. Barley replaced some of the grass silage to provide sufficient digestible dry matter (DDM). Soybean meal replaced some of the added barley to provide sufficient crude protein. Soy hulls replaced some of the grass silage to provide sufficient pfNDF. Calcium carbonate replaced some of the grass silage to raise the Ca:P ratio to about 2:1.

### ***Forage supplement approach***

Complete mixed diets are only an option for silage that has been chopped into a silo that can then be mixed using a forage mixer, usually mounted on a trailer or truck. Most ewe diets will be based upon pasture, hay, or haycrop baleage with a free-choice mineral mix and a simple supplement supplied in the parlor like the ewes in the experiment of Mikolayunas et al. (2008). Assuming a free-choice mineral mix was offered, suppose that the same forage as in the complete mixed diet shown in Figure 4 was offered free choice as silage, pasture, or dry hay.

Feeding 1.5 lb of whole shelled corn and 0.5 lb of soybeans in the milking parlor twice daily would provide a diet that is 72.2% DDM, 15.5% CP, and 24.6% pfNDF. In addition to being low in DDM, the low pfNDF concentration in this diet would limit DDM intake and, therefore, milk production. However, this may be the only option for feeding small flocks.

<b>Feed</b>						
<b>DSANA complete diet</b>			<b>10/21/2014</b>		<b>Thonney</b>	
Copyright ©2012 M. L. Thonney						
			<b>\$ per ton</b>		<b>\$ per ton DM</b>	
<b>Ingredient</b>	<b>%</b>	<b>Ingredient</b>	<b>Feed</b>	<b>% DM</b>	<b>Ingredient</b>	<b>Feed</b>
For - Grass silage 2013 CURC	55.9	40	22.36	29.8	\$133	39.61
Gm - Barley, Heavy - DEH	25.0	118	29.50	39.9	\$131	52.26
Bypr - Soy hulls - 30 Jul 2010	14.0	160	22.40	22.1	\$179	39.69
Prot - Soybean meal, 49%	4.00	343	13.72	6.31	\$385	24.31
Pmx - Hewitt/Old Mill Premix 20	0.6000	750	4.50	1.01	\$789	7.97
Min - Calcium carbonate	0.5000	200	1.00	0.8858	\$200	1.77
<b>Totals:</b>	<b>100.0</b>		<b>\$93</b>	<b>100.0</b>		<b>\$166</b>
<b>Cost per pound:</b>			<b>4.7 ¢</b>			<b>8.3 ¢</b>

<b>Estimated component composition</b>												
019 Ewes: Early lactation (3 lambs)			150.0 lb		Estimated DM intake: 8.3 lb or 3.7 kg							Ca:P 1.99
			68.0 kg									
DM, %	DDM, %	CP, %	NDF, %	Indigestible NDF, %	pnNDF, %	NSCHO, % (max)	EE, %	Ash, %	Ca, %	P, %		
Feed: 56.44	75.50	15.68	42.00	11.47	30.63	33.66	2.42	6.24	0.65	0.32		
Suggested level:	75.00	16.00		10.00	30.00	34.00	5.00	5.00	0.65	0.29		
Feed minus level:	0.50	-0.32		1.47	0.63	-0.34	-2.58	1.24	0.00	0.03		
K, %	Mg, %	S, %	I, ppm	Fe, ppm	Cu, ppm	Mo, ppm	Co, ppm	Mn, ppm	Zn, ppm	Se, ppm		
Feed: 1.40	0.19	0.17	0.85	423.67	6.84	1.97	3.03	63.12	60.21	0.44		
Suggested level:	0.80	0.18	0.28	50.00	10.00	0.50	0.20	40.00	33.00	0.30		
Feed minus level:	0.60	0.01	-0.09	373.67	-3.16	1.47	2.83	23.12	27.21	0.14		
VitA, kIU/lb	VitD, kIU/lb	VitE, IU/lb	Decoquinat, g/lb	Monensin, mg/lb	Lasalocid, mg/lb							
Feed: 1.28	0.16	45.18	0.0000	0.0	0.0							
Suggested level:	1.13	0.15	43.00	0.0138								
Feed minus level:	0.14	0.01	2.18	-0.0138								

Figure 4. Example of a complete mixed diet based upon grass silage for dairy ewes.

Another option is to purchase or mix the non-forage parts of a diet like that shown in Figure 4 and feed it as a supplement (Figure 6) at the rate of 6.5 lb per day or 3.24 lb twice per day per ewe. If not top-dressed or mixed with wet silage, the supplement would be too dusty to feed in the parlor or with hay. Pelleting is the best option. An alternative to pelleting is to include 10% molasses in the supplement.



