
CHEESE IN THE HEARTLAND
DES MOINES, IA
JULY 27-30, 2016
PRESENTED BY
Swiss Valley FARMS
CAVES OF FARIBAULT
AMERICAN CHEESE SOCIETY

Sheep Milk, Sheep Cheese and Thistle Rennet

Mark Johnson & Bénédicte Coudé – Wisconsin Center for Dairy Research

Mariana Marques de Almeida – Ms J. & Co.

Anna Landmark – Landmark Creamery

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General Outline

1. What is the composition of sheep milk?
2. Sheep milk/cheese characteristics and its main defects
3. Characteristics of thistle rennet
4. Sheep cheese making in Spain and Portugal
5. Making sheep cheese in the US

Impact of the breed on milk composition*

	Fat	Protein	Total solids	Ash	Lactose
BELGIUM, BRITAIN					
Milksheep	6.80	5.16	18.60	0.95	5.69
FRANCE					
Lacaune	7.40	5.63	18.63	0.93	4.67
GERMANY					
East Friesian	6.50	5.25	17.00	0.90	4.90
GREECE					
Boutsico	7.68	6.04	19.30	0.93	4.80
Vlahiki	9.05	6.52	20.61	0.95	4.09
Karagouniki	8.70	6.60	20.31	0.93	4.08
Chios	7.90	6.26	19.66	0.92	4.06
Friesland x Local	6.40	5.71	17.59	0.87	4.61
Attikis mixed breed	7.59	5.94	18.98	0.89	4.56
Epirus	7.85	6.56	20.13	0.95	4.77
ITALY					
Sarda	6.99	5.60	18.14	0.95	4.60
NETHERLANDS					
Texel	9.27	4.53	20.13	0.95	5.38
SAUDI ARABIA					
Nadjii, Najdi	5.31	4.71	15.36	0.86	4.48
SLOVAKIA					
Tsigai	7.41	5.45	18.75	0.90	4.99
SPAIN					
Churra	7.30	5.98	18.30	0.95	4.25
Manchega	7.78	6.01	18.98	0.90	4.29
TURKEY	6.61	5.74	18.24	0.93	4.96
Awassi					
Karaman	6.65	5.94	18.28	0.97	4.26
Kivircik	7.08	5.53	17.87	0.87	4.39

* Park & Haenlein, 2006

Impact of seasonality on milk composition*

	February	May	August	
Total Solids	19.3	18.8	17.3	12.8
% Milk fat	7.58	6.74	6.59	3.7
% Protein	5.33	5.27	5.09	3.2
% Casein	4.34	4.33	4.25	2.5
Casein:Fat	0.57	0.66	0.64	0.68
% FDM	56.2	53.5	53.7	53.1
% Cheese Yield	18.45	17.29	16.78	10.16

* East Friesian-crossbred, Lacaune-crossbred, and East-Friesian-Lacaune crossbreds ewes

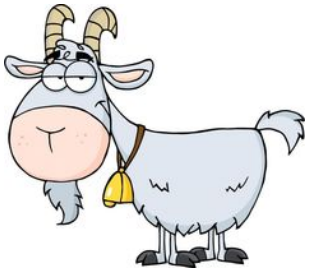
Impact of seasonality on cheese composition

	February	May	August	Cow (May Comp)
Moisture	38.7	38.8	39.4	38.8
% Fat	34.5	32.8	32.5	34.4
% Protein	22.6	24.2	23.6	22.3
% Fat Recovered	83.8	84.2	83.2	92
% Nitrogen Recovered	73.0	75.2	73.8	76
% Yield	18.45	17.29	16.78	18.20
% FDM	56.2	53.5	53.7	54.2

Milk Composition

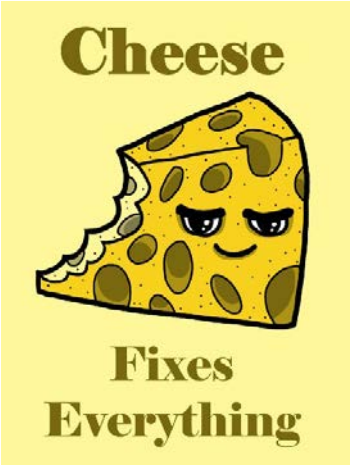
- Basis for payment
  - Fat
  - Protein
  - Other solids
  - Premiums for low bacterial counts and low somatic cells

- Needed to calculate potential cheese yields and cheese composition and financial return



How to improve cheese yield?

- Increase moisture content
- Use milk higher in casein and fat
- Increase casein retention
- Increase fat retention



Understand cheese yield: Van Slyke Predictive Cheese Yield Formula

$$\frac{[RF\ (\%\text{fat in milk}) + RC\ (\%\text{ casein in milk})]\ RS}{\%\text{ cheese solids}/100} = \%\text{ cheese yield}$$

RF = Recovery of fat
range of 0.85 - 0.93

RC = Recovery of casein
range of 0.94 - 0.95

RS = 1 + other solids in cheese
range of 1.08 - 1.20.
Mostly influenced by moisture of the cheese and by the solids in that moisture and salt content of cheese

$$RF = \frac{\text{amount of milk fat recovered in cheese}}{\text{amount of fat in milk}}$$

$$RC = \frac{\text{amount of milk casein recovered in cheese}}{\text{amount of casein in milk}}$$

$$RS = 1 + \frac{(\%\text{ total solids in cheese} - \%\text{ fat in cheese} - \%\text{ casein in cheese})}{\%\text{ fat in cheese} + \%\text{ casein in cheese}}$$

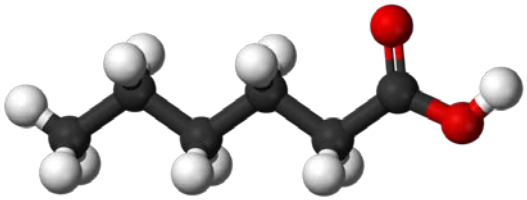
Casein Composition of Milks

Casein			
α_{s1}, %	35	5	56
α_{s2}, %	10	25	-----
β, %	40	50	33
κ, %	15	20	11

(Alichanidia, 1996)

FA composition: impact on flavor

Fatty acids (% total FA)[1]		
Caproic (C6:0)	1.6	2.9
Caprylic (C8:0)	1.3	2.6
Capric (C10:0)	3	7.8
Lauric (C12:0)	3.1	4.4
TOTAL	9%	17.7%

