FARMERS' GUIDE to DAIRY SHEEP UDDER ASSESSMENT

Bee Tolman
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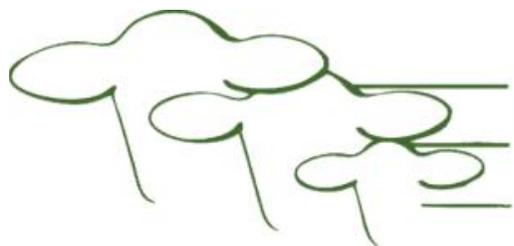**Andrea Mongini DVM**

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Contents

Purpose of the North American dairy sheep udder-assessment system

We are presenting this udder scoring system in two parts:

☆ **Scoring the milking flock**

Every ewe in the flock will be scored using 4 udder traits, all of which can be scored once a year at any point during the peak lactation period, in the milking parlor with clipboard/paper/pencil, and without handling the ewes.

The milking flock scoring will be used in your breeding program to identify the milking ewes from whom you will select replacements – your replacement ewe lambs and any ram lambs that might become herd sires.

Scoring the milking flock is easy to learn, quick to accomplish, and can be readily incorporated into every commercial sheep dairy flock.

☆ **Assessing the dams and grand-dams of potential flock sires**

This part of the assessment system includes udder and structural traits that need only be used on the few dams and paternal grand-dams of potential flock sires.

THE GOAL

The goal in using this udder assessment system is to identify the strengths and weaknesses in your milking string's udder characteristics, so that you can make great improvements in udders and

1. Milk the flock without the use of Sagi hooks or machine-stripping; and
2. Reduce the number of ewes culled for time-consuming or structurally-blown udders, and therefore reduce the percentage of your lamb crop retained as replacements.

Ultimately, the goal is to make your flock more _milkable_ … without sacrificing your flock's milk production.

AS YOU ARE USING THIS GUIDE AND ASSESSING YOUR FLOCK'S UDDERS, REMEMBER:

You are **learning and using a new tool** that will allow you to make breeding program decisions based on two key economic criteria: milk production and udder conformation.

In the process of learning and using this tool, you will start to **see and understand udder traits** and how you can change them in your flock.

You are engaged in **genetic evolution**: by making udder conformation assessment part of your breeding program, you will begin to see some of the first changes in your flock's udder conformation in the first year. But you are engaged in a long-term, ongoing process of strategic improvement in the shape and structure of your flock's udders.

CHAPTER 1: The Udder

A. The Udder: Alveolar and Cisternal areas

Think of the udder as two parts:
1. the milk-producing gland, made up of milk-producing clusters of alveoli and the gland cisterns that hold the milk, *plus*
2. the suspensory apparatus, made up of ligaments and their branching connective tissues which together physically support the gland.

How the **mammary gland** works: think of the gland as having a "factory" that manufactures the milk, and a "warehouse" that holds the milk until it is shipped out.

Two primary parts:
− Parenchyma – "the Factory" – primarily in the upper portions of the gland, made up of milk-secreting cells formed into globes called alveoli;
− Cisterns -- the "Warehouse" – primarily lower in the gland, interconnected caverns filled with milk via ducts from alveoli
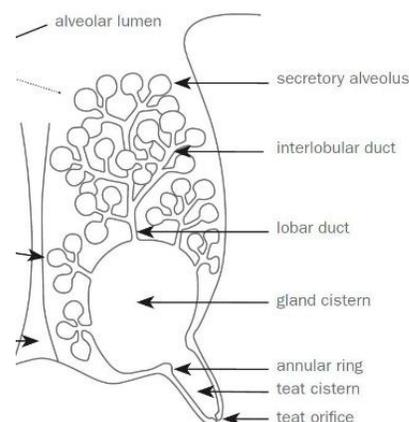
In all dairy animals – cows, goats, sheep – the alveoli in the parenchyma will continue producing milk until the cisterns fill up, and milk starts to back up and accumulate in the alveoli. This milk pressure actually flattens the milk-producing cells, stopping milk production (Nickerson & Akers, 2011).

In dairy cows: 65% of the milk stored in the udder is held in the alveoli; 35% is cisternal. Therefore the more often a cow is milked to empty the cisterns and the alveoli (i.e., 3x/d), the more milk she produces.

In dairy sheep: 35% of the milk stored in the udder is held in the alveoli; 65% of the milk is stored in the cisterns. This is why there is no advantage to milking sheep more than 2x/d, and why many producers can drop to 1x/d milking when daily milk production decreases later in the production season.

Illustration of cross-section of dairy cow udder. Note smaller area taken up by cisterns. But also note the connected, cavernous layout of the cisterns.

Mammary gland (udder)
1. Body of gland
2. Lactiferous sinus (milk cistern)
3. Papilla (cavity of teat)(teat sinus)
4. Lactiferous duct
5. Teat
6. Septum between glands
7. Intermammary groove

Parenchyma -- "the factory" – made up of microscopic clusters of milk-producing alveoli

Cisterns -- "the warehouse" – which receive milk from ducts descending from the alveoli

Picture of small ruminant udder – notice large area taken up by cistern

The importance of cisternal capacity in dairy sheep

As noted above, the majority of the milk "stored" by dairy sheep (i.e., between milkings) is held in the cavernous cisternal regions of the udder. This makes a ewe's cisternal capacity extremely important to her ability to produce milk: when her cisterns fill, her alveoli will slow and then stop their production of milk.

A study of dairy ewes in Spain showed that if environmental influences are equal (i.e., same farm, same group management, same feed), the difference in the milk yield of lower- and higher-production ewes is highly correlated with their cisternal capacity. This study is summarized below.

Evaluation of Udder Cisterns and Effects on Milk Yield of Dairy Ewes, Rovai et. al., 2008.

The alveolar area *vs* cisternal area, and the milk fractions contained in the alveoli *vs* the cisterns, were compared between 3rd-lactation Manchega and Lacaune ewes at 90 days in milk (DIM).

- the Manchega ewes were averaging 0.94 kg/d (2.1 lb/d, equivalent to a lower-producing American ewe producing ~ 775 lb in 240 DIM);
- the Lacaune ewes were averaging 2.07 kg/d (4.6 lb/d, equivalent to an American ewe producing ~ 1,100 lb in 240 DIM).

Sonogram values per half-udder for Manchega and Lacaune ewes differed in cisternal area (12.8 and 23.7 cm^2) and cisternal milk (120 and 269 mL), but not in alveolar milk (95 and 102 mL), respectively. [*In other words, "despite the differences in daily milk yield, alveolar milk did not vary between breeds, emphasizing the role of the cisternal more than the alveolar compartment for maximizing daily milk secretion in dairy sheep".*]

"Cisternal area and cisternal milk were positively correlated (r = 0.79)". [*In other words, when cisternal area increased, cisternal milk volume increased.*]

Ratios between cisternal and alveolar milk were 56:44 and 73:27 for Manchega and Lacaune ewes, respectively. [*In other words, in the higher-producing ewes, almost 75% of the milk was contained in the cisterns.*]

Despite the difference in average daily milk yield at the same stage of lactation, the volume of milk contained in the alveolar portion of the udder were similar.

Rovai concluded that in the dairy ewes studied, cistern size appeared to be a limiting factor for milk production: **"selection for milk yield in dairy sheep has modified the anatomical structure of the udder, increasing the size of the cisternal compartment in high-yielding ewes".**

Rovai, Maristela & Caja, Gerardo & Such, Xavier. (2009). Evaluation of Udder Cisterns and Effects on Milk Yield of Dairy Ewes. Journal of dairy science. 91. 4622-9.

For many years, North American dairy sheep producers have selected for increased production and, in the process, essentially selected for larger cisternal capacity.
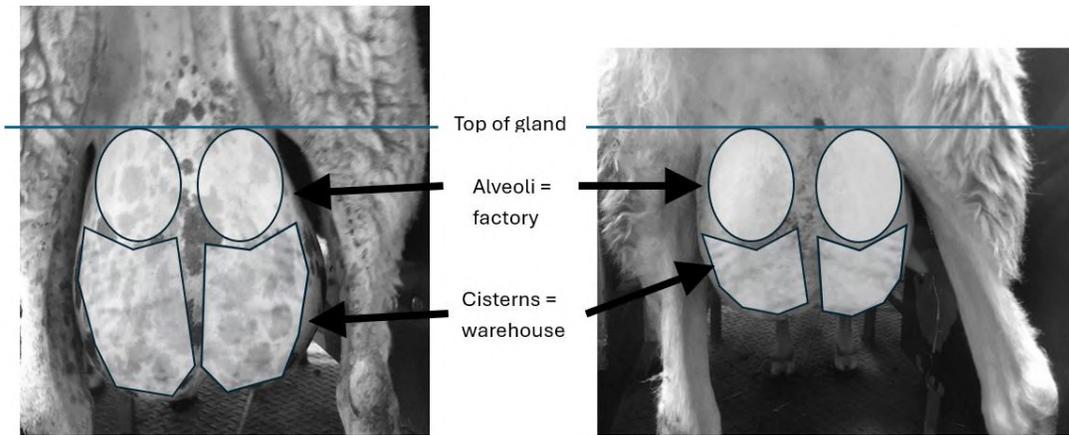
Here is an example of two ewes, of the same age, where you can see the difference in cisternal area and its correlation with milk production.

Ewe 1638. Pictured as a 3-yr-old.
Milked between 11 – 13 lbs/d for the 1st 100 days. Produced 2,020 lbs milk in 245 days.

Ewe 1644. Pictured as a 3-yr-old.
Milked between 4-7 lbs/d for the 1st 100 days. Produced 1,040 lbs milk in 240 days.

So what's the issue? It is this:

When you select for milk production and cisternal capacity, you must also select for the ewe's ability to physically support – to hold up and carry – that additional milk weight.

More milk = more weight. Also, more milk = more swinging force as she walks. Flocks selected for higher production but not for better udder conformation can have udders that cannot withstand the weight of the milk and the motion of the full udder; in these cases many high-production ewes have to leave the flock at young ages because their udders do not hold up.

When a producer scores ewes on udder conformation and selects replacement rams from high-production ewes with strong udder conformation, that producer is selecting for a stronger udder-support apparatus to support the udder and for better teat placement for getting the milk out.

The good news is that most of the udder conformation traits are pretty darned heritable – in other words, if you know what to look for, the sires you choose are quickly going to have a positive effect on the udders of your flock's replacement daughters.

First, a brief overview of lactation physiology – how milk is made in the dairy sheep: Understanding the FACTORY and WAREHOUSE (the alveoli and the cisterns)

(Unsurprisingly, most available illustrations come from cow physiology research. However, the lactational physiology structures between dairy sheep and dairy cows are very similar.)
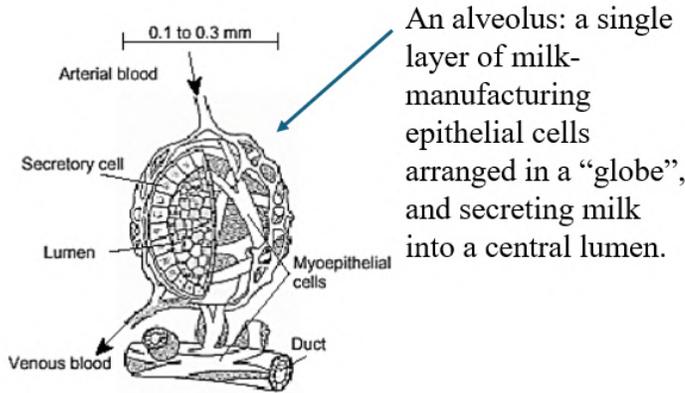
An alveolus: a single layer of milk-manufacturing epithelial cells arranged in a "globe", and secreting milk into a central lumen.

Milk leaves the alveolus via a duct.

Clusters of alveoli are connected via ductwork into lobules, which are grouped and connected by larger ducts, and then grouped into lobes.

This illustration shows groups of alveoli clustered together in lobules and joined to other lobules by "intralobular ducts".

Finally, the primary ducts feed into the "gland cistern" (which is not a single cistern as depicted here, but a great number of interconnected cisterns). And then, of course, the milk flows out through the teat.

How are the alveolar lobes and ducts and cisterns supported?? (They are heavy with milk and certainly can't just be floating in the udder!)

They are supported by a scaffolding of connective tissue, illustrated here and here.

Cisterns in dairy sheep have been described as: "a torturous system of cavities".
Marnet and McKusick, 2001.
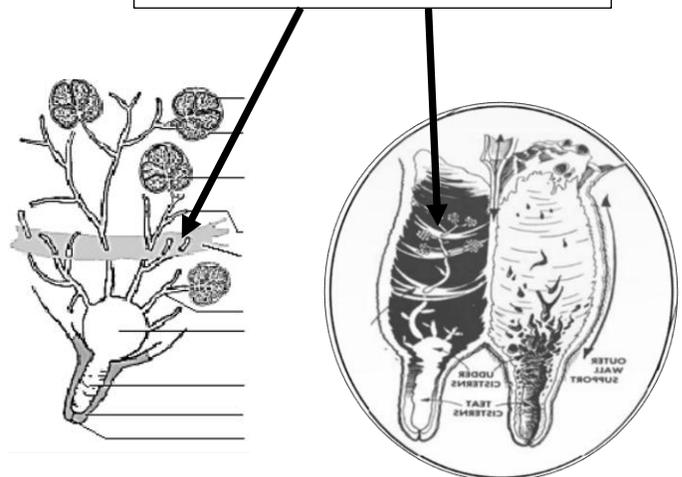
B. The Ligaments

Introducing the support apparatus – the ligaments

The udder's suspensory system consists of 6 structures, listed here in order of importance to the integrity of the udder:

1. **Medial suspensory ligament, the udder's primary support structure, divides and supports the udder's two glands**
2. **Lateral suspensory ligaments form the outer walls of the udder**
3. Subpelvic tendon gives rise to the lateral suspensory ligaments
4. Tissue that connects the udder's fore udder to the abdominal wall
5. Subcutaneous tissue that connects the skin to the lateral ligaments
6. Skin

The Medial Suspensory Ligament and the Lateral suspensory ligaments are key to improving the udder conformation of dairy sheep. It is these ligament structures that support the weight of milk in the high-producing ewe.

The medial and lateral suspensory ligaments have two purposes:

- Support the weight of the udder, particularly when it is full of milk and when the ewe is walking
- Create the "scaffolding" of connective tissue, called "lamellae", that supports the alveolar lobes in the parenchyma

Suspensory apparatus, cross section (schematic)

Suspensory apparatus

- A. **Symphyseal tendon**
- B. **Medial suspensory lig.** (mainly yellow elastic tissue)
- C-D. **Lateral suspensory lig.** (mainly collagenous)
  - C. **Superficial layer of suspensory lig.**
  - D. **Deep layer of lateral suspensory lig.**
- E. **Lamellae**

Connective Tissue

Ducts

Udder Cistern

Teat Cistern

Glandular Secretory Tissues

OUTER WALL SUPPORT

UDDER CISTERNS

TEAT CISTERNS

Remember: these illustrations are of a cow udder. The dairy sheep udder will have a much larger proportion of the "cavernous" cisternal area. However, the illustrations are valuable in showing the connective "scaffolding" that helps support the glands.