Formula Code	Description	Species Code	Ver
HEWCUSHD	HEWITT'S/ CORNELL U. SHEEP MI	5	9
Code	Ingredient Name	Amount	Pct
1080	SALT	1,000.000	50.00
1005	DISTILLERS GRAINS (CARRIER)	917.9290	45.90
3080	VITAMIN E	35.8325	1.79
2020	MANGANESE SULFATE	15.3327	0.77
2090	ZINC SULFATE	11.0413	0.55
1010	OIL	10.0000	0.50
2035	MOLYBDENUM	7.0000	0.35
2220	SELENIUM 3%	2.0000	0.10
3030	A1000/D200	0.3261	0.02
2200	CALCIUM IODATE	0.2520	0.01
3000	VITAMIN A	0.1996	0.01
2170	COBALT CARBONATE	0.0870	
No.	Nutrient Name	Actual	Units
1	WEIGHT	1.0000	LBS
14	LYSINE	0.3580	PCT
15	METHIONINE	0.1838	PCT
30	CALCIUM	0.1877	PCT
32	PHOSPHORUS-TO	0.3396	PCT
33	SALT	50.0000	PCT
34	SODIUM	19.5000	PCT
36	MANGANESE	0.2500	PCT
37	ZINC	0.2000	PCT
38	IRON	0.0019	PCT
39	COPPER	6.9912	PPM
40	COBALT	20.0000	PPM
41	IODINE	80.0000	PPM
44	VITAMIN A	120,000.0000	IU/LB
45	SELENIUM	30.0000	PPM
46	VITAMIN D-3	15,000.0000	IU/LB
47	VITAMIN E	4,250.0000	IU/LB
59	SULFUR	0.2423	PCT

Figure 5. Cornell custom premix formulated and mixed by [The Old Mill](#) (800-945-4474) in Troy, VT.

Supplement			
DSANA supplement		10/22/2014	
		\$ per ton	
Ingredient	%	Ingredient	Feed
Grn - Barley, Heavy - DEH	56.5	118	66.67
Bypr - Soy hulls - 30 Jul 2010	32.0	160	51.20
Prot - Soybean meal, 49%	9.00	343	30.87
Prmx - Hewitt/Old Mill Premix 2010	1.40	750	10.50
Min - Calcium carbonate	1.10	200	2.20
Totals:		100.00	\$161
Cost per pound, ¢:			8.1

Figure 6. Supplement for haycrop silage.

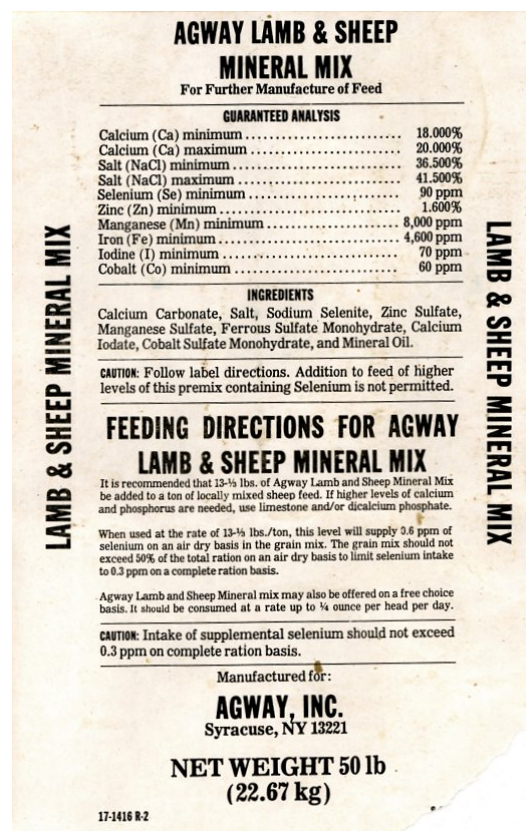


Figure 7. Feed tag for Agway (Cargill) lamb & sheep mineral mix.

### Minerals

The feed tag for a free-choice mineral mix that has worked reasonably well for pasture and for supplementing preserved forages is shown in Figure 7. There is evidence that the iodine concentration should be doubled to 170 ppm to increase lamb vigor at birth. Note that salt (NaCl) is included and that the mineral mix contains the maximum concentration of selenium (90 ppm) allowed by federal law.