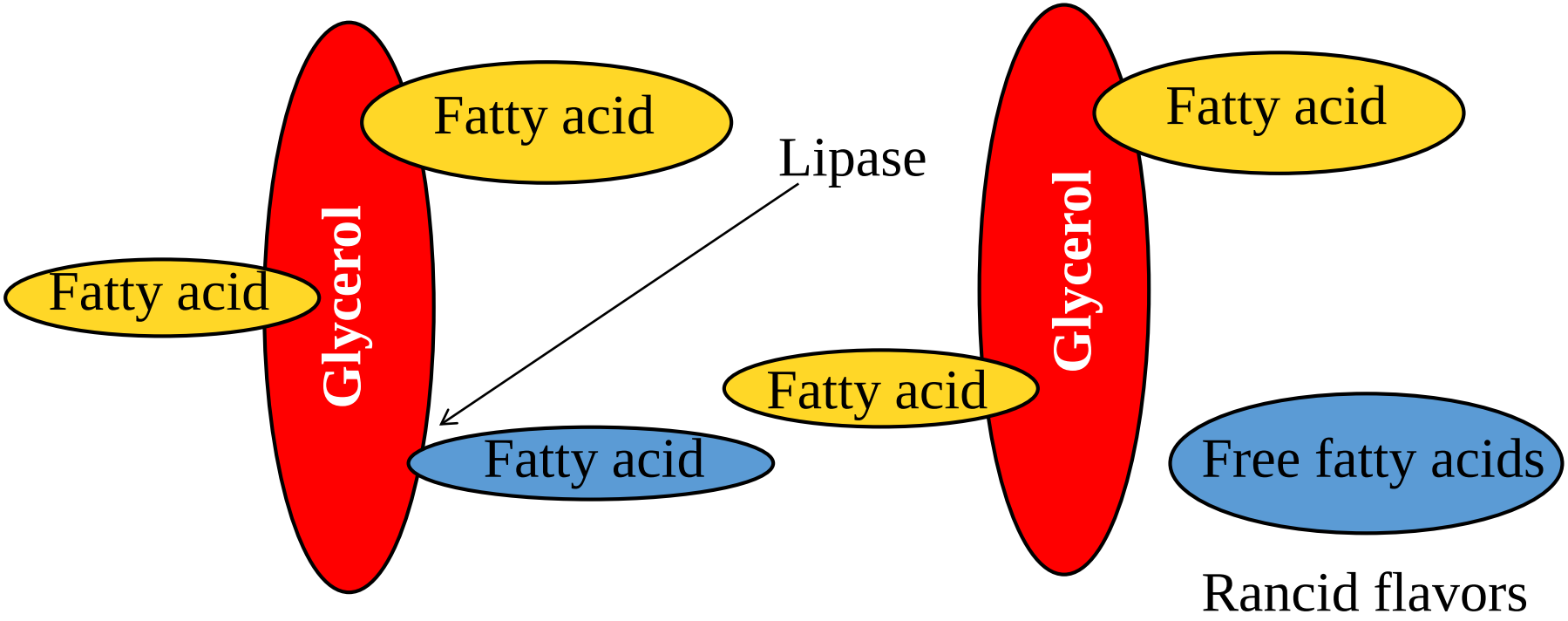


Higher proportion of capric, caprylic, caproic FA

(1) Goudjil et al. (2004), Alonso et al. (1999)

Branched-chain fatty acids are also responsible for waxy/animal flavor found in sheep cheese (**4-methyl/4-ethyl octanoic acid**).

Fat: Triglycerides



Impact of milk composition on cheese ripening

Lactose —**Fermentation**→ Lactic acid

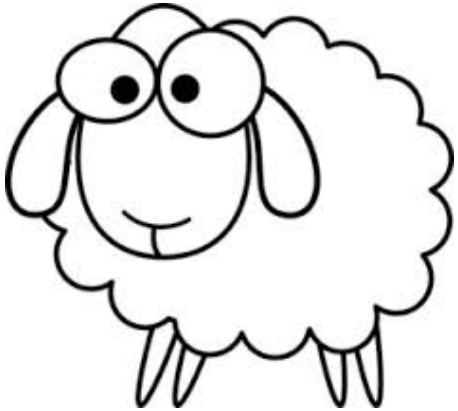
Proteins (caseins) —**Proteolysis**→ Peptides, Free amino-acids

Fat —**Lipolysis**→ Fatty acids

Differences in composition among milks determine the differences in the texture and flavor characteristics of the mature cheese

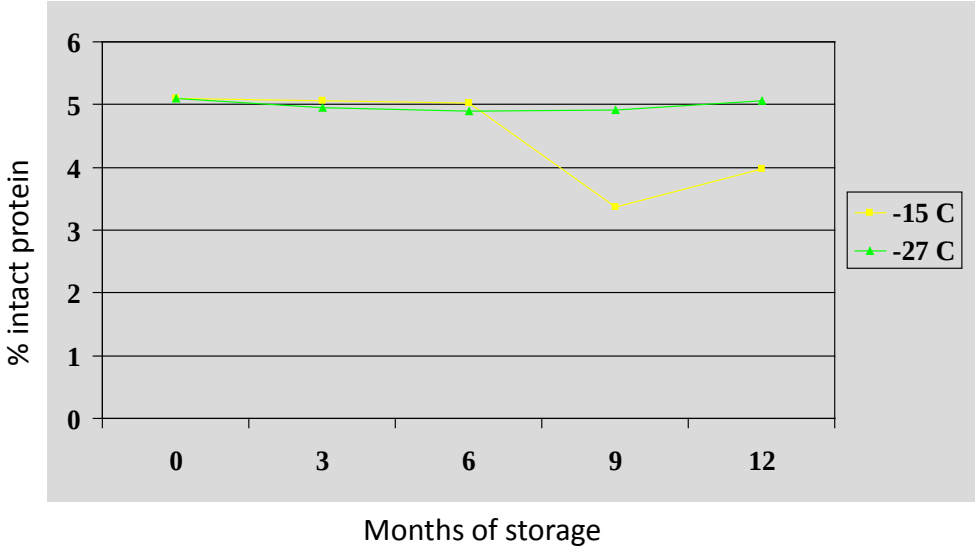
Most common defects in sheep cheeses

- Too sheepy (animal)
- Oxidized
- Rancid
- Grainy/mealy mouthfeel
- Bitter



Early problem with frozen sheep milk [1]

- Milk fat separation
- Poor knit of curd
- Cheese yield decreased
- Oxidized flavor
- Grainy/Mealy texture



Recommended storage conditions for frozen raw sheep milk:

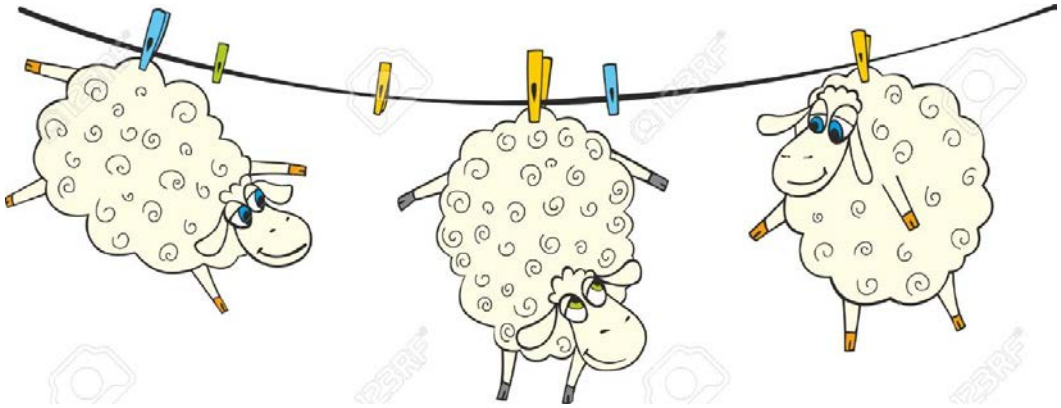
- fast freezing and storage at -27°C or lower for up to 12 months.
- if freezing in home freezer (-12°C), limit storage to 3 months maximum.

[1] Wendorff, 2001

Sheep milk: what do I need to remember?

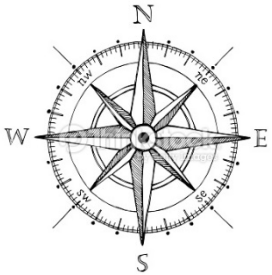
- Higher protein and fat content => coagulates faster, firmer gel, higher cheese yield but higher fat loss.
- Cutting too soon may decrease moisture content.
- High protein content, faster coagulation => grainier cheese texture.
- More prone to oxidation.
- Freezing milk => might lead to issue with grainy texture and oxidation.

Thistle & Sheep Cheeses from Portugal and Spain



Quick Outline

1. Characteristics of Thistle as a milk clotting agent
2. Factors affecting coagulation properties
3. Sheep cheeses from Portugal and Spain
   a. PDO
   b. Genetic variability in the Iberian Peninsula
   c. Example of cheese made with sheep milk and thistle
   d. Example of cheeses made with the Spanish recipe



Thistle: characteristics as a milk clotting agent

Common Name: Thistle or Cardoon

Latin Name: *Cynara Cardunculus*
(C. Cardunculus)

- ✓It is a “weed”, very resistant to dryness and hard conditions
- ✓Present primarily in Mediterranean area (Portugal, Spain, south of France, Italy, Greece and some North Africa countries).
- ✓Other areas like California, Mexico, Argentina and Australia.
- ✓Used for centuries to manufacture traditional cheeses (specially in Portugal and in sheep milk cheeses).

Thistle: *C. Cardunculus*: collection

Source : Martins, A.P.L. 1999

Blossom occurs during summer (June, July) and flowers are collected at that time.

The scale (bracteas) opens and the flower's purple stigmas emerge.

Only the styles and stigmas (purple part of the flower) have milk-clotting capacity and are dried and used all year round.

Thistle -Preparation for cheese making

- Rennet strength is influenced by factors like conditions at collection, conditions at drying, time after conservation, etc…
- Traditional use:
  - Amount of thistle flower per milk volume
  - Daily or weekly preparations

Today we can obtain ready to use thistle extract.

0.5g flower/L of milk

Grind with water and salt

Macerated approx. 12h

Filter

Liquid Extract

Thistle – Proteases characterization

- Liquid extract contains a mixture of proteases:
  - Cardosins (A to H)
  - Cyprosins (1, 2 and 3)

- Proteases activity:
  - Milk Clotting Activity (Specific Activity): Break the bond Phe105- Met106 of κ-casein - like other coagulants.
  - General Proteolytic Activity (Non Specific Activity): break down a lot of proteins.
    - Coagulation: losses in yield and curd firmness
    - Cheese aging: cheeses with softer texture and some bitterness.

Main factors influencing Thistle clotting activity

The same that influence other coagulant proteases.

HOWEVER:

- Temperature: Thistle proteases are active up to 70ºC (158ºF) vs. other milk coagulants up to 40-45ºC (104-113ºF) except for Microbial Miehei coagulants type.
- pH: Optimum pH: 5.0-5.5. More resistant to pH increase then other coagulants.
- Calcium: Less sensible to $CaCl_2$ addition then other coagulants. > $CaCl_2$ => < pH until a certain amount of $CaCl_2$.

What to take home

- Thistle it is still a very artisanal coagulant

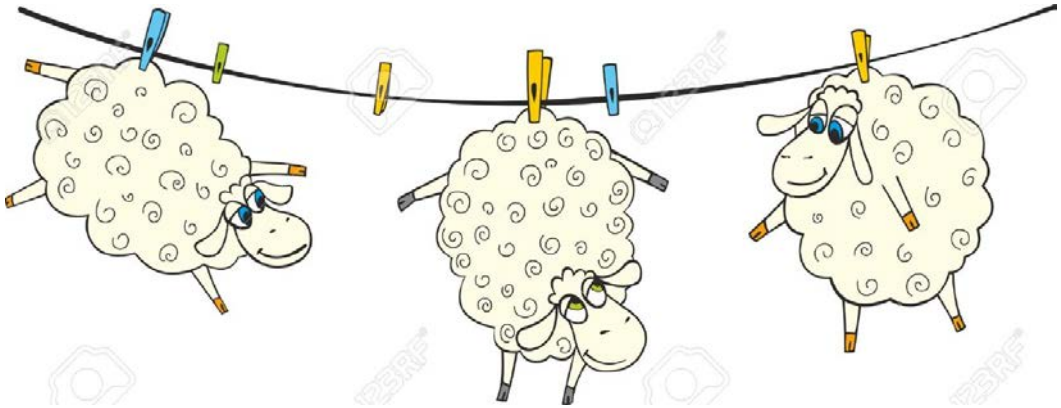
- Need to do trials with your own milk for the amount to be used taking into account aspects like clotting time, milk yield; cheese texture and final flavor.

- Thistle's General Proteolytic Activity and its effects is what really makes thistle different from other coagulants.

  - Enhanced effect if making cheese with goat or cow's milk.

- Thistle is resistant to high temperatures.

Sheep Cheeses from Portugal and Spain



Where are Portugal and Spain?

Importance of Sheep milk in Portugal and Spain

Milk Production 2013
(Thousand Tons*)

Milk Type	Portugal	Spain
Cow	2,040	7,230
Sheep	77	662
Goat	33	520
%Sheep on Total Milk Production	**1.5%**	**7.8%**

Spain is the 2nd European country on sheep milk production (after Greece).