The Medial Suspensory Ligament

The most important part of the suspensory system in dairy sheep is the Medial Suspensory Ligament (MSL)

- The MSL is two adjacent heavy sheets of tissue composed of both yellow elastic and fibrous tissue. The MSL attaches the udder to the ewe's abdomen and creates medial flat surfaces that separate the left and right halves of the udder.
- The MSL's fibrous connective tissue has great tensile strength but its yellow elastic tissue is able to stretch somewhat as the gland fills with milk, to allow for the increased weight of the gland.
- The MSL is located at the udder's center of gravity -- it keeps the gland balanced under the ewe. There is *no* internal crossover of the milk duct system between the two udder halves.
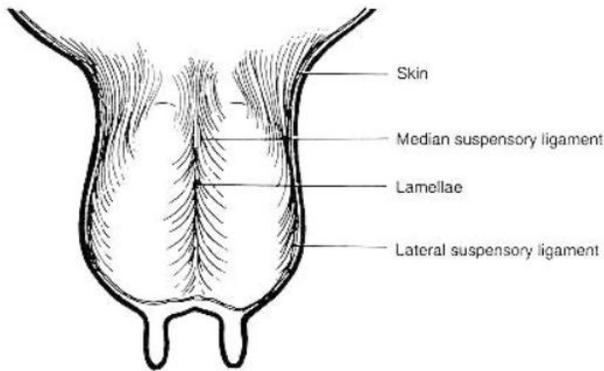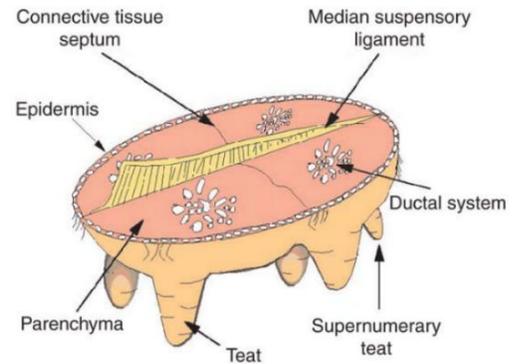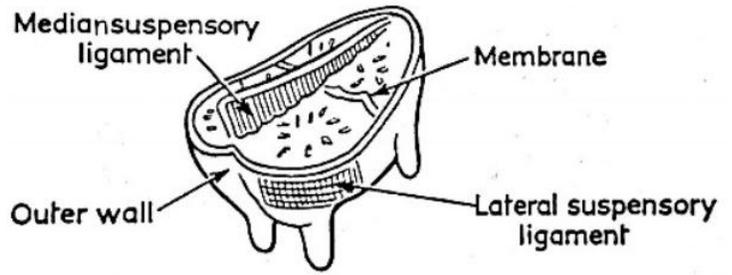
Above: Two cross-section illustrations of a cow dairy udder, showing the medial suspensory ligament. Aside from two halves instead of four quarters, the anatomy is the same for dairy sheep: the MSL divides the udders into two distinct halves and suspends the entire udder from the abdominal wall.

The medial suspensory ligament also has lateral branches (lamellar plates) that insert into the parenchyma to help support the alveolar lobes. The drawing above and the two below illustrate the lamellae branching into the gland.
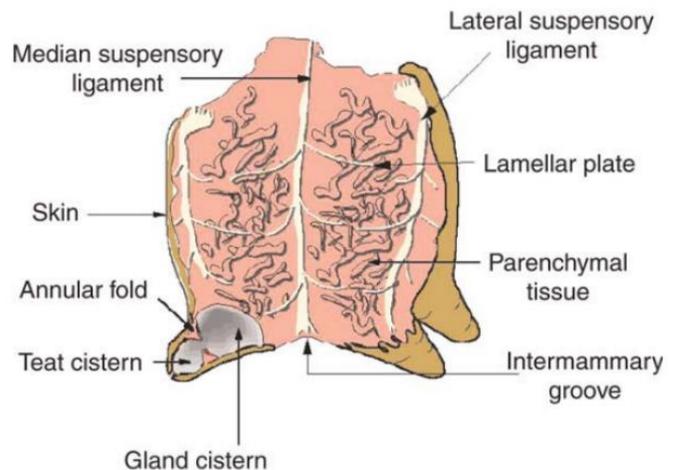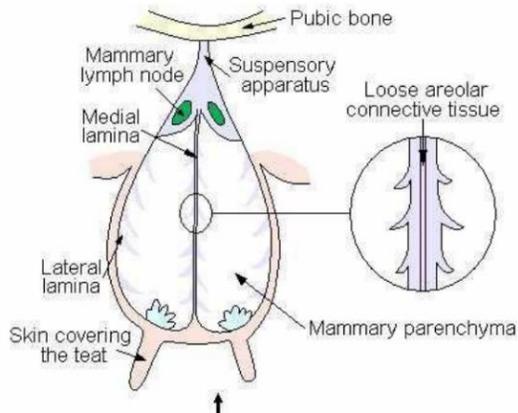
Comparing two ewes –
differences in the strength/weakness of the Medial Suspensory Ligament

	1629	1634	
<u>As yearlings</u> As yearlings, you can see that 1629 has a more defined MSL than 1634			Two ewes of the same age, with nearly identical production levels for four lactations. The primary difference between the two: the strength of their Medial Suspensory Ligaments.
<u>As a 2-yr-old</u> 1629 as 2-yr-old, produced ~ 950 # milk in 190 DIM * 1629's MSL is still defined			<u>As a 2-yr-old</u> 1634 as 2-yr-old, produced ~ 1,100 # milk in 180 DIM * 1634's MSL is weakening, her udder is starting to drop, and she's needing a Sagi hook during milking
<u>As a 3-yr-old</u> * 1629's MSL is staying strong			<u>As a 3-yr-old</u> * 1934's udder continues to collapse
<u>As a 4-yr-old</u> Producing a lot of milk. 1629 as 4-yr-old, peaked at 12#/d & produced ~ 1,400# milk in 195 DIM.			<u>As a 4-yr-old</u> Producing a lot of milk. 1634 as 4-yr-old, peaked at 9#/d & produced ~ 1,500# milk in 240 DIM.
<u>As a 5-yr-old</u> * 1629's udder is maintaining integrity 1629 continued milking through her 7th lactation			<u>As a 5-yr-old</u> * 1634's udder support has collapsed 1634 had to be culled midway through her 5th lactation
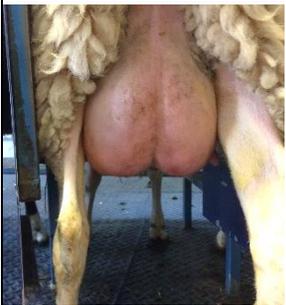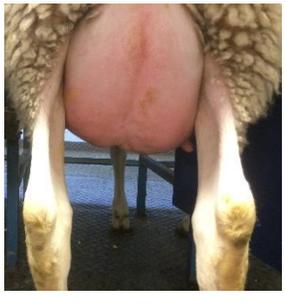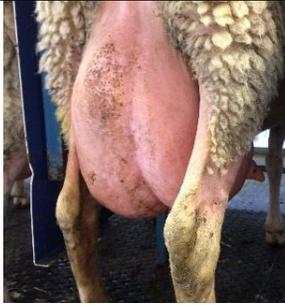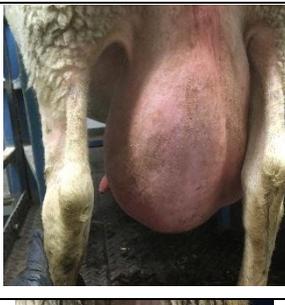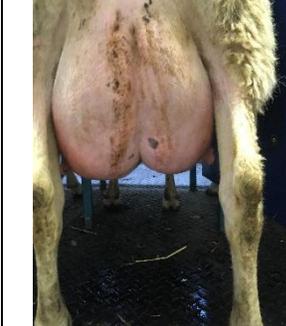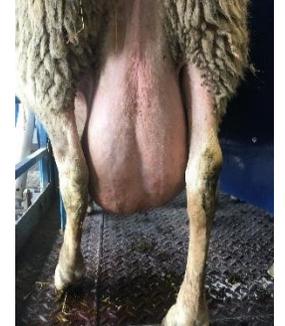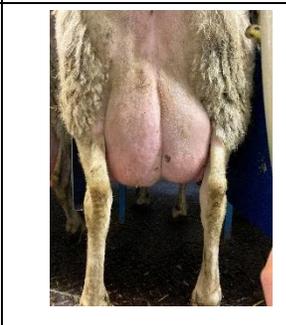
For an economic comparison of these two ewes, go to the "Economics" section of this Guide.

The **Lateral suspensory ligaments**

The lateral suspensory ligaments (LSL) are deep side tissues – tough, fibrous, suspensory tissue that almost envelop the udder to create a "hammock" or a "sling" and provide support for the udder.

The lateral suspensory ligaments connect to the floor of the pelvic bones at multiple points. Strong lateral suspensory tissues also attach the udder to the body wall and the inner surface of the hind leg, fanning out to give the outward appearance of width at the top of the udder. They fasten at the other end to the inner surface of the udder via platelike attachments.

The LSL are laminated layers or plates of non-elastic collagen fibers. They do not stretch as the gland fills with milk.

These branches of the laminated layers – "lamellae" – pass into the gland and become part of the "scaffolding" framework that supports the gland tissues. In the parenchymal tissue, the lamellae divide the parenchyma to provide the internal framework for the alveolar lobules and lobes.

In the three illustrations below, and pointed out with the red arrows, you can see the "lateral lamellae" with their individual layers that have branched off from the outer wall of lateral ligament to create the internal scaffolding that supports the levels of the alveolar and cisternal tissues of the gland.

Société des éleveurs de moutons de race pure du Québec
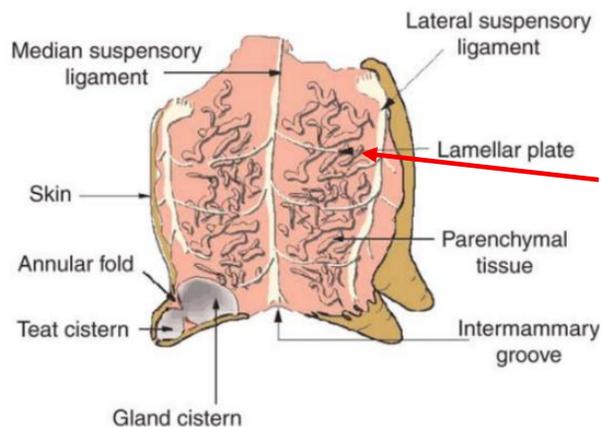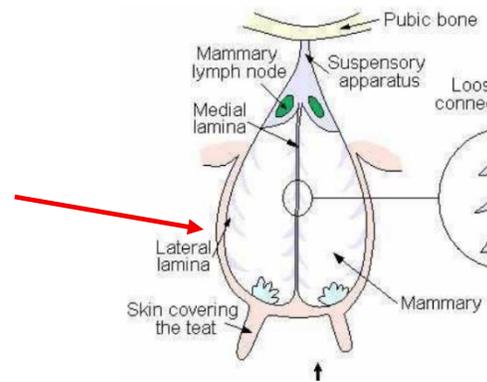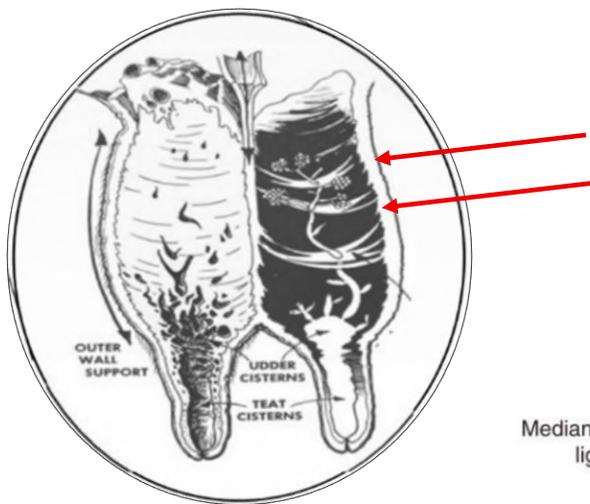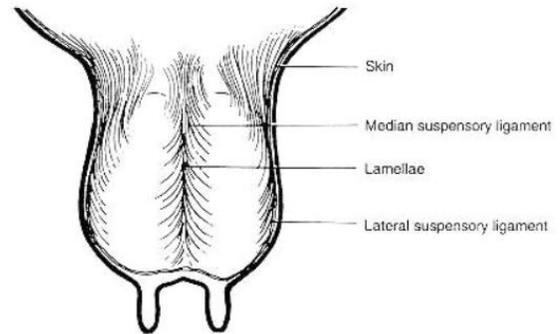
The illustration to the right (drawn by Dr Alvin Weber, University of Minnesota, 1949 – 1973) shows how the lateral suspensory ligament descends from the subpelvic tendon and extends down around the udder, and forward to connect with the abdominal wall.

The incredible drawing below shows how the lateral suspensory ligament creates a supportive "hammock" for the udder.

The superficial layer of lateral suspensory ligament ("C" in illustration below) arises from the subpelvic tendon and extends downward and forward from the pubic area. When it reaches the udder it spreads out, continuing downward over the external udder surface beneath the skin and attaching to the subcutaneous tissue.

Deep lateral suspensory ligaments ("D" in illustration) are another layer of fibrous tissue, thicker than the superficial layer. They also do not stretch as the gland fills with milk. This layer extends down over the udder, almost enveloping it (the left and right lateral suspensory ligaments do not join under the bottom of the udder).
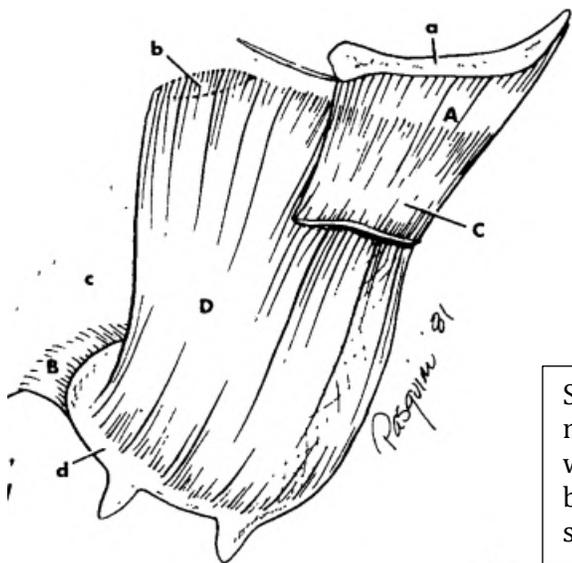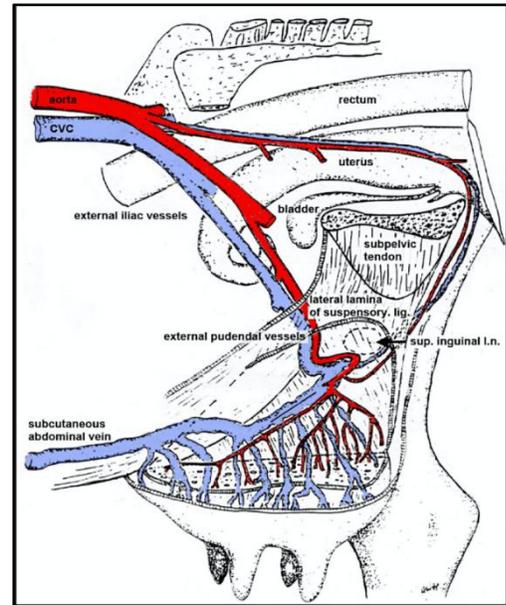
Suspensory apparatus

A. Symphyseal tendon
B. Medial suspensory lig. (mainly yellow elastic tissue)
C-D. Lateral suspensory lig. (mainly collagenous)
C. Superficial layer of suspensory lig.
D. Deep layer of lateral suspensory lig.
E. Lamellae

a. Pelvic symphysis
b. Superficial inguinal ring
c. Body wall (abdominal tunic)
d. Udder

Strong lateral ligaments are needed to carry the weight of the milk and to limit the udder's fluid-weight swing as the ewe walks. Without a strong lateral ligament structure, the udder becomes dependent on the medial suspensory ligament for support. This is shown by pictures of the two udders below.
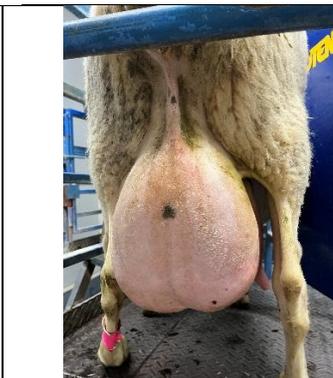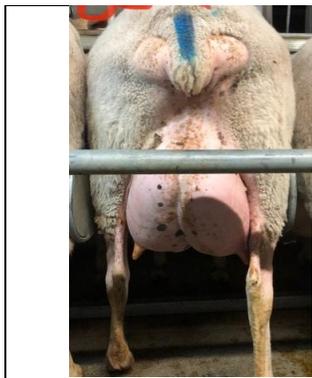
Ewe on the left: Lots of lateral ligament support in a 4th lactation ewe

Ewe on the right: Very little lateral ligament support in a 4th lactation ewe. Her udder is entirely dependent on the Medial Suspensory Ligament.