Animals consume minerals because they like the taste of salt (NaCl). Therefore, all minerals – including salt – should be offered mixed together in one feeder. Like humans, sheep do not have nutritional wisdom (Burghardi et al., 1982) to choose appropriate minerals.

### ***Suggested levels of dietary feed component***

General guidelines for feed component levels are given in Figure 1. “Feed components” are specified rather than “nutrients.” Approximate “suggested dietary levels” are used instead of “requirements.” Specific suggested values for feed components are provided in the *FeedForm* diet formulation package<sup>1</sup> for a variety of farm animals. Guidelines for dairy ewes are shown in Table 6.

Table 6. Suggested levels of feed components for highly productive lactating ewes.

Weight, lb	DMI, % BW	Estimated DMI, lb	Estimated DMI, kg	DDM, %	CP, %	INDF, %	pfNDF (min), %	NSCHO (max), %	EE, %	Ash, %					
150.00	5.5	8.25	3.74	75.00	16.00	10.00	30.00	34.00	5.00	5.00					
Ca, %	P, %	K, %	Mg, %	S, %	I, ppm	Fe, ppm	Cu, ppm	Mo, ppm	Co, ppm	Mn, ppm	Zn, ppm	Se, ppm	VitA, kIU/lb	VitE, IU/lb	VitD, kIU/lb
0.39	0.29	0.80	0.18	0.26	0.80	50.00	10.00	0.50	0.20	40.00	33.00	0.30	1.13	43.00	0.15

### ***Feed component values***

Some approximate feed component values are given in Table 7 with more in the feed library of the *FeedForm* diet formulation package. Included are several forages at different maturity levels, the major grains, and a variety of by-products widely available for feeding. Values are listed for NSCHO (sugars and starches), neutral detergent fiber (NDF) divided into potentially-fermentable (pfNDF) and indigestible (INDF), crude protein (CP), ether extract (EE), and ash. These components sum to 100% of the dry matter.

The DDM, CP, EE and Ash values were taken from existing tables, primarily those of Van Soest (1992). Digestible dry matter generally was considered to be equivalent to TDN except for feeds rich in EE or Ash. Furthermore, INDF is highly negatively correlated with DDM so that one or the other could be omitted. However, digestible dry matter at 1X maintenance was included so that INDF could be calculated as the difference between indigestibility and endogenous fecal losses. Intake levels higher than maintenance result in a depression in digestibility (Tyrrell and Moe, 1975; Van Soest and Fox, 1992; Wagner and Loosli, 1967). Because it is primarily fiber digestibility that is depressed as intake increases, FNDF levels of ingredients will be lower for producing animals with consumptions above maintenance. To compensate for this digestibility depression, correspondingly higher pfNDF levels were suggested in Figure 1 and in the *FeedForm* diet formulation package. Most feed components will have considerable variation and therefore the numbers in Table 7 and in the *FeedForm* tool should be considered as being approximate.

<sup>1</sup>Available at:

<http://www.sheep.cornell.edu/management/economics/cspssoftware/feedform/index.html>.

Table 7. Some approximate feed component values for intake at maintenance.

Ingredient		NSCHO	pfNDF	INDF	CP	EE	Ash	DDM
Forages		----- % of dry matter -----						
Alfalfa	Early bloom	27	19	23	19	3	9	62
	Mid bloom	25	21	25	17	3	9	60
	Late bloom	23	23	32	12	2	8	53
Orchard grass	Early bloom	20	37	20	10	3	10	65
	Late bloom	13	36	31	8	3	9	54
Timothy	Late veg.	20	40	15	14	3	8	70
	Early bloom	18	40	21	11	3	7	64
	Late bloom	14	39	29	8	3	7	56
	Seed stage	14	34	38	6	2	6	47
Corn silage, 45% grain		42	28	13	9	3	5	72
Wheat straw		2	40	45	3	2	8	40
Grains								
Barley	Heavy	63	14	5	13	2	3	84
	Light	52	17	11	14	2	4	77
Corn		75	6	3	10	4	2	87
Oats, 32 lb/bushel		37	27	15	13	3	5	73
Wheat		69	10	6	11	2	2	84
By-products								
Beet pulp		32	40	14	8	1	5	74
Citrus pulp (15 pls <sup>1</sup> in pfNDF)		44	32	6	7	4	7	82
Corn germ meal		26	29	12	27	3	3	76
Corn gluten feed		18	40	5	25	7	5	83
Cottonseed hulls		0	50	40	4	2	4	45
Dried brewers grains		17	28	18	26	7	4	67
Dried distillers grains		10	42	8	26	10	4	80
Hominy		25	50	5	12	7	1	85
Oat hulls		9	28	50	4	2	7	35
Soy hulls		11	62	8	12	2	5	80
Wheat midds		40	32	5	18	3	2	83
Protein supplement								
Soybean meal, 44% CP		28	9	5	49	2	7	80

<sup>1</sup>Pectin-like-substances.