Sources:
*FAO http://faostat.fao.org/ (converted from Metric Tonnes)

Portugal and Spain Genetic Diversity

FAO definition:

Breed- '…Domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species…'

Autochthonous or Native Breed- Breed which have been in the country for a sufficient time to be genetically adapted to one or more of traditional production systems or environments in the country.

	Native Sheep Breeds*	Dairy Sheep
Portugal	15	9
Spain	43	5

Portugal and Spain Genetic Diversity
Dairy Sheep Portugal (examples)

Campaniça

Churra Terra Quente

Mondegueira

Saloia

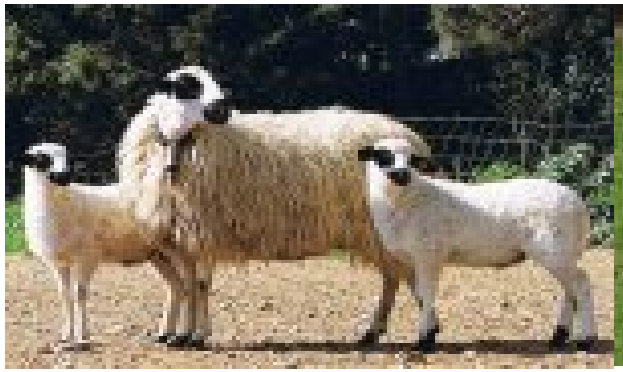
Serra da Estrela

Exotic Breeds

Lacaune

Assaf

Portugal and Spain Genetic Diversity
Dairy Sheep Spain (examples)



Churra

Latxa

Merina

Manchega

Exotic Breeds

Lacaune

Assaf

Protected Designation of Origin - P.D.O.

European regulations that protect a **cheese making tradition,** defines quality standards and tie the name to a geographic region.

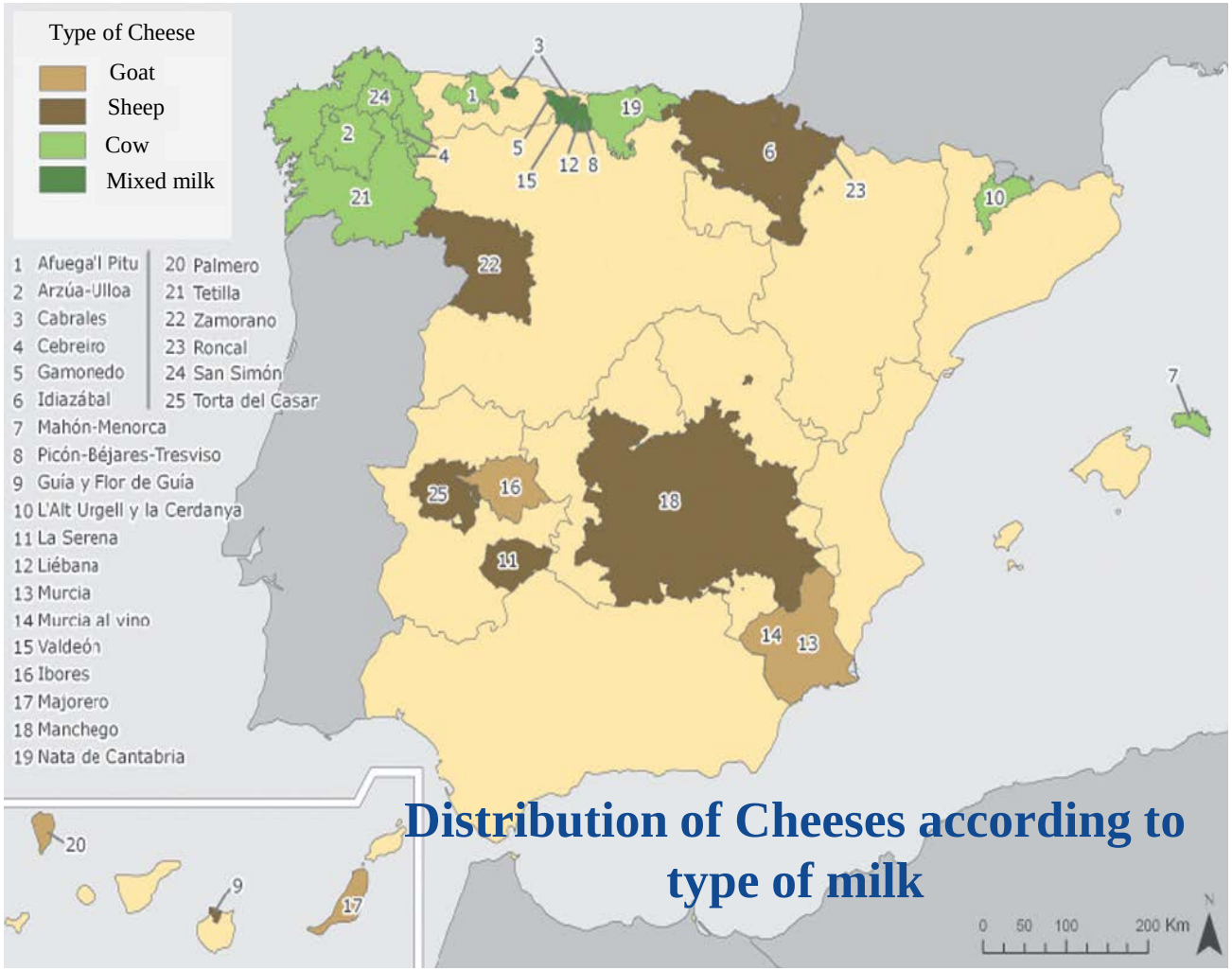
- A P.D.O. has rules about:
  - ✓ type of milk or animal breed
  - ✓ region where milk and cheese is produced
  - ✓ cheese making techniques and/or aging process
  - ✓ cheese size, appearance, flavor, etc…

Portugal: P.D.O. Cheeses

14 traditional cheeses:

- 7 sheep milk
- 2 Cow milk
- 1 Goat milk
- 4 Mixed milk

Spain: P.D.O. Cheeses



Distribution of Cheeses according to type of milk

25 traditional cheeses:

- 6 sheep milk (brown)
- 8 Cow milk
- 6 Goat milk
- 5 Mixed milk

Examples of Cheeses made with Thistle

Cheese making is similar to 6 PDO Portugal "**Amanteigado**" and Spain "**Torta**":

PT
- Queijo da Serra (the beginning)
- Queijo de Azeitão
- Queijo de Serpa
- Queijo de Castelo Branco

ES
- Torta del Casar
- Queso de La Serena

“Amanteigado/Torta” Sheep Cheeses

- Is a unique cheese made in the Iberian peninsula.
- Is made only with Sheep’s raw milk, Thistle and Salt.