Example views of the strong lateral suspensory ligaments in some fresh ewes

|		
	The deep lateral suspensory ligaments are clearly visible in this fresh ewe (pictured L and R). The layers of the left and right sets of lateral ligaments extend down over the udder, almost enveloping it. Here you can also see that the left and right lateral suspensory ligaments do not join under the bottom of the udder.	
The lateral suspensory ligaments are somewhat visible here		
And the lateral suspensory ligaments are visible in this fresh yearling		
A couple of less stellar but still interesting examples. On the left, a ewe with weak (and visibly strained) lateral ligament attachments supporting her udder. On the right, an udder with almost no lateral ligament support, putting tremendous (and visible) strain on her Medial Suspensory Ligament.		

Why are strong medial and lateral suspensory ligaments so important?

The weight of the udder of a high-producing dairy ewe is substantial. We don't know the weight of the empty udder in lactating dairy sheep, but we know that an empty gland in dairy goats will range from 2 lbs in lower-producing yearlings to 5 lbs in high-producing mature does (Linzell, 1966). Top dairy ewes will produce 10-12 lbs milk at peak lactation and thus will be carrying 5-6 lbs milk at each milking. With this milk weight, plus with the weight of the udder tissue, an udder full of milk can easily weigh 10 to 12 lbs – more than the weight of a full gallon of milk! – plus the force applied as the udder swings when she walks. Strong support from medial suspensory ligament and the lateral suspensory system are critical for high-producing dairy ewes.

Carrying 10 lbs of milk to every milking? Needs good support!

The heritability of the suspensory ligaments

The strength or weakness of a ewe's median suspensory ligament and lateral suspensory ligament (as seen in her rear attachment width) is influenced substantially by genetics. The heritability of these ligament structures is ~ 20% [moderately strong] in dairy sheep, meaning that genetics contribute significantly to the variation seen in ligament strength among ewes. In other words, ewes with weaker ligaments can be prone to passing on the trait to their replacement daughters and sons, and conversely, selecting dams with stronger ligament strength (or rams whose dams had better ligament structures) leads to improved medial and lateral ligaments in their daughters.

What exactly are "strong" or "weak" ligament structures?

- A weak lateral ligament structure (LSL) has too few attachment points connecting the lateral ligaments to the pelvic bone, resulting in inadequate "hammock" support for the udder and increased strain on the Medial Suspensory Ligament (MSL).
- As the ewe matures and her udder matures with increased milk production, the slightly-elastic MSL stretches to accommodate the milk and also stretches with the weight of the milk.
- With a weak medial suspensory ligament, the attachment points are too narrow and thus too weak, degrading faster or stretching under the pressure of milk weight or walking.
- Excessive stretching and weakening will lead to a "pendulous" udder, resulting in difficulty walking, difficulty keeping teat cups on during milking, udder injury, and increased risk of subclinical mastitis.

Only carrying 4 lbs of milk to every milking? She'll be fine…

C. Non-heritable factors – non-genetic reasons for the udder's ligament structures to weaken

With a Heritability of 20%, that means of course that 80% of the condition of the Medial and Lateral suspensory ligaments is influenced by other factors, such as:

- More milk production. More milk = more weight = more strain on the suspensory ligaments

- Pasture and walking. More walking = more lateral strain on the udder. Ewes on pasture are going to walk more, both to get to and from pasture, and while grazing. The strain on big-uddered ewes can be seen as they come in to be milked – the more-limber and smaller-uddered yearlings will often be first, while older and big-uddered ewes will lag behind.

- Nutrition. Suspensory ligaments tissues are made of collagen, a protein fiber. In humans, balanced diets with adequate protein, plus adequate mineral and vitamin intake, are known to support collagen synthesis and maintenance. And the reverse is true: poor diet and mineral balance = less collagen fiber.

- Overfilling.

  – Colostrum. In the last weeks before lambing, high-producing ewes will make 1.5 to 2 gallons (12 – 16 lbs) of colostrum. This volume and weight can result in subcutaneous hemorrage and can cause udder damage before milking even starts. This is especially true if the ewe is forced to run or if her udder is already pendulous. To prevent this damage, some farmers might be advised to milk the colostrum out of large-uddered ewes before lambing.

  – At dry-off. In high-producing ewes, the sudden "cold-turkey" cessation of milking can cause udder damage when the udder fills and over-stretches the ligaments.

Société des éleveurs de moutons
de race pure du Québec

Farmers' Guide to Dairy Sheep Udder Assessment
Bee Tolman, Johanne Cameron, Andrea Mongini

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16

D. Teat position

Teat placement can be assessed from the rear perspective (the view from behind) or their side perspective (the forward angle). For this ewe assessment system, we will focus on the teat position assessed from the rear: it is the easiest to assess and also has a far-greater impact on udder conformation and ultimately on dairy economics.

In dairy sheep, teat placement has the largest genetic variability, meaning a range of teat positions can be seen within a flock, between flocks, and between breeds.

Teat position, assessed from the rear
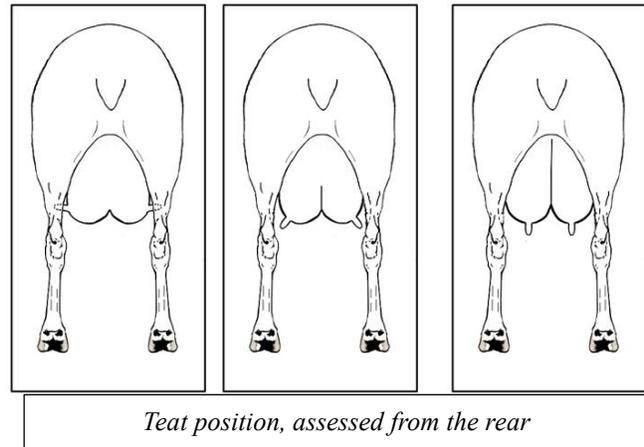
Forward angle of teats: lower heritability, lower variability. Discussed in sire selection chapter.
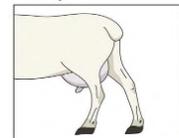
This milker (photo left) is demonstrating a stance very familiar to most of us: holding up the center of the udder to machine-strip the milk out of the cisterns. Many of us do this with our dairy ewes. Their teats are positioned too high at the side of the udder and therefore the cisternal milk can't flow out of the teats without manual help.

Teat position is a high-impact trait: teat position is negatively correlated with milking time (Pourlis, 2020), i.e., as the teats are positioned higher up the side of the udder, milking time increases. And teat position is the #1 udder trait variable impacting somatic cell counts (for more on this, see chapter on the economics of udder conformation). Luckily, the heritability of teat position is high (heritability, h^2 = 42%, Gootwine, 1980)

This is why it is important to identify and use dairy breeding sires who will have a positive impact on teat placement without decreasing milk yield. And how can you predict a potential sire's genetics for teat placement? By assessing his dam's udder (or pictures of his dam's udder) at peak milk.

> Dr Andrea Mongini specializes in small ruminant dairy management and says she believes that teat placement is one of the factors that most hold us back as dairy sheep producers in North America. *"Our national flock's teat position limits us. Our ability to scale is often limited by the time available to spend milking in the parlor, or our available money to pay for other people's time to milk. We don't have more time because we are having to attend to each ewe, to make sure we get the milk out without overmilking and causing teat damage. If we had better teat placement in our flocks, we would have better opportunities for growth – we could use the labor-saving technologies that have made growth possible in the other dairy sectors, such as automatic take-offs or even rotary parlors."*

The impacts – positive and negative – of the highly-heritable trait of teat position

First, an example of the *positive* impact of the heritability of teat position.

In a 150-ewe dairy flock, poor teat placement was a real conformational flaw in many of the top-producing ewes.

Ram lamb "Ramone" was selected from ewe #1854 (shown, top right), who had strong EBVs for yield, and who also had a history of daughters with good teat placement.

"Ramone" was bred to the flock's best milk producers, regardless of their udder conformations, in the hopes of producing replacement ewe lambs with improved teat placement without losing milk production.

One ewe was #2117, a solid producer with great medial suspensory ligament, but with terrible teat placement.

The farm had great results from Ramone: all of Ramone's yearling daughters had improved teat placement.
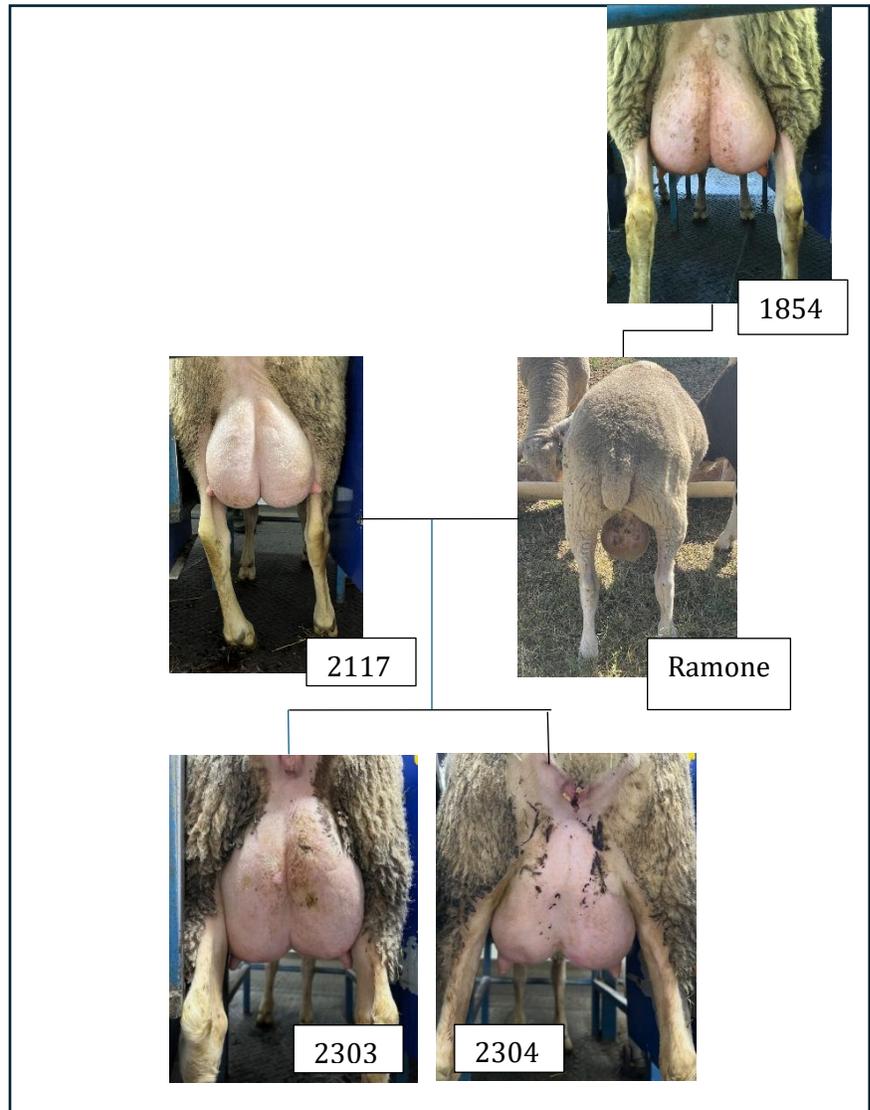
The most dramatic effect on teat placement was seen in his twin daughters from ewe# 2117 (2303 and 2304, shown above). Not bad for one generation!

And now an example of the *negative* impact of the highly-heritable trait of teat position:

This same farm had a good ewe (#1714 shown right) with a good udder and great teat position. As a yearling she was bred to a farm sire whose dam had a great udder, and had daughter #1930 (shown far right) whose udder was even better than her dam's, with wider udder attachment and similar teat placement. Wonderful!

Two years later in 2020, #1714 was bred to a purchased ram. This ram was purchased for his dam's and grand-dam's milk yields, but with *no pictures of his dam's udder or his grand-dam's udder* [the italics are to signal impending doom, like the foreboding music in the movie "*Jaws*"....] .

Her triplet daughters from this purchased sire gave us a rather unfortunate example of the heritability of teat position, and of the single-generation effect of this highly-heritable trait in a breeding ram.

1714

1930

Mystery ram: Purchased ram, chosen for his dam's milk yield, but with no pictures of dam's udder.

1714

2112

2113

2114
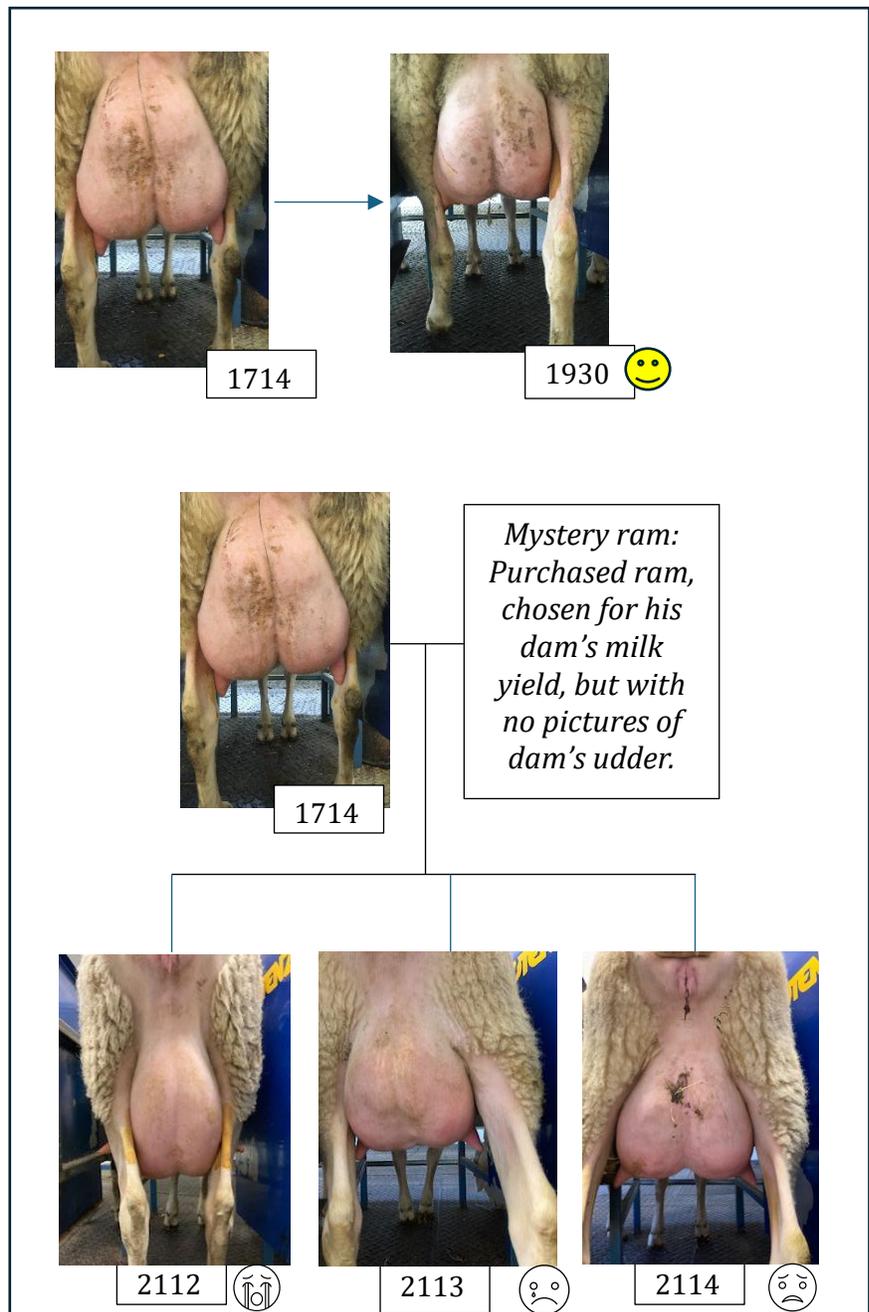
E. Illustration credits, references for Chapt. I, Udder Anatomy