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## **BLACK SHEEP CREAMERY**

**Brad and Meg Gregory  
Chehalis, Washington, USA**

Along with our three boys, we are the second family to own this 130 acre farm in the Chehalis valley. Our farm was established about 120 years ago in what was then a leading hop growing area. Hops gave way to peas, corn, grains and cows just after 1900. The original family, the Tramm, milked cows until the mid 70's, and raised beef cows for some years after that. We bought this farm 21 years ago and backed up a little bit by starting with growing peas, corn and grains with no plans or experience with animals. As time went on, and those didn't pay we moved to growing grass seed crops and hay.

We got a nudge in a different direction when our middle son, Andrew was born with a (cow) milk allergy. A very skinny baby, we went looking for alternatives to rice and soy milks that weren't keeping him fed well enough. Thus started our sheep education.

After asking this same question we've been asked at many farmers markets; "You do what with sheep?", we bought our first three ridou arcott ewes and a ram in 2000. After sending them off to do their breeding thing, we set back to wait the five months of gestation for our first lambs. Four months later we were the happy farmers of some cute looking ridou arcott/Navaho churro lambs. Something about the brother of the original owner letting off a ram in their ewe pen before the ewes were sold.

One of these ewes was very patient with me the first time I tried to milk her. She got to spend several hours in our newly made wood milking stand before I got the first drop of milk out of her. See above note about "no experience with animals." And so our sheep dairying experience has progressed.

We now milk 85 ewes from the first of February until they give it up sometime in September. They are on pasture as soon in Feb as it starts growing until high river waters keep us off pasture sometime in November or so. We make our own rye grass/fescue hay for winter and buy in some Eastern Washington alfalfa in the winter. We feed a local oat/barley grain mix as an additional feed late lactation and milking. On this our ewes average 500# a season with a few just shy of 1000#.

We make a variety of cheeses. From the start of milking to mid August, we make a fresh cream type pasteurized cheese. We make several hard cheeses, both raw milk and pasteurized. We have also recently started buying some cow milk and make two mixed milk cheeses. One is a hard cheese and the other is a robiola, semi-soft type. Our facilities include a milk parlor converted from cow to sheep, a main cheese making room that was the "bulk tank room" in the cow days, and a refrigerated container for a cave. We also have a packing room next to our cave to prep cheese for market.

In the past, we sold at several farmers markets in the Seattle to Portland areas. We now sell primarily to stores, cheese shops and distributors. Most of our sales are on the West coast, with some cheese tickling to the East coast.

In the last three years, Meg has begun to develop a wool and yarn side to our business. At shearing, we grade our fleeces into handspinning, yarn, felting, or composting qualities and process them accordingly.

Lambs for meat is our last profitable frontier. We sell animals to people for meat, but don't currently have a USDA approved processor close enough to deal with. That may change soon as there is a mobile slaughter unit in the works for our area. This will be USDA inspected meat and will allow us to sell cuts or sausages.

**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
- 2012 – Bill Halligan, Bushnell, Nebraska, USA – Dairy sheep producer
- 2013 – Axel Meister, Markdale, Ontario, Canada – Dairy sheep producer and early importer of East Friesian dairy sheep into North America

## **Locations and Chairs of the Organizing Committees of the Dairy Sheep 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
- 2013 – 19th Dairy Sheep Association of North America Symposium – Cambridge, Ontario, Canada  
Eric Bzikot - Chair
- 2014 – 20th Dairy Sheep Association of North America Symposium – Chehalis, Washington, USA  
Terry Felda, Brad and Megan Gregory – Co-Chairs





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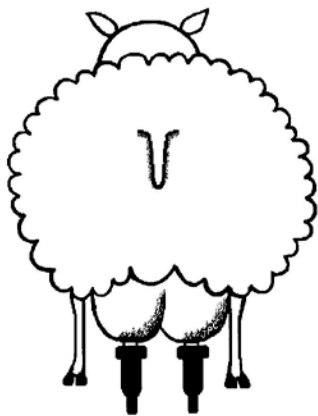
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