Description: Cylindrical shape and yellow in color. Texture is soft and buttery. Deformable when cutting. Flavor mixture of lactic, salty and slightly bitter taste due to the thistle.

This is a general description, changes occur according to PDO

“Amanteigado/Torta” Sheep Cheeses

Cheesemaking (1)

Milk: Sheep’s Milk produced in the PDO region

Heat Treatment: Raw milk

Additives: Not allowed, No adjuncts

Starter Cultures: Not allowed

Salt: Added to milk before clotting (Recommendation: between 15 - 25 gr/L ≅ 0.24 - 0.4 oz/lb milk
Rubbing with dry salt

Clotting agent: Thistle Flower (freshly made)

“Amanteigado/Torta” Sheep Cheeses

Cheesemaking (2)

Clotting: Temp: 29ºC (84ºF)
Time: 60 min.

Cooking: No cooking

Filling: Cut and stir until corn size grain is obtained

Aging: *explained in more detail below

Cheese Size: 3 different weights: 100gr, 250gr and 1 kg (3.5oz, 8.80z and 2.2lb)

“Amanteigado/Torta” Sheep Cheeses

Ripening Conditions

1st Stage: Temp: 9-10ºC (48.2 – 50ºF)

HR: 95-99%

⇒ High moisture prevents the cheese to develop rind

⇒ Intense proteolysis and fermentation with dramatic drop on pH

⇒ The cheese smears and deformation occurs

Between stages: washed with normal water and a cloth is placed around the cheeses to keep the shape.

2nd Stage: Temp: ± 12ºC (55.4ºF)

HR%: 75-80%

⇒ Lower moisture conditions so rind can form.

“Amanteigado/Torta” Sheep Cheeses

With a simple recipe (only 3 ingredients) and a simple technology are these cheeses really different?

YES, They are!!!

“Amanteigado/Torta” Sheep Cheeses

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“Amanteigado/Torta” Sheep Cheeses

Differences (1): Breed and milk composition

Queso de la Serena

Queijo Serra da Estrela

Merino

Serra da Estrela

Lactation Length (d)	60-80	195
Total Milk prod. (kg)	30-40L (66-88lb)	185L (407lb)
Protein (%)	5.8	5.7
Fat (%)	8.5	7.3

“Amanteigado/Torta” Sheep Cheeses

Differences (2): Feeding and Milk treatment

Queso de la Serena

Queijo Serra da Estrela

Graze in the vast dry lands of Extremadura

Graze in the green pastures of Serra da Estrela Mountain

Milk Treatment: **ONLY RAW MILK**

“Amanteigado/Torta” Sheep Cheeses

Differences (3): Technology

Queso de la Serena

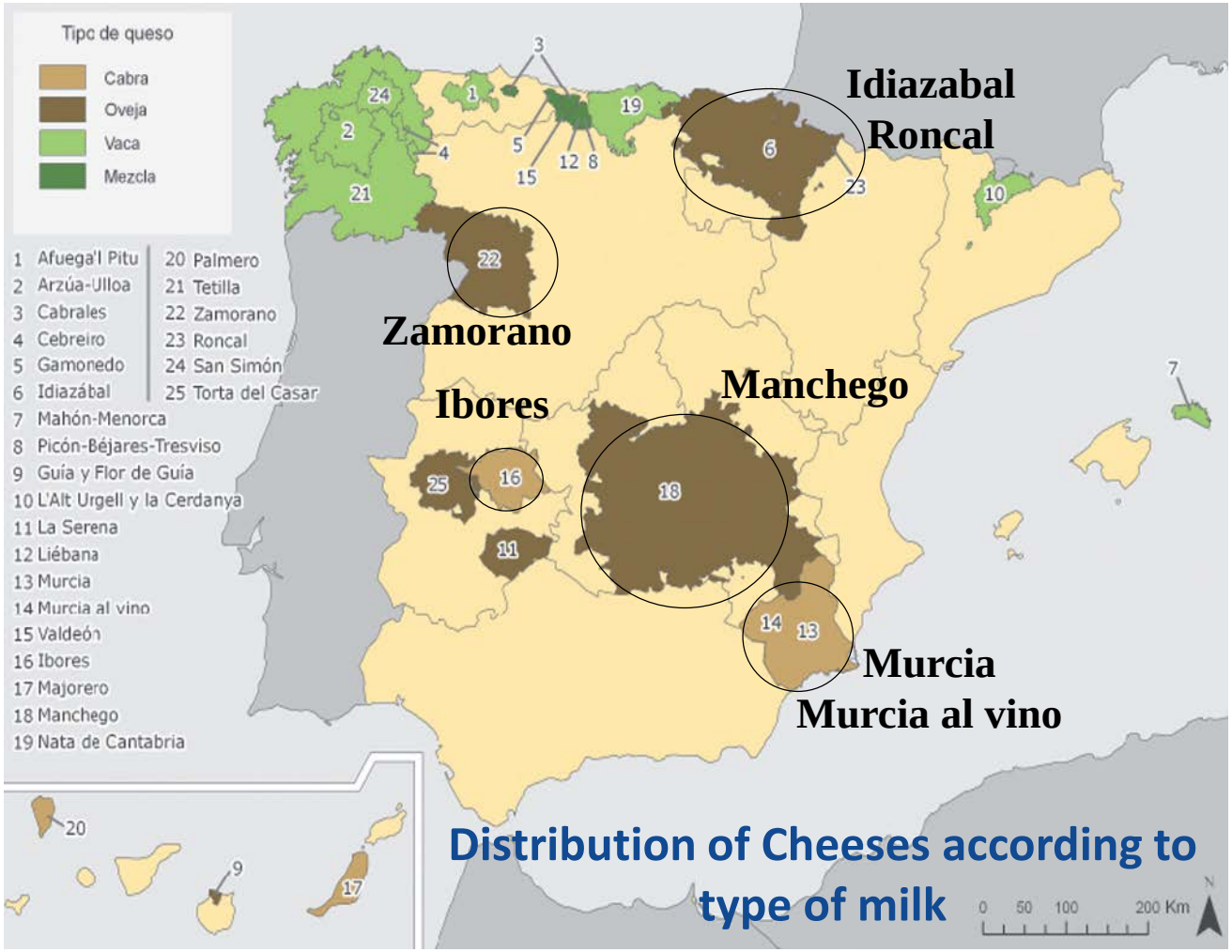
Queijo Serra da Estrela

- Different ways for Thistle use.
- Slight different aging times.
- Different size of cheese: size matters!