Miguel Ángel Sanz Franco, DVM, Small Ruminant Technical Specialist, HIPRA Spain, https://aboutsmallruminants.com/ sheep-goat-udder-basics-anatomy-physiology/	Chris Pasquini DVM, Atlas of Bovine Anatomy. 1982. Sudz Publishing, Eureka California. Pg 192.	Barone, R., 2001. Anatomie Comparée Des Mammifères Domestiques. Tome 4, Splachnologie II, Vigot Paris.	From: https://agrisujan.wordpress.com/ 2018/05/11/ internal-and-external- anatomy-of-mammary-gland/	Barone, R., 2001. Anatomie Comparée Des Mammifères Domestiques. Tome 4, Splachnologie II, Vigot Paris.
From: https://agrisujan.wordpress.com/ 2018/05/11/ internal-and-external- anatomy-of-mammary-gland/. Illustration not credited.	Taken from Univ. of Wisconsin: The Cow, Introduction, Udder Anatomy. Illustration not credited. https://uwmril.wisc.edu/ CowIntroUdder	Chris Pasquini DVM, Atlas of Bovine Anatomy. 1982. Sudz Publishing, Eureka California. Pg 192.	Taken from Univ. of Wisconsin: The Cow, Introduction, Udder Anatomy. Illustration not credited. https://uwmril.wisc.edu/	From: https://agrisujan.wordpress.com/ 2018/05/11/ internal-and-external- anatomy-of-mammary-gland/
Nickerson SC and Akers RM (2011) Mammary Gland Anatomy. In: Fuquay JW, Fox PF and McSweeney PLH (eds.), Encyclopedia of Dairy Sciences, Second Edition, vol. 3, pp. 328–337. San Diego: Academic Press.	Bearden and Fuquay, Applied Animal Reproduction, 1980. Pg 113. Mississippi State University, Reston Publishing Company, Inc.	Chris Pasquini DVM, Atlas of Bovine Anatomy. 1982. Sudz Publishing, Eureka California. Pg 192.	Nickerson SC and Akers RM (2011) Mammary Gland Anatomy. In: Fuquay JW, Fox PF and McSweeney PLH (eds.), Encyclopedia of Dairy Sciences, Second Edition, vol. 3, pp. 328–337. San Diego: Academic Press.	https://pressbooks.umn.edu/ largeanimalanatomy /chapter/ pelvic-inlet-perineum/. Modified from drawing by Dr Alvin Weber
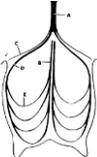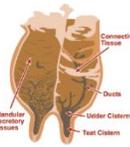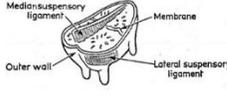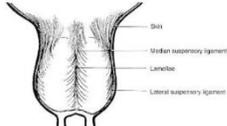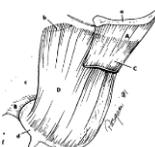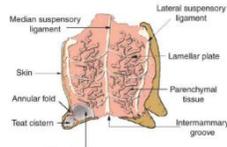
CHAPTER 2: How to Score the Four Milking Flock Traits

Udder Floor Depth (UFD)	Teat Placement (TP)
5 : > 3 inches and above (close to the body) 4 : > 2 inches and < 3 inches above the hock 3 : Equal to the hock and up to 2 inches above 2 : Below the hock by 1 to 2 inches 1 : > 2 inches below the hock	1 2 3 4 5
Medial Suspensory Ligament (MSL)	**Rear Attachment (RA)**
5 : Definition at more than 80% of udder height 4 : Definition at 75% of udder height 3 : Definition at 50% of udder height 2 : Definition between 10% and 25% of udder height 1 : No definition	5 4 3 2 1
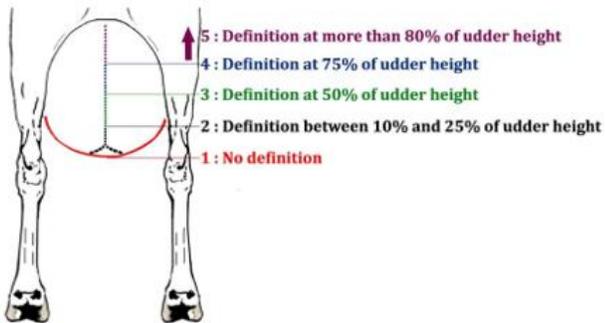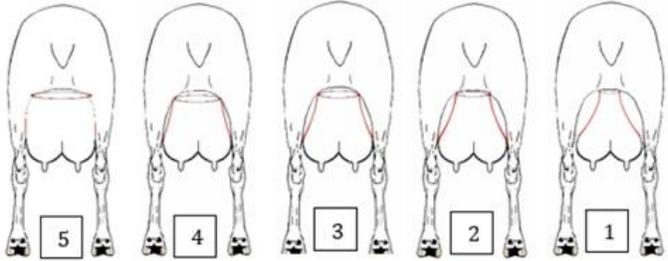
Illustrations of 4 traits for dairy sheep udder scoring: Johanne Cameron and SEMRPQ

Each trait is given a barn score from 1.0 to 5.0. Barn scores for each trait are "weighted" as a percentage of the target trait characteristic, up to 25 points for each trait. In the case of Udder Floor Depth, the barn score is also weighted for lactation number.

A ewe's composite score is the sum of each of her "weighted" traits. An udder with a composite score of 84 has on average more desirable udder traits than a ewe with a composite score of 42. (A "perfect" udder—which doesn't yet exist! – would have a maximum of 100 points.)

UFD	TP
Barn score (1.0 – 5.0) * % of 25 = Wt'd pts for UFD	Barn score (1.0 – 5.0) * % of 25 = Wt'd pts for TP
MSL	**RA**
Barn score (1.0 – 5.0) * % of 25 = Wt'd pts for MSL	Barn score (1.0 – 5.0) * % of 25 = Wt'd pts for RA
Composite score = total points out of 100	

In this Chapter, for each of the four traits we have provided a diagram with details on how to barn-score the trait, the weighted scale indicating the "ideal" for each trait, and examples of barn scores for each trait. On the DSANA website there are three separate files for producers to download:

1. **Scoring Reference Card**, a pdf to be printed in color for reference during udder scoring in the milking parlor.
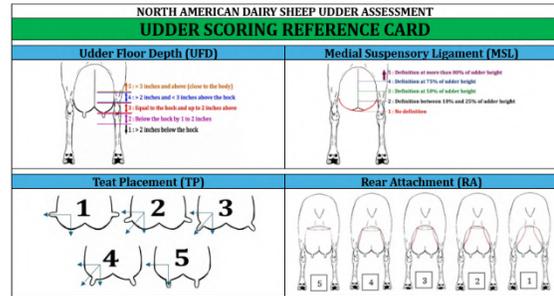
2. **Barn Udder Score Sheet**, a pdf document for recording udder scores in the milking parlor.

3. The **Trait Score Calculator**, an Excel file that producers can copy onto their computers.

Ewe #	Lact. #	Udder floor depth	Medial susp'y ligament	Teat place-ment	Rear attach-ment	Ewe #	Compo-site score	Wt'd UFD	Wt'd MSL	Wt'd TP	Wt'd RA
2305	2	3.5	4	3	3.5	2305	86	24	24	19	20
2151	4	3.0	2	1.5	3	2151	61	25	11	8	18
2304	2	3.5	4.5	2.5	3.5	2304	85	24	25	16	20
2303	2	4	2.5	2	2.5	2303	61	25	14	10	13
2462	1	2.5	1.5	2.5	1	2462	31	5	5	16	5

After the barn scoring, producers can enter the ewe tag numbers, lactation numbers, and trait barn scores on their computer (yellow cells). The "Trait Score Calculator" Excel file will automatically adjust the barn scores to produce weighted scores for each trait and the composite score for each ewe (blue cells).

A note as you learn about the four traits:

☆ You are scoring each of the four udder traits _individually_. Although there are some genetic correlations between the traits, these have been accounted for in the weighted scores. The overall udder score is found in the Composite Score in the Trait Score Calculator.

Next: The four udder traits…

G. Udder floor depth (UFD)

Measuring the udder floor depth (UFD) gives an overall picture of the strength of udder's ligament support system.

This trait is scored by the depth of the udder relative to the point of the hock.

- Score "3" when the bottom of the udder (not including the teats) is level with the point of the hock or within 2 inches above the hock.
- Score "4" when the udder floor is between 2-3" above the hock.
- Score "5" when the udder floor is over 3 inches above the hock.
    - *Scores of 4 and 5 are more often seen in yearlings (1st lactation), as their mammary system is still developing.*
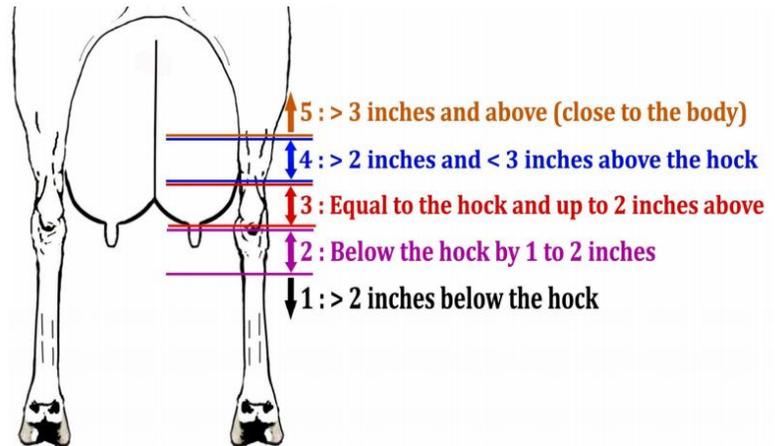
5 : > 3 inches and above (close to the body)
4 : > 2 inches and < 3 inches above the hock
3 : Equal to the hock and up to 2 inches above
2 : Below the hock by 1 to 2 inches
1 : > 2 inches below the hock

- Score "2" when the udder floor is between 1-2 inches below the hock.
- Score "1" when the udder floor is between over 2 inches below the hock.
    - *Scores 2 and 1 are indications of a weakening or weak suspensory system, particularly the medial suspensory ligament.*
- ☆ *Note: you can use ½ scores! If you are unsure whether her UFD is only just below the hock, give her a 2.5! Or if her UFD appears exactly 2 inches above the hock, give her a 3.5.*

This is the only trait in the udder conformation assessment for which the score is adjusted and *weighted based on the ewe's number of lactations*, because all ewes' udders will stretch and become deeper with every passing lactation.

Udder Floor Depth

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
	High above hock								*Low below hock*
Lact 1	20%	100%	90%	60%	50%	20%	20%	20%	20%
Lact 2	20%	90%	100%	95%	60%	40%	33%	30%	20%
Lact 3	20%	75%	98%	100%	95%	60%	40%	30%	20%
Lact 4	20%	60%	90%	98%	100%	60%	40%	30%	20%

When the final trait score is calculated, "ideal" (shaded darker green in the chart above) is 4.0-4.5 in a first lactation yearling. In a yearling, a score of 3.0 or 3.5 (i.e., level with the hock) is less than ideal. But in a ewe in her 4th lactation or more, a score of 3.0-3.5 is ideal, and her final conformation points will be calculated to reflect that.

- ☆ *Note: Ewes in 4th, 5th, 6th lactations are all recorded as a Lact. # of "4". Research has shown that there is no significant difference in selection value of UFD after the 4th Lactation.*

Examples of Udder Floor Depth

3"+ above hock **Score 5** ↓	>2" & <3" above hock **Score 4.0 – 4.5** ↓	At hock to 2"'above **Score 3.0 – 3.5** ↓	Below hock by up to 2" **Score 2.0 – 2.5** ↓	>2" below hock **Score 1.0 – 1.5** ↓
1st Lact, score 5.0	2nd Lact, score 4.5	3rd Lact, score 3.5	3rd Lact, score 2.0	6th Lact, score 1.0
1st Lact, score 5.0	1st Lact, score 4.0	4th Lact, score 3.0	5th Lact, score 2.0	3rd Lact, score 1.0
	2nd Lact, score 4.5	3rd Lact, score 3.0	2nd Lact, score 2.5	4th Lact, score 1.0

5 : > 3 inches and above (close to the body)
4 : > 2 inches and < 3 inches above the hock
3 : Equal to the hock and up to 2 inches above
2 : Below the hock by 1 to 2 inches
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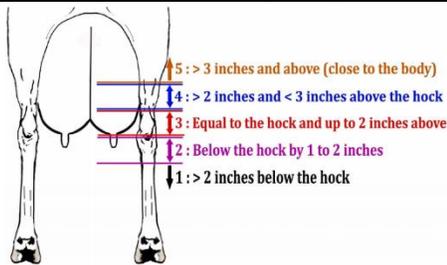
Udder Floor Depth

Barn scores	High above hock								Low below hock
	5	**4.5**	**4**	**3.5**	**3**	**2.5**	**2**	**1.5**	**1**
Lact 1	20%	100%	90%	60%	50%	20%	20%	20%	20%
Lact 2	20%	90%	100%	95%	60%	40%	33%	30%	20%
Lact 3	20%	75%	98%	100%	95%	60%	40%	30%	20%
Lact 4	20%	60%	90%	98%	100%	60%	40%	30%	20%

How to score for the Udder Floor Depth

First – get yourself at eye level with the point of the hock! Bend your knees! Looking down on the hock will change the score you assign. If it helps, use your pen or pencil to create the line between the hock elbows to guage whether the udder floor is just over or just under the level of the hocks.

For udders above or below the hock, you want to find some means of measuring the distance – without touching the ewe and making her stamp or jump. One easy suggestion: use your finger to gauge the number of inches above or below the hock. As an example, Bee's middle finger is almost exactly 3" long, and the two finger joints pretty much indicate 1" increments. This is very handy in finding lengths or widths of almost everything, but extremely handy in assessing udder floor depth.

"But that's not accurate!", you squawk. Fret not. We are not conducting a university trial that requires precise measurement. Nor do we want to spend valuable time dithering about whether her udder is 1" or 1.5" above or below the hock, making the ewes jumpy with needless handling and delayed milking. If we spend too much time, we will discourage ourselves from going through this exercise – an exercise that is critical to the future of the flock and your wallet. What we are trying to achieve here is an assessment of all our ewes' udders in a way that is quick and *relatively accurate** from one ewe to the next, so that we can select our replacements from ewes with better udder conformation. *The value of relative accuracy is discussed in later Chapter: "Using Udder Scores in Your Breeding Program".*

H. Medial Suspensory Ligament (MSL)

Assessing the apparent strength of the Medial Suspensory Ligament (MSL) by the strength and visibility of a cleft, or crease, between her udder halves. Remember: the udder consists of two separate glands, one on the left and the other on the right, each comprising of alveolar tissue (generally above) and cisternal tissue (generally below).

The MSL trait is scored by the height and visibly-defined crease between the glands. The score will incorporate both the depth of the crease between the left and right glands, and the height to which it visibly extends up between the two glands:

- Score "5" when the suspensory ligament is visible and has a defined cleft > 80% to the top of the gland.
- Score "4" when the suspensory ligament is visible and has a defined cleft up to up to ~ 75% of the gland.
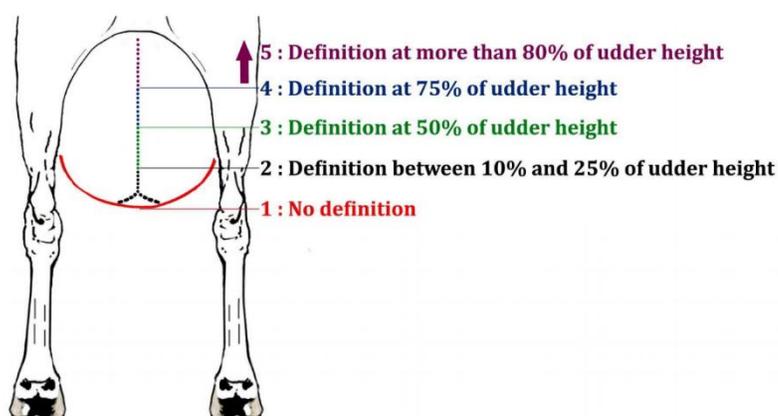
Scores of 4 and 5 indicate a strong medial suspensory ligament that clearly separates the left and right glands to the top, or nearly to the top, of the alveolar portions of the udder's glands.

5 : Definition at more than 80% of udder height
4 : Definition at 75% of udder height
3 : Definition at 50% of udder height
2 : Definition between 10% and 25% of udder height
1 : No definition

- Score "3" when the suspensory ligament is visible and has a defined cleft up to ~ 50% of the gland
- Score "2" when the suspensory ligament is visible up to ~ 25% of the gland. Note: if the udder has sagged, you do not count the all the skin and tissue above the glands. You are looking for the SL as it divides the two right and left halves of the active gland.
- Score "1" when the bottom of the udder has very little or no discernable division between the two udder halves.

Scores of 1 and 2 indicate a weak medial suspensory ligament.

Medial Suspensory Ligament

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	99%	95%	80%	75%	55%	45%	20%	20%

☆ *Note: use those ½-scores. They will save you time! If you think her MSL crease doesn't quite reach halfway up her udder gland, don't dither, just give her a 2.5! Or if her MSL crease goes just above halfway, but maybe not to 75%, don't debate, just give her a 3.5!*

And another note: the MSL crease is much easier to see and determine its depth and height when assessed at peak lactation, and when the cisterns are full of milk. So do your scoring at 20-60 days in milk (DIM), and before you milk each row during morning milking.

Examples of Medial Suspensory Ligaments

Cleft >80% Score 5 ↓	Cleft ~ 75% Score 4.0 – 4.5 ↓	Cleft ~ 50% Score 3.0 – 3.5 ↓	Cleft 10%-25% Score 2.0 – 2.5 ↓	Cleft <10% Score 1.0 – 1.5 ↓
2nd Lact, score 5.0	2nd Lact, score 4.5	2nd Lact, score 3.0	4th Lact, score 2.5	2nd Lact, score 1.0
4th Lact, score 5.0	3rd Lact, score 4.0	4th Lact, score 3.0	2nd Lact, score 2.0	3rd Lact, score 1.5
6th Lact, score 5.0	3rd Lact, score 4.5	6th Lact, score 3.0	5th Lact, score 2.0	5th Lact, score 1.0
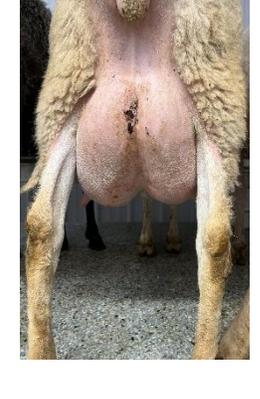
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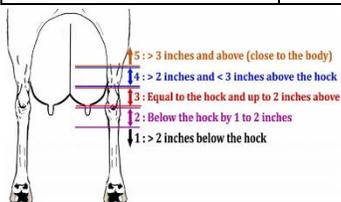
I. Teat placement (TP)

This trait is scored by the position of the teat on the gland half, as seen from the rear of the ewe, relative to the each gland's vertical axis.

- Score "5" when the teats are positioned straight down.
  A score of 5 is now commonplace in the dairy cow and dairy goat industries, but is very rare in the North American dairy sheep industry. But TP score 5 does exist in dairy sheep, see pictures on the next page!
- Score "4" when the teats are positioned halfway between the 45° point and straight down.
  A score of 4 is a very easy-to-milk udder.
- Score "3" when the teats are positioned at a 45° angle.
  Teat scores of 3 are common in North American dairy sheep. It is at this score that a producer will spend less time with Sagi hooks, and can start to take advantage of labor-saving automatic take-offs of milking clusters.
- Score "2" when the teats are positioned halfway between the 90° and the 45° point.
- Score "1" when the teats are positioned up fully on the side of the udder, 90° off the vertical axis.
  Scores of 1 and 2 indicate teat placement that will place a greater percentage of udder cistern <u>below</u> the "outlets" of the teats, and which will require more manual/machine stripping to get much of her milk out.
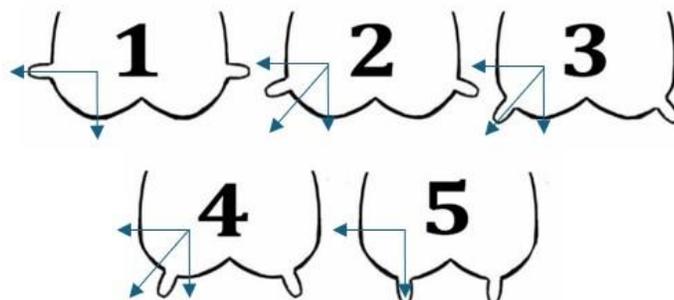
Teat Placement

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	98%	95%	85%	75%	65%	40%	30%	20%

☆ *Note: this trait is very subjective and therefore essential to use those ½-scores! Be honest with yourself, for the future of your flock's next generation. If her teats don't quite make it to the 45° of a "3" score, by all means score her at a 2.5.*

☆ *Another note regarding teat "direction": you are scoring the score the placement of teat attachment to the udder, not the direction the teat is pointing. Think about the amount of cistern below the point where the teat attaches.*

Examples of Teat Placement scores

5 **Straight down** **Score 5** ↓	**4** **Between straight down & 45%** **Score 4.0 – 4.5** ↓	**3** **At 45%** **Score 3.0 – 3.5** ↓	**2** **Between 45% and 90% at side** **Score 2.0 – 2.5** ↓	**1** **90% at side** **Score 1.0 – 1.5** ↓
1st Lact, score 5.0	1st Lact, score 4.5	1st Lact, score 3.0	2nd Lact, score 2.0	2nd Lact, score 1.0
3rd Lact, score 5.0	1st Lact, score 4.0	2nd Lact, score 3.0	3rd Lact, 2.0	3rd Lact, score 1.0
	2nd Lact, score 4.5	3rd Lact, score 3.0	4th Lact, 2.0	4th Lact, score 1.5

Teat Placement

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	98%	95%	85%	75%	65%	40%	30%	20%

Société des éleveurs de moutons de race pure du Québec

Farmers' Guide to Dairy Sheep Udder Assessment
Bee Tolman, Johanne Cameron, Andrea Mongini

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Sustainable Agriculture Research & Education

29

J. Rear Udder Attachment (RA)

Assessing the strength and "fanned-out" lateral suspensory ligament attachments.

* * A strong rear-udder attachment can be seen in a gland that is very close to the vulva, tucked up between the top of the legs. Conversely, a weak rear-udder attachment will be seen in a gland that begins a further distance from the vulva.
* * A strong rear-udder attachment will have lateral suspensory ligaments that fan out to connect with the subpelvic tendon at many points, and give the appearance of a very wide gland at the top of the udder. Conversely, a weak rear-udder attachment will have few lateral suspensory ligaments and appear very narrow at the top of the udder's glands.

This trait is scored on how close or "tight" the gland is to the vulva area, as well as on the width at the top of the gland relative to the shape of the total gland.

* Score of "5" when the gland is close to the vulva, tucked up by the top of the legs, and has a large and smooth width at the top, making the udder appear almost rectangular.
* Score of "4" when the gland is a few inches below the vulva, and is boxy but has a little less width at the top, making the udder appear slightly tapered at the top.
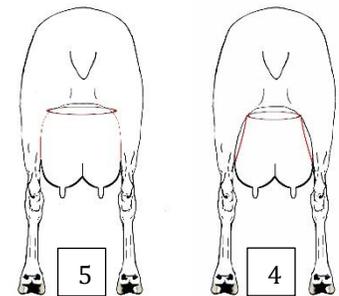
Scores of 4 and 5 are udders with lateral suspensory ligament attachment points fanned out widely around the top perimeter of the gland and will keep the gland securely attached to the pelvis. These udders will greatly assist the medial suspensory ligament to support an udder full of milk over many lactations, ideally past the 3rd and 4th lactations.

* Score of "3" when the gland is a few more inches below the vulva, appears to have a little less top width and appears tapered, giving it a shape of an upside-down heart.
* Score of "2" when the gland is well below the vulva, and the width tapers at the top giving the shape of an upside-down heart with a narrowing or more acute point.
* Score of "1" when the gland is again well below the vulva, but the width at the top has taped to a seemingly single and acute point.
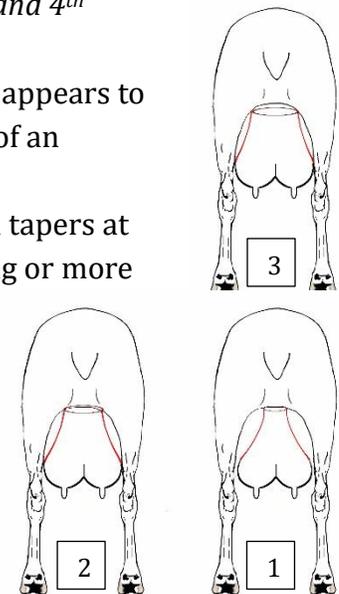
Scores of 1 & 2 indicate fewer attachment points for the lateral ligaments and less udder support as the ewe moves to graze or be milked. A weaker RA will not help suspend the udder. The result is a dropped udder due to a stretched-out and strained medial suspensory ligament.

Rear Attachment

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	95%	90%	80%	70%	50%	30%	25%	20%

Examples of Rear Attachment scores

Tight to vulva, wide at gland top **Score 5** ↓	Close to vulva, some taper at top **Score 4.0 – 4.5** ↓	Less close, upside-down heart **Score 3.0 – 3.5** ↓	Well below vulva, narrower gland top **Score 2.0 – 2.5** ↓	Far below vulva, narrow at gland top **Score 1.0 – 1.5** ↓
1st Lact, score 5.0	2nd Lact, score 4.0	2nd Lact, score 3.0	3rd Lact, 2.5	2nd Lact, score 1.0
1st Lact, score 5.0	3rd Lact, score 4.5	2nd Lact, score 3.0	4th Lact, 2.0	4th Lact, score 1.0
2nd Lact, score 5.0	5th Lact, score 4.0	4th Lact, score 3.5	5th Lact, 2.5	4th Lact, score 1.5
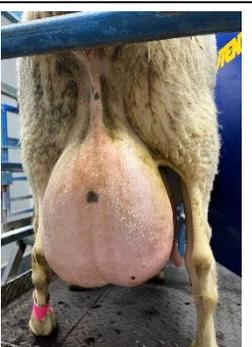
Note: this trait can be challenging to assess, and particularly subjective to score in udders that hang below the hock. It will be essential to use those ½-scores! Be honest with yourself, and you will recognize the "4" scores when you see them!

Rear Attachment

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	95%	90%	80%	70%	50%	30%	25%	20%

Where exactly is the "top of the gland" when we are scoring the Rear Udder Attachment trait? The "top of the gland" is where you can see the uppermost portion of the alveolar tissue that manufactures the milk. (You can actually feel it soften up after the ewe's second let-down.)
In the pictures below, we have drawn the top of the glands for a number of udder shapes.

☆ *Note: the top of the glands are much easier to locate at peak lactation, and when the alveolar region is full of milk. Do your scoring at 20-60 DIM, and before they are milked in the morning!*

CHAPTER 3: When and How to Assess and Score Udder Conformation

When

☆ **Between 20 – 60 days in milk (DIM)**, in early peak lactation, to see the full definition of the udder when the udder is full. … Note ewe #9082 at right – her picture on the left is at 20 DIM; her picture on the right is at 200 DIM.

Same ewe: peak lactation (L), not peak lactation (R)

   o If the ewe suckles lambs for 30 days, then assess at 30-60 DIM

☆ **Before being milked in the morning**, to see the definition of the udder when the udder is full

   o *"Before morning milking" means that you will score a row (or the intended ewes in a row), then take their pictures, then milk that row. And then repeat for the next row, etc.*

☆ **When there is no more than 1" of wool**

Too much wool! Can't see the Rear Attachments!

   o This is critical to see the full udder shape, particularly the Rear Udder Attachment and its relationship to the vulva and thighs.

☆ **Every ewe, once per year**

   o Different ewes' udders will change over the course of successive lactations, so it is important that every year you capture the data on every ewe in your parlor.

   o Once a year is enough. The conformation score is "highly repeatable" *(Fernandez et. al., 1997)*, meaning that repeated assessments will not change the scoring over the course of one production season.

☆ Not every ewe has to be assessed on the same day, or at the exact same DIM

   If for example you have seasonal production but lamb out in two groups: high-production ewes in the 1st 6 weeks, followed by yearlings and lower-production ewes in the 2nd 6 weeks. Score and photograph the 1st group of ewes 20 days after the last ewe has lambed out – all ewes will be within the 20- to 60-day peak lactation window for assessment. Then score the 2nd group 20 days after the end of their lambing cycle.

Mature ewes vs yearlings

☆ The mature udder is very important to assess.

   o Yearling udders are certainly an indication of the future. But they also give an inaccurate picture of how the udder will hold up over time and through successive lactations, as the weight of milk and the pull of gravity starts to have impact. This is particularly true of

heavy producers. But do assess the yearling udder! If she doesn't make it to her 2nd or 3rd lactation, you want a record of her udder traits.

☆ *This is a QUICK PROCESS. Once you start training your eye to the four traits, it should only take you ½-minute per ewe to record the scores. Then perhaps 5 seconds to take the picture. The part that will take the most time is getting the tag numbers. So the whole process should take less than 1 minute per ewe. The Barn Score Sheet is set up to allow you to see how you scored the other ewes in the row, if you start to doubt yourself.*

☆ *Be honest with yourself – this is a big part of your flock's and your farm's future (see Chapter 5 on the Economics if you are not yet convinced.) But DO NOT AGONIZE over the ½-scores – make your best assessment, and move on.*

Taking pictures

Immediately after you score a row of ewes, take one picture of every ewe, every year.

- Vertical orientation
- Top of the body, to the floor
- When the wool is short, to clearly see the rear attachment width
- Get your camera (and your head) down to the level of the udder, so that the picture is not skewed by the camera angle.

- If the rail is in the way, don't worry about it, just take the pic!

You may need to move a leg to capture the teat position

- Download pictures onto your computer, label each picture with the ewe's tag number. Also, ideally, name the picture with her birth year. For example, a picture of yearling #53, born in 2024, would be named "2453".

☆ *A BIG NOTE: **you must score udders on the live animals!** Don't use pictures to score. Pictures are an important record for future reference (see the next chapter on incorporating udder scores into your breeding program). But scoring must be done on the live animal, when you can discern the MSL cleft, and see the rear udder attachment, and distinguish between a teat placement score of 2.5 and 3.0.*

CHAPTER 4: Using trait points and the composite scores to design a breeding program

Step 1. Score udders in the parlor before morning milking. Print off the Scoring Reference Card to help you score. Write the trait scores on the Barn Score Sheet. Both can be downloaded from the DSANA website. (And don't forget to take pictures.)
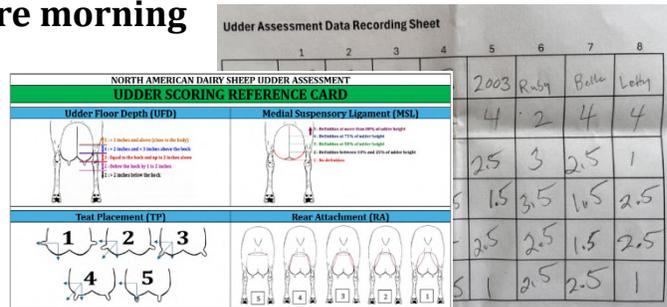
Step 2: Enter the scores in the Trait Score Calculator. This Calculator is a separate Excel file on the DSANA website. For each ewe, you will enter the tag #, the lactation #, and the barn scores (enter in the yellow cells). The weighted score for each trait is automatically calculated and appears in the blue cells, as well as the composite udder score for each ewe.