Spanish Type Cheeses

Description: Pressed curd, not cooked, rennet cheese. Cylindrical shape and natural rind (sometimes waxed). Firm body with uneven small mechanic eyes. Texture is dry with low elasticity and flavour….

Spanish Type Cheeses



Sheep
- Queso Idiazabal
- Queso Manchego
- Queso Zamorano
- Queso Roncal

Goat
- Queso Murcia
- Queso Murcia al Vino
- Queso Ibores

Mixed cheese:
- Iberico (All over Spain)

Spanish Type Cheeses

Cheesemaking (1)

Milk: Sheep, Goat or Mixed Milks (according to P.D.O.)

Heat Treatment: Raw or Pasteurized

Additives: $CaCl_2$ (when milk is pasteurized)

Starter Cultures: Yes or no - according to P.D.O.

Clotting agent:: Animal Rennet (Calf, Lamb or Kid)

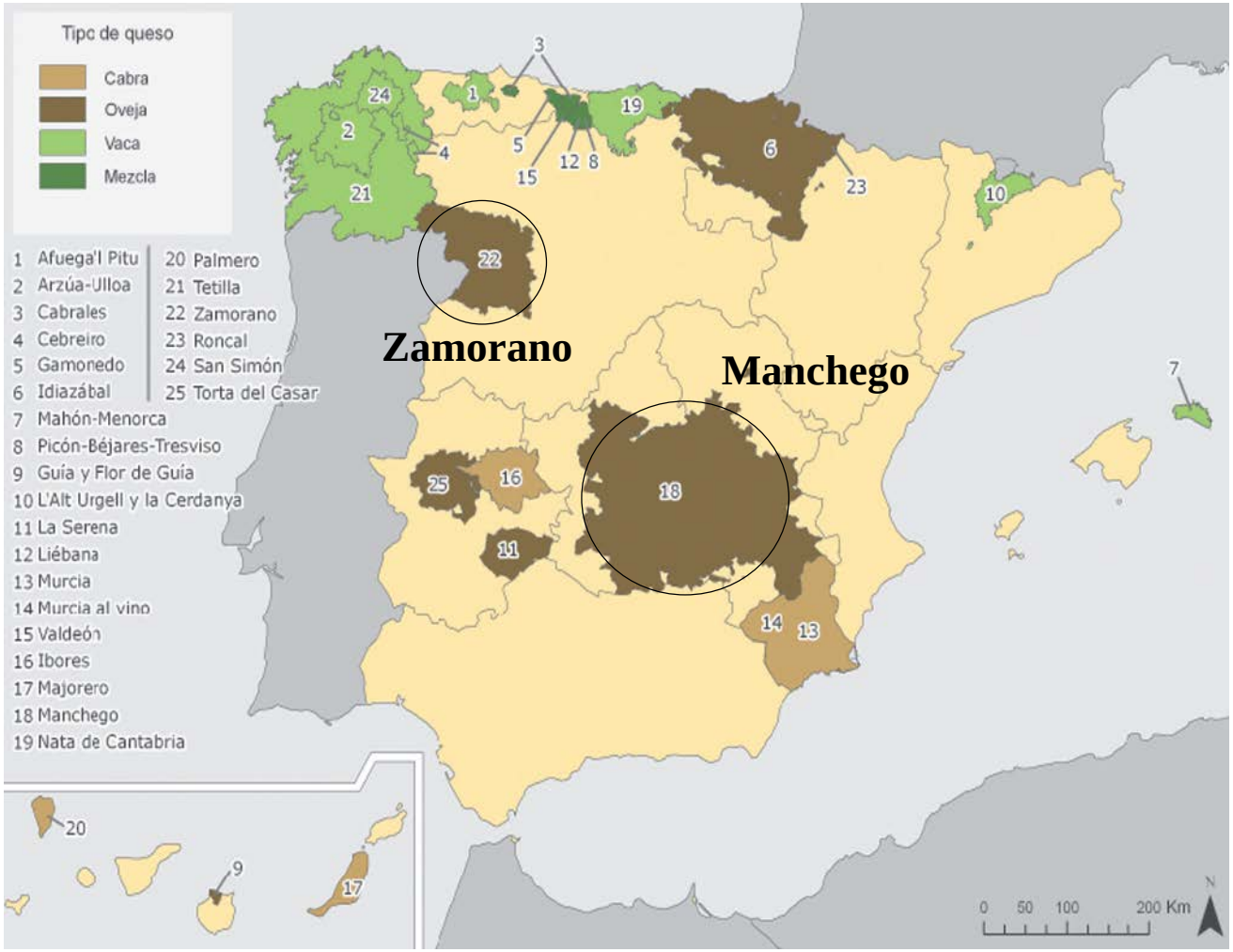
Clotting: Temp: 30ºC (86ºF)
Time: 50 min.

Spanish Type Cheeses

Cheesemaking (2)

Cooking:	Temp: 37ºC (96-100ºF) Curd size: Rice size pH: 6.3
Filling:	When pH is reached (Directly to the forms) Until pH 5.3 is reached
Salting:	Brine (right after pressing) Rubbing with dry salt
Aging:	Temp:10-13ºC (50-55.4ºF); HR:75-85%
Cheese Size:	Average weights 1.5 and 3kg (3.3 and 6.5lb)

Spanish Type Cheeses



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Spanish Type Cheeses

Differences (1): Breed and milk composition

Queso Manchego

Queso Zamorano

Manchega

Assaf (Churra or Castellana)

		Standard	Total lactation
Lactation Length (d)	P150*	P150*	270
Total Milk prod. (kg)	170 (374lb)	364 (800lb)	467 (1028lb)
Protein (%)	5-6	5.3	5.4
Fat (%)	7-8	6.2	6.7

*P150d: Standard lactation = Total milk production after 150 days of lactation.