Ewe #	Lact. #	Udder floor depth	Medial susp'y ligament	Teat place-ment	Rear attach-ment	Ewe #	Compo-site score	Wt'd UFD	Wt'd MSL	Wt'd TP	Wt'd RA
2305	2	3.5	4	3	3.5	2305	86	24	24	19	20
2151	4	3.0	2	1.5	3	2151	61	25	11	8	18
2304	2	3.5	4.5	2.5	3.5	2304	85	24	25	16	20
2303	2	4	2.5	2	2.5	2303	61	25	14	10	13
2462	1	2.5	1.5	2.5	1	2462	31	5	5	16	5
Ruby	2	3	3.5	1.5	2.5	Ruby	55	15	20	8	13
Belle	4	2.5	1.5	1.5	2.5	Belle	40	15	5	8	13
Letty	4	1	2.5	2.5	1	Letty	40	5	14	16	5

➢ Each Barn Score has been linked to the % value which you have seen in the pages above and which you can see copied below. Each trait has a maximum score of 25 points.

➢ The Weighted UFD score for each ewe has been adjusted for her Lactation #.

➢ The Composite Score is the sum of all the weighted scores for each ewe, and gives the Composite Score out of the maximum 100 points.

Udder Floor Depth

High above hock ... *Low below hock*

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
Lact 1	20%	100%	90%	60%	50%	20%	20%	20%	20%
Lact 2	20%	90%	100%	95%	60%	40%	33%	30%	20%
Lact 3	20%	75%	98%	100%	95%	60%	40%	30%	20%
Lact 4	20%	60%	90%	98%	100%	60%	40%	30%	20%

Medial Suspensory Ligament

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	99%	95%	80%	75%	55%	45%	20%	20%

Teat Placement

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	98%	95%	85%	75%	65%	40%	30%	20%

Rear Attachment

Barn scores	5	4.5	4	3.5	3	2.5	2	1.5	1
% of max value	100%	95%	90%	80%	70%	50%	30%	25%	20%

Step 3: Look at your flock's trait scores and composite scores

Questions to ask yourself as you look at the assessment results:

- Do I see patterns of strengths or weaknesses?
- Do I see patterns in age groups? Do I see patterns in family lines?
- If I could improve one or two traits next season, what would they be?
- What rams are available that have a strength in one of the traits I want to improve on?

Ewe #	Lact. #	Udder floor depth	Medial susp'y ligament	Teat place-ment	Rear attach-ment	Ewe #	Compo-site score	Wt'd UFD	Wt'd MSL	Wt'd TP	Wt'd RA
2302	2	3.0	3.5	2.5	3.5	2302	71	15	20	16	20
2304	2	2.0	3	2	2.5	2304	50	8	19	10	13
2305	2	2	2.5	1.5	2.5	2305	42	8	14	8	13
2308	2	4	4	2.5	4	2308	88	25	24	16	23
2309	2	3	4	2.5	4	2309	78	15	24	16	23
2310	2	3	4	2.5	2.5	2310	68	15	24	16	13
2315	2	3	4.5	2.5	4	2315	79	15	25	16	23
2316	2	3	3.5	2	3	2316	63	15	20	10	18
2317	2	4	3	2.5	3	2317	78	25	19	16	18
2318	2	2.5	4	2.5	3	2318	68	10	24	16	18
2334	2	3	3	3	3.5	2334	73	15	19	19	20
2336	2	2	3	3.5	2.5	2336	61	8	19	21	13
2406	1	4	3	3.5	3	2406	80	23	19	21	18
2407	1	4	2	2.5	3	2407	68	23	11	16	18
2409	1	4	4	2.5	3	2409	80	23	24	16	18
2415	1	4	4	2.5	3	2415	80	23	24	16	18

☆ *Note: Remember that this is a process. It is an evolution that will involve incremental changes in your flock's udder conformation. Look closely for patterns and opportunities to make change.*

Step 4: Use your trait scores to develop your breeding program.

Use your udder trait score results to develop the priority/priorities for your breeding program that will improve your priority udder traits:

1. Add udder conformation scores to your ewes' production information (and EBVs if you use them).
2. Identify your higher production ewes. These are your pool of ewes to select from, to breed to a dairy ram to produce replacement ewe lambs.
3. Prioritize the udder traits that you want to improve on.
4. Select rams whose dams have strengths in those prioritized traits.
5. Pair those rams judiciously with select ewes to produce daughters that will improve your priority traits.
6. Consider dividing your better ewes into two groups to target different improvements in each of the two groups.

Ewe #	Lact. #	Udder floor depth	Medial susp'y ligament	Teat place-ment	Rear attach-ment	Ewe #	Prod'n 210-d, 2025	Compo-site score	Wt'd UFD	Wt'd MSL	Wt'd TP	Wt'd RA
2302	2	3.0	3.5	2.5	3.5	2302	1,069	71	15	20	16	20
2304	2	2.0	3	2	2.5	2304	1,309	50	8	19	10	13
2305	2	2	2.5	1.5	2.5	2305	968	42	8	14	8	13
2308	2	4	4	2.5	4	2308	1,333	88	25	24	16	23
2309	2	3	4	2.5	4	2309	1,145	78	15	24	16	23
2310	2	3	4	2.5	2.5	2310	1,205	68	15	24	16	13
2315	2	3	4.5	2.5	4	2315	953	79	15	25	16	23
2316	2	3	3.5	2	3	2316	843	63	15	20	10	18
2317	2	4	3	2.5	3	2317	1,205	78	25	19	16	18
2318	2	2.5	4	2.5	3	2318	1,236	68	10	24	16	18
2334	2	3	3	3	3.5	2334	1,134	73	15	19	19	20
2336	2	2	3	3.5	2.5	2336	809	61	8	19	21	13

☆ *Note: **you want to keep your replacement daughters from your higher-producing ewes.** Then select rams to improve priority traits in your top-producing ewes. By doing this, you will be able to maintain your milk production while improving your flock's udder conformation.*

Let's use one farm as an example.

Gabriel and Bathsheba Oak own **Oak Sheep Dairy Farm**. They have assessed their dairy sheep udders for the first time. They have two dairy rams on the farm, both of whom they used in the last breeding season. They have made the following observations:

- *"We spend too much milking time holding up udders to get the milk out."* This observation is validated by low Udder Floor Height and Suspensory Ligament scores in mature ewes in their 3rd and 4th lactations.
- *"We want to improve udder conformation without impacting average milk production."*
- *"The yearling daughters with the better Rear Attachment scores are all from the same ram."* From this observation, Gabriel and Bathsheba believe that that ram has the genetics to improve the ligament support in some of their older ewes.
- *"In our two-year-olds, the lowest average trait score is teat placement."*

Using the udder conformation scores in conjunction with the flock milk production data, Gabriela and Bathsheba come up with a plan for the next breeding season:

Ewe #	Lact. #	Udder floor depth	Medial susp'y ligament	Teat place-ment	Rear attach-ment	Ewe #	Prod'n 210-d, 2025	Compo-site score	Wt'd UFD	Wt'd MSL	Wt'd TP	Wt'd RA	Ram
2302	2	3.0	3.5	2.5	3.5	2302	1,069	71	15	20	16	20	Back-up
2304	2	2.0	3	2	2.5	2304	1,309	50	8	19	10	13	Dairy - TP*
2305	2	2	2.5	1.5	2.5	2305	968	42	8	14	8	13	Terminal
2308	2	4	4	2.5	4	2308	1,333	88	25	24	16	23	Dairy - TP
2309	2	3	4	2.5	4	2309	1,145	78	15	24	16	23	Dairy - TP
2310	2	3	4	2.5	2.5	2310	1,205	68	15	24	16	13	Dairy - RA
2315	2	3	4.5	2.5	4	2315	953	79	15	25	16	23	Terminal*
2316	2	3	3.5	2	3	2316	843	63	15	20	10	18	Terminal
2317	2	4	3	2.5	3	2317	1,205	78	25	19	16	18	Dairy - TP
2318	2	2.5	4	2.5	3	2318	1,236	68	10	24	16	18	Dairy - TP
2334	2	3	3	3	3.5	2334	1,134	73	15	19	19	20	Dairy - TP
2336	2	2	3	3.5	2.5	2336	809	61	8	19	21	13	Terminal

- *"We will use our ram with better rear-attachment daughters on a few high-production but low-RA-score ewes."*
- *"We will purchase an additional ram whose dam and paternal grand-dam have better teat placement, to use on our selected high-producing yearlings."*
- *"We will be selective about which yearlings to breed to the new dairy ram."*
  - *"Our two-year-olds averaged 1,100# milk and their composite scores averaged 68. Ewes going to dairy rams must have at least average milk production and must have > 68 composite score."*
  - *"Our unselected ewes will be bred to a terminal sire and their lambs will go to our meat market."*

And the Oaks make a couple of exceptions to their rules:

  - *Exception: "One of our two best producers, tag #2304, has a below-average udder score of 50. We want to keep her high-production genetics in our flock, and we understand the high heritability of teat placement, so she will be bred to the purchased ram with better TP genetics."*
  - *Exception: "One ewe, tag #2315, has a good udder but comes from a family of below-average producers. We want her milk, but we don't want to perpetuate her lower-production genetics. She will be kept in the flock but bred to a terminal sire."*

CHAPTER 5: The Economics of Udder Conformation
Why it matters

a. **Milking time**
b. **Unharvested milk**
c. **Higher SCC --> lower production and lower milk quality**
d. **Fewer lactations per ewe --> more replacements needed**

Milking time or unharvested milk

This ewe is 3 years old, and milks ~10 lb/d for 115 days – Great!! She pays some bills!   But what does it take to get the milk out of her?

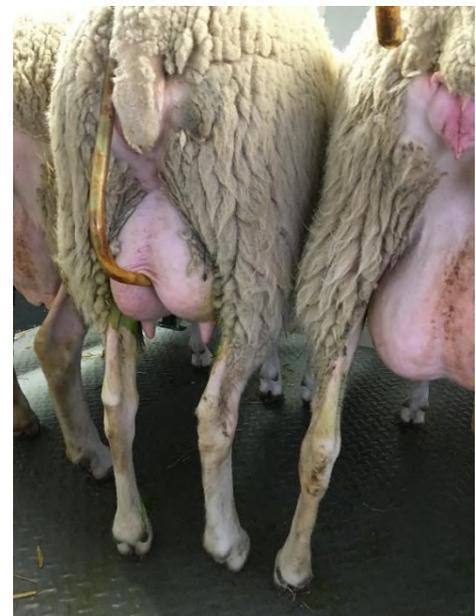Here is the level of her teats, the natural outlet for her milk.

And here is the volume of cistern, full of milk, below the "outlet" of her teats.

Many of us will use our hand to lift her udder up in the middle, …

….or use a Sagi hook,

… or, cleverly and quickly, use a piece of 2x4 to prop up the udder.

We get her cisternal milk out, and it doesn't really take *that* much time, right? …
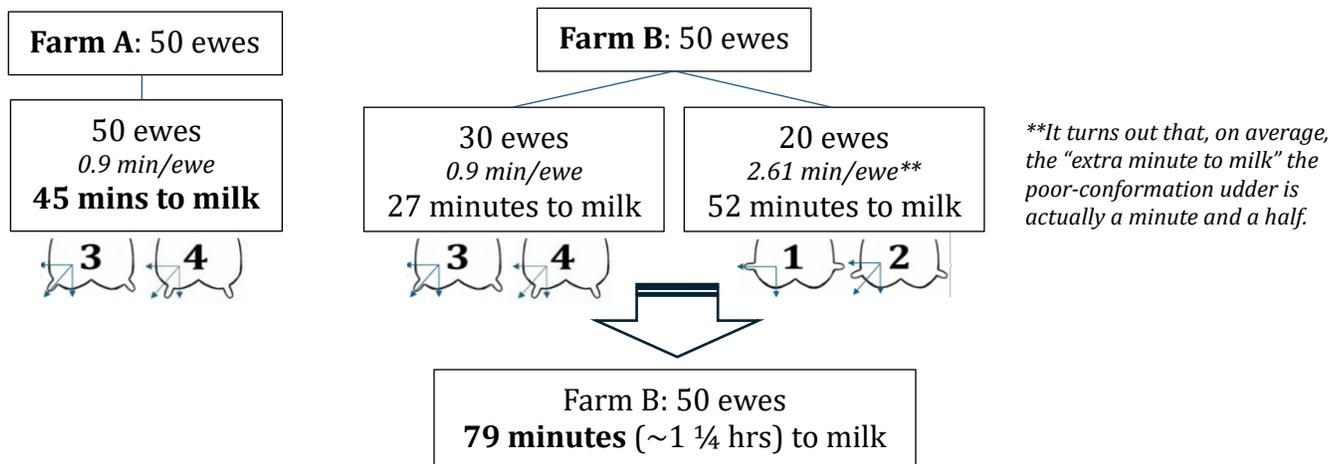
K. The economics of milking time

"We know that these bowling-ball udders slow us down," you say. "But it only takes an extra minute per ewe, and I'm not sure it's worth the time to score udders." Hmmm. Let's start with a back-of-the-envelope valuation on your time lifting up udders.

- 1 minute of extra time @ $20/hr only costs $0.33 per Sagi-hook ewe. Not a big deal.
- But what if you have 20 ewes who require the extra 1 minute of machine-stripping, whether by using your hand a Sagi hook to lift the udder. Now that machine-stripping is costing you 40 minutes a day, *every day* (as if you had that extra time!) = $13/d.
- And let's say that you have to lift those 20 udders through 100 days of peak lactation = $1,300 in additional labor. Or more likely, you're lifting udders through a 200-day season for most of your flock = either 133 hours of your unpaid time or $2,660 in paid labor.

If you doubt the back-of-the-envelope approach, let us show you some actual research with dairy sheep. A Spanish study (*Fernandez et. al., 1989**) found that machine-stripping reduced the number of ewes milked per hour by 42%. Let's see how this plays out on *two very typical farm scenarios*.

Farm A. Has a 50-ewe flock with a low-line 10-bail parlor and no automatic take-offs. After years of selection, they have no ewes requiring machine-stripping. Milking time is 45 minutes, including pre-dip and post-dip routines.

Farm B. Also has a 50-ewe flock with the same milking system. Many of their ewes have poor udder conformation and they use Sagi hooks and manual lifting for machine-stripping.

Farm A: 50 ewes	**Farm B**: 50 ewes	
50 ewes *0.9 min/ewe* **45 mins to milk**	30 ewes *0.9 min/ewe* 27 minutes to milk	20 ewes *2.61 min/ewe*** 52 minutes to milk

***It turns out that, on average, the "extra minute to milk" the poor-conformation udder is actually a minute and a half.*

Farm B: 50 ewes
**79 minutes** (~1 ¼ hrs) to milk

At Farm B, because of the poorer-conformation udders needing assistance, milking 50 ewes takes 34 minutes longer than it takes at Farm A. A combined 72 minutes a day, every day … **to get out the same amount of milk.**

Fernández, N., Joy, S., Torres, A., Molina, P., Peris, C., Rodríguez, M., Gallego, L., 1989. Mechanical milking system in dairy sheep herds of the La Mancha breed. IV International Symposium on Machine Milking in Small Ruminants Tel-Aviv, Israel. pp. 252–271.

L. The economics of unharvested milk.

Some great research was conducted in Israel (*Sagi and Morag, 1974**) with Assaf dairy ewes with different udder shapes. The researchers measured how much milk came out each of four udder types (depicted right).
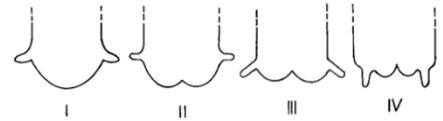
With each ewe, milk was measured at each "phase" of milking:
> Phase 1: Machine milk. Milking cups are put on and milk is measured after the machine-milked flow stops.
> Phase 2: Machine strip. Milk flow begins again with assistance by lifting the udder up in the middle (drawing, right). Milk is measured after the assisted flow stops.
> Phase 3: Hand strip. Milking cups are removed and the remaining milk is manually worked out. Milk is measured after hand-stripped flow stops.

For this economic exercise, let's compare the amounts of milk collected at each stage from Type I udders (ewes with poor teat placement and poor suspensory ligaments) vs. Type IV udders (ewes with good teat placement and good suspensory ligaments). Let's assume the ewes have ~ 10 lb/milk/d in their udders during the first 100 DIM, and that the value of the milk is $1.10/lb.

- How much milk is harvested from each ewe with the machine alone and without human assistance?
- How much milk requires hand assistance or a Sagi hook? This Machine Strip fraction is the milk we'd leave behind in the lower cistern if we did not pick up that udder, by hand or with a Sagi hook.
- How much milk is only available after manually massaging and stripping the udder?

	Udder Type I		Udder Type IV	
	Lbs collected	*$ value, $1.10/lb.*	*Lbs collected*	*$ value, $1.10/lb.*
Machine milk (no assistance)	3.3	$3.59	7.0	$7.65
Machine strip (hand or Sagi hook)	3.7	$4.06	1.6	$1.78
*Hand strip (uncollected)***	*3.0*	*$ 3.35*	*1.4*	*$ 1.57*
Total value harvested/d	**$**	**7.65**	**$**	**9.43**

> ➢ Udders with better conformation collected 2x milk w/o assistance

> ➢ Poor conformation udders left 37% of milk for machine stripping

> ➢ Even after machine stripping, poor udders left behind ~ 30% of milk.

***Note: hand-stripping is not recommended under any circumstances, regardless of udder conformation – it adds time, increases somatic cell counts, and spreads mastitits.*

The take-home message: better udders produce more milk and more revenue with less labor. Dairies with better udder conformation harvest more milk *without* human intervention than do the dairies who need to machine strip because of generally poor udder conformation.

A case study, and a bit of a goal for many sheep dairies: A farm in Quebec milks ~ 150 ewes, all of which have **Teat Placement scores ≥3.0. This has allowed automatic take-offs**; one person can milk ~ 125 ewes/hr. Their flock average is 1,100# milk collected/ewe over 250 DIM, and in early lactation averages ~ 7.5 lb collected/ewe/d.

We know from the Fernandez research on pg 39 that it actually takes an extra 1.71min/ewe to machine strip = $0.57/ewe = $1.14/ewe/d. Using the Sagi research fractions above, we can see that for this farm, the machine-stripped milk is not worth the labor cost.

Case study	
Lbs collected	*$ value, $1.10/lb.*
7.5	$8.25
1.7	$ 1.87
1.5	$ 1.65
$	**8.25**

* R. Sagi, M. Morag. Udder conformation, milk yield and milk fractionation in the dairy ewe. Ann. Zootech. (Paris), 23 (1974), p. 185

M.   The economics of increased somatic cell counts

Elevated Somatic Cell Counts (SCCs) are the bane of the dairy sheep producer. In the affected ewe, elevated SCCs lower milk yeild. In the bulk tank, elevated SCCs slow cheese curd formation and lower cheese yield.

Decades of research has established that, in general, ewes with better udder conformation trait scores have lower somatic cell counts.

☆ **Teat placement.** *"In udder traits, teat placement was the #1 genetic variable for improving Somatic Cell Counts" in dairy sheep.* (*Fernandez, 1997**)

  - Teats that are angled to the side come in more contact with the [not sterile] inside of the leg, particularly immediately after milking, when the teat canal has not yet closed.
  - Conversely and logically, teats that point down have less contact with the inside of the leg, particularly immediately after milking, when the teat canal has not yet closed.

☆ *Medial suspensory ligament. Stronger medial suspensory ligaments and better lateral ligament attachment are positively correlated with improved somatic cell counts in dairy sheep. (Marshall et al., 2024*)*

  - Udders with weaker ligament support are more likely to drop in depth (i.e., below the hock) and come into more ground contact when the ewe is lying down.
  - As the MSL weakens and drops in the middle, the teat position moves up relative to the depth of the udder.

☆ *Milking time. Poor udder conformation is correlated with longer milking time for a ewe. (Sagi and Morag, 1974*)*
  - Extended milking time for a ewe (minutes with cups on) damages teat end tissues and extends the time needed for the teat sphincter muscle to close. This period of time is the highest risk period for intramammary infection because the streak canal – the primary physical barrier against bacteria – remains open and the ewe is more susceptible to bacteria invasion at the udder level.
  - In the immediate post-milking period, udders with poor conformation are more likely to have open teat sphincters in contact with the inside of legs or the barn floor.

Take-home message:

Better udder conformation ⤏ **improved SCC**
　　　　Improved SCC ⤏ **more milk or more efficient cheese production**
　　　　　　More milk and more cheese ⤏ **more milk revenues** …
　　　　　　　　… from the same amount of labor and feed inputs

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*G. Fernández, J.A. Baro, L.F. de la Fuente, F. San Primitivo. Genetic Parameters for Linear Udder Traits of Dairy Ewes. Journal of Dairy Science. Volume 80, Issue 3, 1997. Pages 601-605.

*Marshall, A. C., Lopez-Villalobos, N., Loveday, S. M., Weeks, M., & McNabb, W. (2024). Udder and teat morphology traits associated with milk production and somatic cell score in dairy sheep from a New Zealand flock. New Zealand Journal of Agricultural Research, 67(3), 348–360.

*R. Sagi, M. Morag. Udder conformation, milk yield and milk fractionation in the dairy ewe. Ann. Zootech. (Paris), 23 (1974), p. 185

N. Fewer lactations per ewe => more replacements needed

Udders with poor ligament support will not withstand the weight and strain of high milk production over the years. Even top producers in their peak years of mature production will have to be culled if their ligaments are weak and their udders collapse.

Remember these two high-producing ewes, with their Medial Suspensory Ligaments compared on pg. 11?

	Ewe# 1629	Ewe# 1634	
As a yearling			As a yearling
	Avg mature production (3rd & 4th lactations): 1,421# in ~225 DIM	Avg mature production (3rd & 4th lactations): 1,418# in ~225 DIM	
1629 as a 5-yr-old Udder is maintaining integrity 1629 continued milking through her 7th lactation			1634 as a 5-yr-old Udder support has collapsed entirely 1634 was culled midway through her 5th lactation. Her udder was un-milkable and had become an animal-welfare concern.
In her 5th – 7th lactations, she produced a cumulative 3,025 lbs of milk			In her 5th lactation, she produced < 1,000 lbs before being dried off.
Lifetime production:	**8,889 lbs milk**	**5,562 lbs milk**	

There are two costs to culling ewes after only a few lactations:

a. **Loss of milk in years of mature production:**
- 1634, shown above: Loss of 2½ years of milk (5th-7th lactation): 2,300# @ $1.10 = $2,500 in milk.

b. **Having to raise additional replacement ewe lambs**

The cost of rearing additional replacement ewe lambs

Milking ewes (economically) to their 6th, 7th, and 8th lactations will reduce the number of ewe lambs you need to retain as replacements.

If your milking ewes average five lactations, you will need to replace 20% of your flock every year. When poor udder conformation causes prematurely culling due to chronically high SCC, mastitis, or collapsed udders, more ewe lambs must be retained to replace them. Furthermore, as yearlings these replacements will only produce ~ 70% of their mature milk volume, and so a larger percentage of yearlings in the milking flock will reduce the flock's total production.

Replacement costs for 100-ewe milking string

$450 per-head cost to rear replacement lambs to 1st lactation

Milking string: Avg yrs lactation	Replace-ment rate	# Repl. ewe lambs needed	Annual cost to rear Repl ELs to 1st lactation
3	33%	33	$ 15,000
4	25%	25	$ 11,250
5	20%	20	$ 9,000

CONCLUSIONS on the ECONOMICS of UDDER CONFORMATION

Improved udder conformation means

    a. **Less time milking**
    b. **Less unharvested milk**
    c. **Lower SCC ⋯➔ better milk yield and better milk quality**
    d. **More lactations per ewe ⋯➔ fewer replacements needed**

Overall, this system of assessing and scoring your flock's udder conformation is about making your ewes *more milkable* and making your milking process *more efficient* –

more milk of higher quality from the same feed inputs and less milking labor.

Okay! The End! You are launched! Grab your pencil and clipboard, your Barn Reference Card and Barn Scoring Sheets, and head out to the milking parlor!

CHAPTER 6:   Scoring for the Selection of Replacement Flock Sires

When you have scored your flock and identified how you would like to improve selected ewes, you will start looking for rams that are more likely to pass those trait improvements to their daughters.

How do you do that?? **YOU LOOK AT THEIR DAMS (live and in person, if you are lucky). If you can't see their dams in the flesh, you look at pictures of their dams' udders – tail to floor, at 20-60 DIM, so that you can see udder floor depth, medial suspensory ligament strength, teat placement, and rear udder attachment.**

After you have assessed the potential sire's dam for the four major udder traits, and hopefully found a couple candidates that will improve the traits you want to focus on this year, you might want to train your eye for four additional conformational traits.

These traits do not outweigh the four major udder traits detailed above, but if it's a toss-up between Ramboro and Ramville, assess these traits as you are making your sire selections:

1. **Rump angle**
2. **Fore Udder attachment**
3. **Forward Teat Angle**
4. **Hip/rump width**

Société des éleveurs de moutons de race pure du Québec

Farmers' Guide to Dairy Sheep Udder Assessment
Bee Tolman, Johanne Cameron, Andrea Mongini

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44

O. Hip slope

The American Dairy Goat Association developed its whole-body linear appraisal system for dairy goats, and changed the dairy goat industry in the process. The milkability and the uniformity of the does and udders in the dairy goat industry is thanks to ADGA's system. There are some dairy sheep traits that are currently best illustrated by the same trait in the dairy goat, and hip slope – which ADGA refers to as "Rump Angle" – is one.

From the American Dairy Goat Association's "*Linear Appraisal System for Dairy Goats ©*"

Structure – Rump Angle
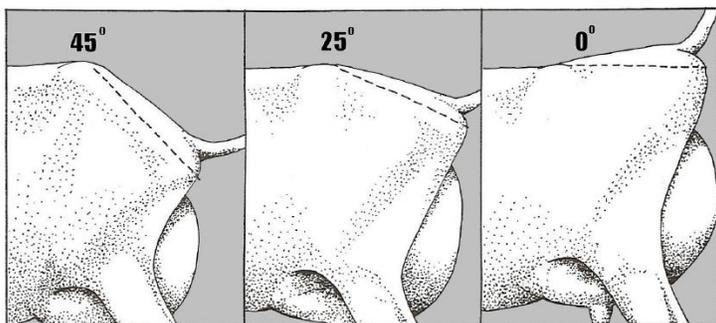
"The angle of the rump or pelvis from hips to pins has a direct bearing on the reproductive performance of a goat because it influences the ease of kidding and drainage of the reproductive tract. The angle of the rump is also related to the length of udder from fore to rear, strength of fore udder attachment, and udder depth." [Linear Appraisal System for Dairy Goats ©, pg 6]. In these diagrams, the ideal hip has a moderate slope, with an angle of 20° to 30°.

Many of our North American dairy sheep have hip slopes that are too pitched or steep. There are two major effects that can result from this: a weakened rear udder attachment and a sickled leg shape.

➢ **Effect on rear udder attachment**

In these pictures you can see an example of a ewe with an over-steep hip slope, and the resulting weakened rear udder attachment, seen as a convex shape between vulva and mammary gland.
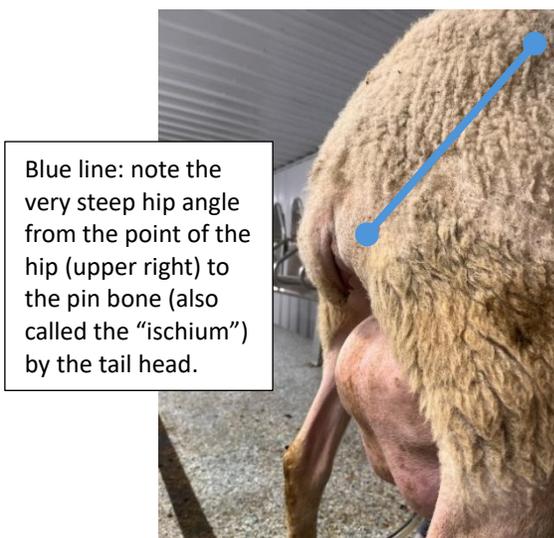
Blue line: note the very steep hip angle from the point of the hip (upper right) to the pin bone (also called the "ischium") by the tail head.

Her steep hip angle creates a convex cavity below the vulva, seen as a shadowed area (blue arrow) in this picture. This structure will have weaker rear udder attachments due to increased strain on the ligaments supporting the udder.
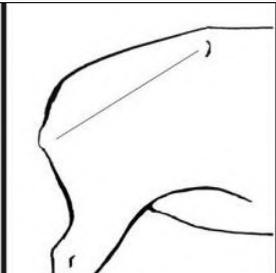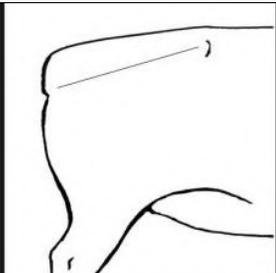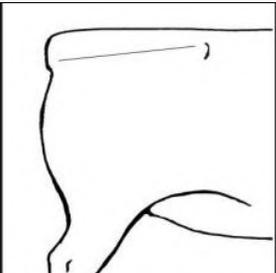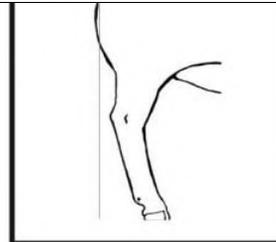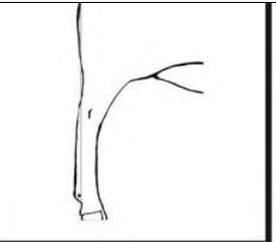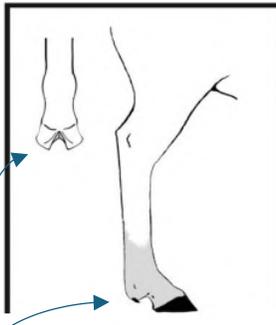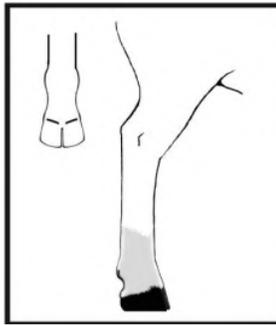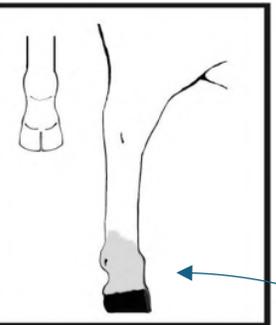
Effect on rear leg structure

Hip angle is connected to leg shape and pastern shape, as seen in the three columns below. Rear leg shape, as evidenced by the degree of angle at the hock, impacts the durability of the legs and feet.

The following diagrams are from the "Programme de classification des ovins" (Program for sheep classification) developed by La Société des éleveurs de moutons de race pure du Québec (The Society of Purebred Sheep Breeders of Quebec, SEMRPQ). These diagrams are for meat breeds, but the ideal skeletal structure for meat and dairy sheep is very similar.

Below are illustrations of Rump angle, Rear legs seen from side, and Rear pasterns:
- Left column: hips too sloped, linked with rear legs too angular/sickle-shaped, and pasterns too flat.
- Center column: hips nicely sloped, strong rear leg stance, and pasterns with natural flex.
- Right column: hips too flat, linked with rear legs too straight, and pasterns too upright.

HIP ANGLE		
Drop-off, very steep angle between the tip of the hip and the ischial bones	Shallow angle between the tip of the hip and the ischiums	Extremely strong and straight, angle very light between the tip of the hip and ischial bones

LEG SHAPE		
Elbowed, under the animal	Good position	Too straight, with no angle at the hocks

PASTERN SHAPE		
Weak. Sagging. Poor structure.	Ideal. Good pastern angle, pastern wide and strong	Pastern too steep.

Weak pasterns, with dew claws almost touching the ground, put extreme pressure on the foot tendons and cause the toes to splay.
Splayed toes lead to skin breakage between the toes and increased susceptibility to foot scald and foot rot.

Pasterns that are too steep can cause arthritis in the hock and lead to mobility issues when the ewe is grazing or walking.

P. Fore Udder attachment

Again, we will turn to the American Dairy Goat Association's whole-body linear appraisal system. The dairy goat description for Fore Udder Attachment can help dairy sheep producers understand the same trait in dairy sheep.