Spanish Type Cheeses

Differences (2): Feeding and Milk Treatment

Queso Manchego

Queso Zamorano

Graze +
Semi-intensive systems

Intensive or semi-intensive systems

Milk Treatment: **Raw or Pasteurized Milk**

Spanish Type Cheeses

Differences (3): Technology

Queso Manchego

Queso Zamorano

- Raw milk are considered artisan cheeses
- When pasteurized: starter cultures are used

Conclusion – Portugal and Spain cheeses

P.D.O. CHEESES:

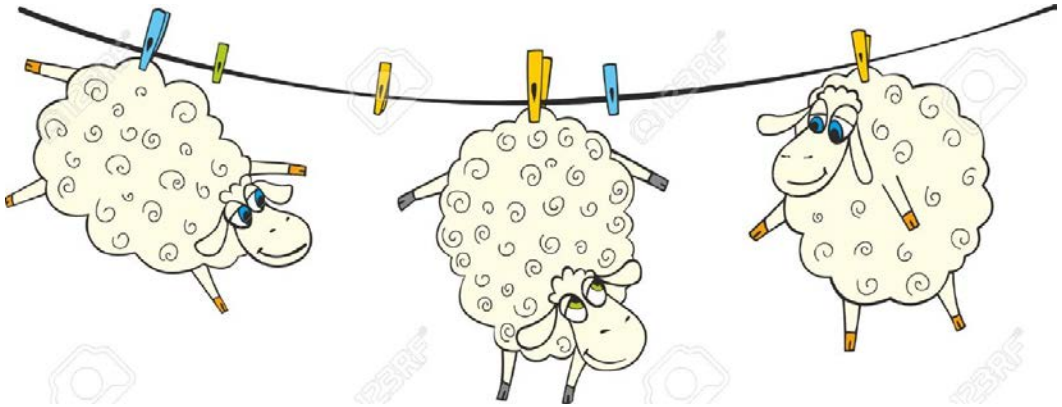
- It is not JUST about the name or the cheese recipe.

IT IS ABOUT PRESERVATION OF A:

- **Genetic variability**: inherent differences in milk composition
- **An ancient cheese making tradition**
- **Different regions and environments:** feed, weather, landscape, etc).

Practical Cheesemaking with Sheep Milk

Or, what I wish I had read in books but had to learn the hard-knock way



LANDMARK CREAMERY

Dairy Sheep in the US

- Because we've been able to import very limited dairy genetics, we don't have differences so much by breed, but by flock, farm to farm.
- Most dairies in the US share the same E. Friesian and Lacaune genetics.
- Each farm has crossed in different non-dairy breeds that have been accessible to them.

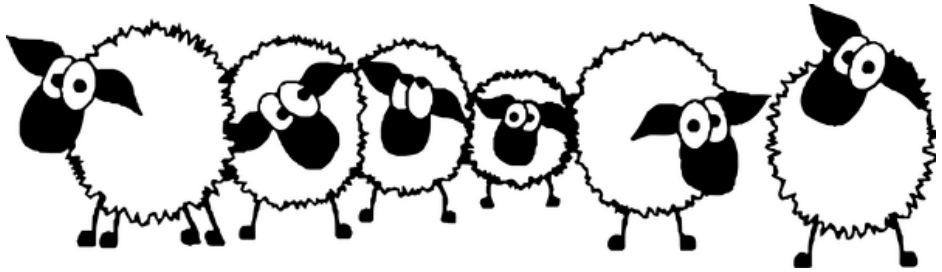
This Flock

- # Ewes Milked: 100 in 2014, 180 in 2015, 280 in 2016
- Flock genetics: 90% East Friesian, 2-3% Lacaune, PolyPay crosses being phased out
- Feed: 2.5 lbs corn grain mix, 5+ pounds hay/grass, 18% protein, no sileage

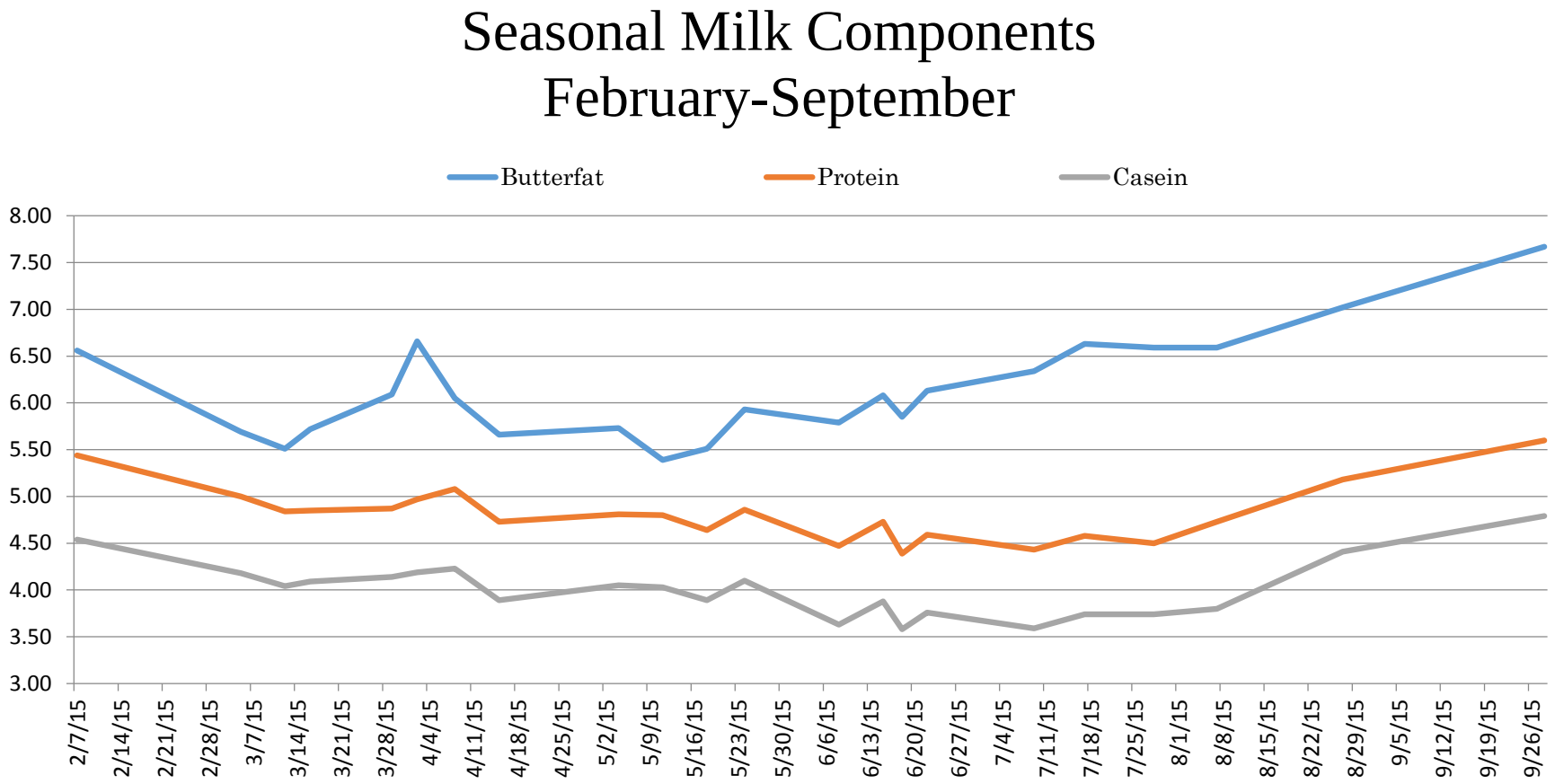
The Flock

- Average Lbs Per Lactation: 700 lbs in 2015, hoping for 800 lbs in 2016 over 8 months
  - February-September