From the American Dairy Goat Association's "*Linear Appraisal System for Dairy Goats* ©"

Mammary – Fore Udder Attachment
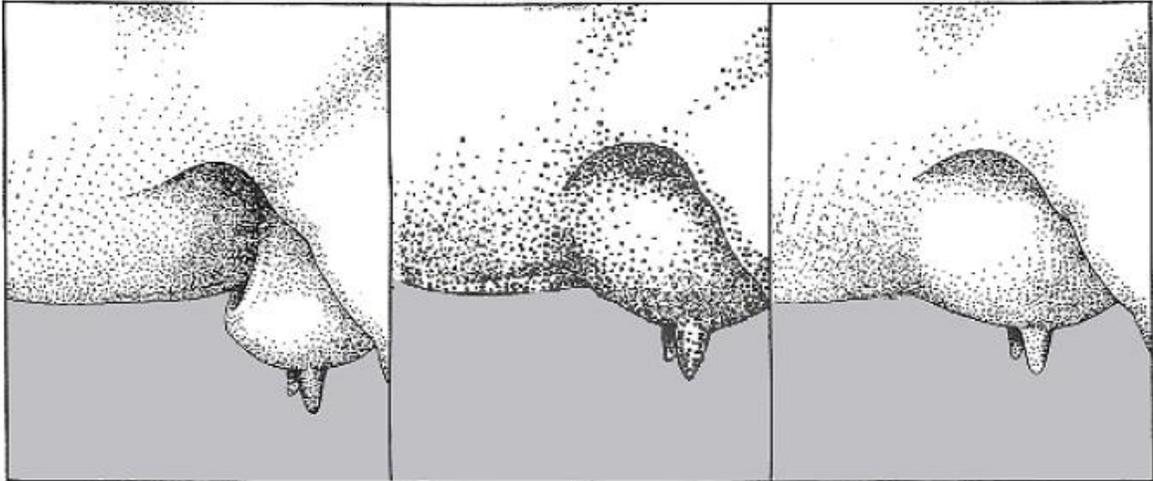
In evaluating the fore udder attachment, [the farmer] looks at the strength of the attachment of the lateral ligaments as they extend forward and laterally to the body wall. [Linear Appraisal System for Dairy Goats ©, pg 8]. Left: an extremely loose attachment; Center: intermediate strength of lateral ligament attachment; Right: extremely snug and strong fore udder attachment.

# Pictures of dairy sheep with a range of fore udder attachments:

Above: Ideal fore udder attachment: long and smooth to the body wall, indicating strong lateral ligament attachments.

Above: Good fore udder attachment: good connection of lateral ligaments to the body wall.

Left: Moderately weak fore udder attachment: note the visible break between the foreudder and the body wall. With your hand, you can feel this break.
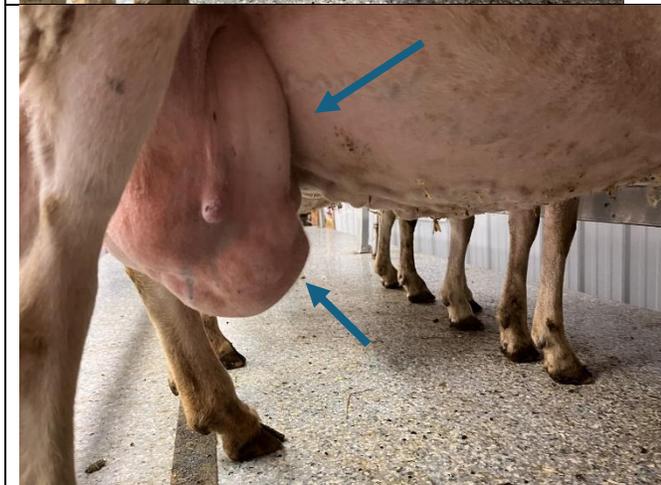
*Left: Very poor/weak fore udder attachment.*

Top blue arrow: note the deep crevasse between the right fore udder and the body wall.

Lower blue arrow: The lateral ligament has actually ruptured from the body wall, and the left gland has dropped.

Q. Hip/rump width

Again, we will turn to the American Dairy Goat Association's whole-body linear appraisal system for dairy goats. The dairy goat description for Rump Width can help dairy sheep producers understand the same trait in dairy sheep.

From the American Dairy Goat Association's "*Linear Appraisal System for Dairy Goats* ©"

Structure – Rump Width
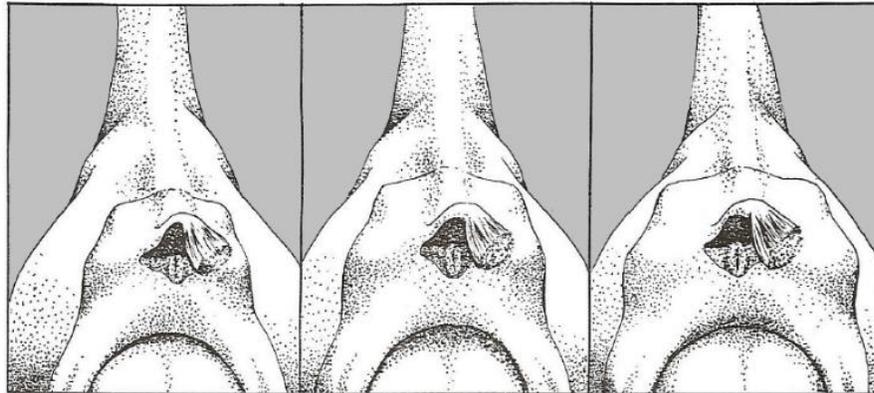
"The width of the rump is important for three reasons. The width of the rump relates to kidding [lambing] ease; the wider the rump or pelvis, the easier the delivery of kids [lambs]. The width of the rump also is an indicator of general body width throughout, as well as the potential for udder width. Rump width is determined as the width between the thurls; that is, the width of the pelvic girdle." [Linear Appraisal System for Dairy Goats ©, pg 7]. In these diagrams, the ideal hip has an intermediate width.

In dairy sheep, ewes with narrow hips are noticed as we try to milk them and struggle to gain access to their teats between their hind legs. Ewes with wide hips have the capacity to carry their udders high and tight to the pelvis under their vulva.

Wider hips also provide more area for rear udder attachment, and allow the udder to seat higher and closer to the vulva.

Narrow	Wide
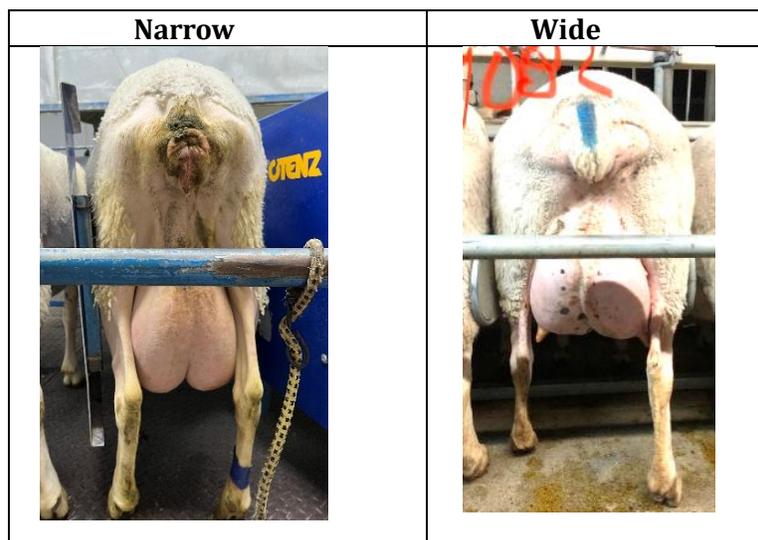
R. Forward teat angle

Forward teat angle in dairy sheep is a genetic hold-over of meat sheep breeding, where suckling lambs benefit from slightly forward-pointing teats.

In dairy sheep, milking efficiency is improved when teats point down!

Forward-pointing teats are much less efficient in dairy sheep:

- Milking cups are more difficult to attach without leaking air
- Cisterns tend to be lower behind forward teats, and require more machine stripping to lift the suspensory ligament and access the cisternal milk.
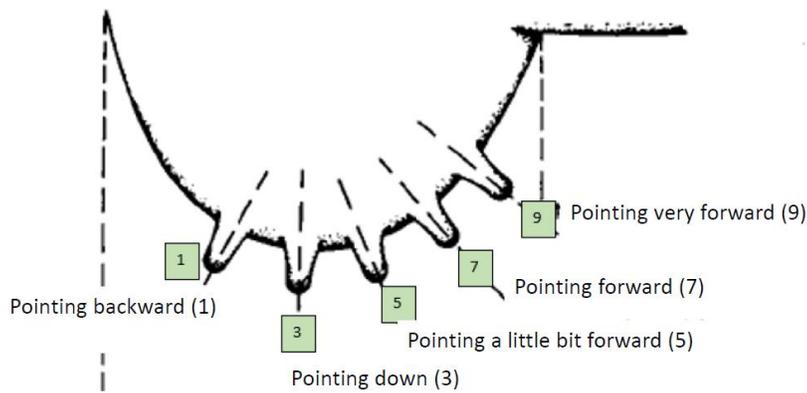
Behind the udder	1	2	3	4	5	6	7	8	9	In front of the udder
	60%	90%	100%	90%	80%	50%	20%	10%	0%	

When assessing the dams and grand-dams of potential sires, look for teats pointing in the 3-4-5 positions as seen in the drawing above.*

Drawing provided by Joanne Cameron and SEMRPQ, 2025

About the Authors

JOHANNE CAMERON. Ms Cameron is co-owner/operator of a 2,000-head sheep farm located in Saint-Charles-sur-Richelieu in Quebec. She grew up near her grandfather's family farm. This exposure to livestock pushed her towards agronomy where she completed her Bachelor's degree at Laval University and then a Master's degree researching the use of photoperiod to manage out-of-season production in sheep. In 2003 she joined the Centre d'expertise en production ovine du Québec (CEPOQ), where she worked as Extension Coordinator. In 2011 she took a position as a project manager at CEPOQ, to work on various research projects for sheep production, including the development of the dairy sheep module at GenOvis which has made EBVs available to dairy sheep producers. In 2018, Johanne decided to stop working in research to focus her work on her constantly-developing farm. She still teaches sheep production at the Collège d'agriculture de St-Hyacinthe and acts as an advisor and consultant to the sheep industry in her region, including a recent project on milk quality.

Johanne is very involved in the sheep industry, in agriculture, and in the community. She has been a member of the Board of Directors of the Canadian Sheep Breeders' Association since 2011 and since 2018 has been President of the Société des éleveurs de moutons de race pure du Québec (SEMRPQ, Purebred Sheep Breeders Society of Québec). She was Project Lead for the Classification for Dairy ewes in Quebec, a classification system for dairy ewe traits including nine traits for the mammary system, and is also a co-Lead for the ovine genomic database project located at Laval University in Quebec City.

Johanne has spoken at two DSANA Symposia, first on the light-extension system that facilitates out-of-season estrous in ewes (*Light-Extension Protocols for Out-Of-Season Breeding*, Jan 2022), and then on the background of dairy sheep udder classification (*Improvement of the Conformation of the Mammary Gland in Dairy Sheep*, Nov 2023). DSANA members have access to both of Ms Cameron's presentations through the DSANA website: https://www.dsana.org/symposium-proceedings.

As an author of this Assessment System and the Farmers' Guide: Johanne Cameron is renowned for her dedication to developing programs to meet the genetic and production needs of the dairy sheep industry in Quebec. She conducted an extensive review of the European research on udder conformation genetics in dairy sheep, and then worked with SEMRPQ's Executive Director, Cathy Michaud, to transform decades of European research into a dairy sheep module in SEMRPQ's "Programme de classification des ovins" ("Program for Sheep Classification"). Without this foundational work and Ms Cameron's willingness to share her work for the benefit of everyone in the dairy sheep industry, the North American Sheep Dairy Udder Conformation System presented in this Farmers' Guide literally would not exist.

BEE TOLMAN. Ms Tolman has worked on, owned, or managed livestock farms for 44 years. She managed Meadowood Farms, a 150-head sheep dairy in Cazenovia NY, from 2004-2025, focusing on genetic gains and the use of EBVs in the breeding program, and transitioning the flock to 100% out-of-season (fall-lambing) production to meet the unfilled market for fall/winter milk. Now as Tolman Sheep Dairy Services, Bee facilitates projects that progress the dairy sheep industry. Her prior experiences have allowed her to be involved with a variety of livestock enterprises: 6 years as owner/operator Tolman Sheep Dairy Farm in Upstate NY, milking 350 ½-dairy ewes (1998-2004); 5 years as a [cow] dairy farm worker in New Zealand (1993-1998); 7 years as a shepherd in New England and Scotland (1982-1989).

Bee received a Masters degree in Animal Science from Virginia Tech in 1993, which gave her experience in farm business management (Masters Thesis: *Budget analysis of crossbred ewes in two lambing systems*) and in translating research into educational materials. In New Zealand she freelanced in ag journalism, including a 3-article series in *The New Zealand Dairy Exporter* on "*Calving Date Systems Comparison Trial at Massey University*" and a harrowing term as Managing Editor of a North Island farming newspaper. Since 2017 Bee has served as President of DSANA (the Dairy Sheep Association of North America).

As an author of this Assessment System and the Farmers' Guide: What Bee Tolman brought to the table, for better or for worse, was 27 years' of struggle with unmilkable dairy sheep udders and attempts at all sorts of *ad-hoc* udder scoring systems. Her years of milking cows had shown her that other industries had evolved their animals' udders, and her stint at graduate school gave her the background to learn about the anatomy behind udder conformation. This pushed her to work with Johanne Cameron and Andrea Mongini to develop an assessment and scoring system that could be easily adopted by farmers, along with a Guide that would present the system in accurate and understandable language.

ANDREA MONGINI DVM. Dr. Mongini is partner in M&M Veterinary Practice in Denair, California. She has a significant background as a nutrition, herd health management, and veterinary consultant with dairy farms, and a specialty in small ruminant dairies. She currently works as a consulting vet and nutritionist on cow, goat, and dairy sheep farms across the United States

She also owned and operated Ewetopia Dairy, a 300-ewe dairy in California, for 14 years. As a sheep dairy producer herself, she understands the limitations and bottlenecks that sheep dairy producers face on a daily basis. Feeding and managing her own herd has given her a unique comprehension of the struggles facing the industry.
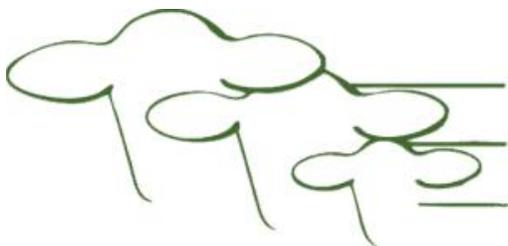
Andrea has given nine presentations at DSANA's Dairy Sheep Symposia: *Nutritional Management of Production in Dairy Sheep* (2018); *Management of AI Reproduction in Dairy Ewes* (2018); *Introduction to Udder Conformation in Dairy Ewes* (2021); *Raising Dairy Replacement Ewe Lambs* (2022); *Raising Dairy Ewe Lambs from First Breeding to Freshening* (2022); *Breeding for Improved Udder Conformation* (2023); *Colostrum Quality* (2024); *Managing Milk Quality* (2024); and *Dairy Sheep Nutritional Needs During Lactation* (2025). She is a regular speaker at veterinary conventions where she educates veterinarians on health, management, and nutrition topics related to sheep and goats.

DSANA members have access to all of Dr Mongini's past presentations through the DSANA website: https://www.dsana.org/symposium-proceedings

As an author of this Assessment System and the Farmers' Guide: Dr Andrea Mongini brought her unparalled understanding of small-ruminant dairy anatomy and her experience with breeding programs for dairy sheep to advise on the development of both the scoring system and the Guide. She saw the role played by the Lateral Ligaments and determined how to describe and score the fourth trait for "Rear Attachment", which had been elusive to us up to that point. And she continuously reviewed the ongoing development of the Farmers' Guide, with meticulous attention to detail, resulting in a manual that is both accurate and professional. This detail and accuracy will make the Guide a go-to manual for both farmers and industry professionals for years to come.