- Not metering, for individual production numbers
- Culling: Less than 5%, health reasons only
- Breeding Traits: milk production & multiple lambs



The Milk



LANDMARK CREAMERY

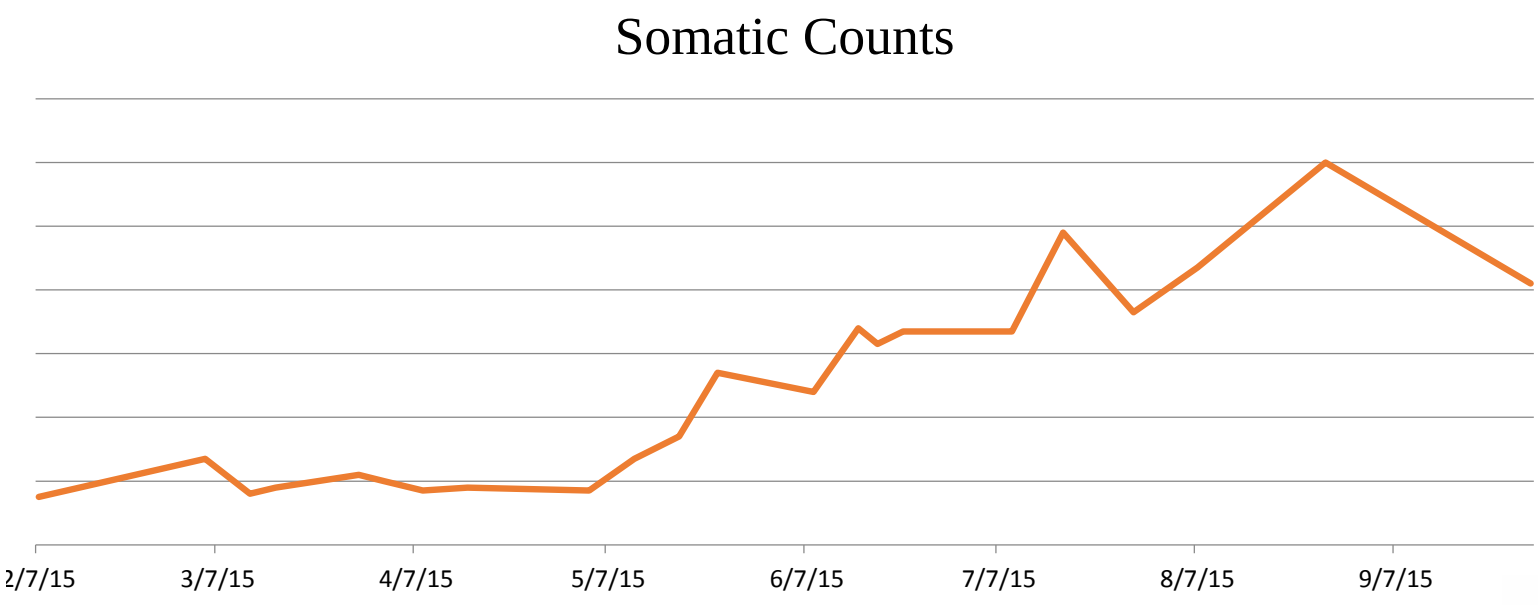
Seasonality

- Changing with the seasons is a hard thing to master.
- Things I'm trying to do better:

1. Monitoring milk samples and past season's records for changes in protein/casein to better predict when changes in amount of rennet will be needed.
2. Increasing/decreasing cook temperature appropriately, instead of just stirring longer/faster to get desired curd firmness.

Some Realities

- Low average yield per ewe
- Low cull rates, to build flock numbers
- Diluted dairy genetics
- Farmers doing the best with what they've got



It’s more than just less rennet

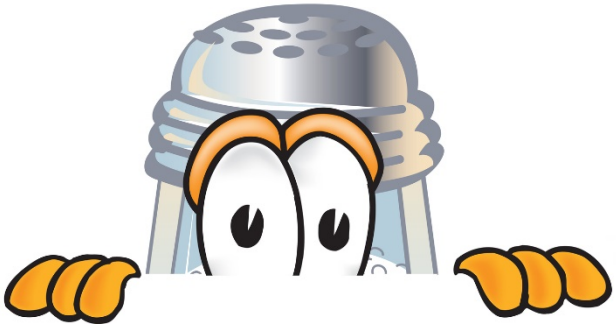
- Coagulation is quite different from cow milk
- 35-45% less rennet needed
- Lower set temperatures, or shortened coagulation time
- Greater sensitivity to temperature
- Little to no calcium chloride needed

Coagulation doesn’t quit at the first cut

- Coagulation continues even after cutting
- Cut “soft” to prevent major clumping
- Don’t rest between double cuts
- Little to no resting needed after cutting, 5 minutes max

Salt, Salt, Salt

- We've found that sheep milk cheese needs much more salt, due to greater % of solids:
  - Haven't yet had a batch we would consider overly salty
  - Add **30%** to what you would use for cow milk, and go up from there



Cheeses

- Ossau Iraty
- Fresh brebis
- Cheddar
- Havarti-ish
- Reblochon
- Pecorino
- Lactic-set bloomy rind

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Cheddaring

- Need very high TA (60+) to lose brittleness and get a nice stretch and a squeaky bite in milled curds.
- BUT, this cheese doesn’t age well, too acidic & lacking flavor. We also under salted, which exacerbated the acidity.
- For aged cheddars, stirred curd has given me better results, better texture.

Soft Ripened Cheeses

- Because the curd is firmer and will continue to knit after cutting, it tends to require more stirring to get desired moisture level.
- Recipes that call for stirring 10 minutes, rest 5 min, stir 10 min: I've achieved better results with slow, continuous stir for the whole duration.
- Graininess in the rind – calcium precipitation. Drain at a lower pH to remove more calcium – or wash the curd. Pasteurization. Don't add $CaCl_2$.

Soft Ripened Cheeses

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Thank you!

Questions?

Mark Johnson - jumbo@cdr.wisc.edu
Bénédicte Coudé - benecoude@gmail.com
www.cdr.wisc.edu

Mariana Marques de Almeida
mariana@msjandco.com
www.msjandco.com

Anna Landmark
www.landmarkcreamery.com
alandmark@gmail.com