Proceedings of the 4th Great Lakes

Dairy Sheep Symposium

June 26 - 27, 1998 • Spooner, Wisconsin USA

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Sponsored By:

University of Wisconsin-Madison
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4th Great Lakes Dairy Sheep Symposium

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Background:

- East Friesian dairy ewes at the farm of Tom and Laurel Kieffer, Strum, Wisconsin

Photos (from upper right to lower left):

- Tom and Laurel Kieffer, dairy sheep producers, Strum, Wisconsin
- Bill and Janet Butler, dairy sheep producers and sheep milk processors, Whitehall, Wisconsin
- Janet Butler in her sheep milk processing plant
- The 2 x 12 dairy sheep milking parlor at the Spooner Agricultural Research Station
- Dick Schlapper (left) and Yves Berger, Sheep Research Unit, Spooner Agricultural Research Station

Copies of the 1995, 1996, and 1997 Proceedings of the Great Lakes Dairy Sheep Symposia can be ordered from the Wisconsin Sheep Breeders Cooperative, P.O. Box 159, Rio, WI 53960-0159, USA (phone: 414-992-6183)

Additional copies of the 1998 proceedings can be ordered from Yves Berger, Spooner Agricultural Research Station, W6646 Highway 70, Spooner, WI 54801, USA (phone: 715-635-3735, fax: 715-635-6741, email: ymberger@facstaff.wisc.edu)

PROGRAM

4th Great Lakes Dairy Sheep Symposium

Spooner, Wisconsin

Thursday, Friday, and Saturday
June 25, 26, 27, 1998

June 25

All Day	**No official program -** The doors of the Spooner Agricultural Research Station are open for those wishing to observe milking. Milking is at 5 p.m.

June 26

7:30 am	**Registration -** Badgerland Civic Center, Spooner, Wisconsin
8:30 - 9:30 am	**Nutrient Requirements and Feeding of Machine Milked Ewes -** Robert M. Jordan, University of Minnesota
9:30 - 10:00 am	**Lamb and Milk Production of East Friesian Crossbred Ewes -** David L. Thomas, University of Wisconsin-Madison
10:00 - 10:15 am	**Break**
10:15 - 11:15 am	**Milking Parlours and Milking Machines for Dairy Sheep -** Pierre Billon, Institut de l'Elevage, Le Rheu, France
11:15 am - Noon	**The Econimics of Dairy Sheep -** Yves M. Berger, Spooner Agricultural Research Station, University of Wisconsin-Madison
12:00 - 1:00 pm	**Lunch on your own**
1:00 - 2:00 pm	**Making and Marketing Sheep Milk Cheese -** Cynthia L. Callahan, Bellwether Farms, Petaluma, California
2:00 - 3:00 pm	**Mastitis of Dairy Ewes: Etiology, Detection, and Control -** Pierre Billon, Institut de l'Elevage, Le Rheu, France
3:00 - 3:15 pm	**Break**
3:15 - 4:00 pm	**Updates on Sheep Milk Research -** Bill Wendorff, University of Wisconsin-Madison
5:00 pm	**Milking at the Spooner Agricultural Research Station -** Outside banquet (lamb, cheese, wine, and much more . . .)

June 27

9: 00 am	**Load bus**
11: 00 am	**Visit farm of Laurel and Tom Kieffer**, Strum, WI
12: 00 pm	**Lunch**
2: 00 pm	**Depart Kieffer farm**
2:30 pm	**Visit farm and processing plant of Janet and Bill Butler,** Whitehall, WI **Wisconsin Dairy Sheep Producer picnic**
8: 00 pm	**Return to Spooner**

TABLE OF CONTENTS

NUTRIENT REQUIREMENTS AND WAYS TO FEED EWES BEING MACHINE MILKED

R.M. Jordan
Professor Emeritus
University of Minnesota

While millions of sheep have been milked in the Mediterranean basin for centuries there is very little hard data on the nutrition of dairy ewes (hand milked). Therefore we have to rely on data from ewes suckling lambs and on dairy cattle data. Unfortunately sheep are not simply small cows and ewes being milked rather than suckling their lambs bear little milk yield resemblance to one another.

Energy Requirements:

Cannas (1996) summed up the energy needs of 60 kg milked ewes vs 600 kg lactating cows as follows: a) Maintenance requirements are based upon metabolic weight (wt $kg^{.75}$). A 600 kg cow with a metabolic weight of 121.2 kg is only 5.6 times greater than the 60 kg ewe with a metabolic weight of 21.6, not 10 times greater. b) Cattle have more kg of GI tract available per unit of energy required for maintenance than sheep and can “store” more feed stuffs in the GI tract per unit of energy required than sheep. c) Cattle retain feedstuffs in the rumen longer than sheep therefore fibrous feeds are digested more highly by cattle. d) Feed passes through the sheep’s gut faster so sheep need to eat more as a percent of body weight. e) Sheep choose better feed, masticate it more thoroughly, thus, reducing particle size which affects passage rate. Sheep digest highly digestible diets better and low digestible diets less well than cattle. f) Major differences between the dairy ewe and the dairy cow is the sheep’s inconsistent response to changes in nutrient intake and their lack of yield persistence or, in short, less dairy temperament. As a hypothetical example a ewe being fed 4 units of feed and producing 4 units of milk will not necessarily increase milk production when fed 5 units or decrease yield appreciably when fed only 3 units of feed. This lack of response obviously makes determining nutrient requirements for dairy ewes frustrating to the researcher.

Suckled vs Milked Ewes:

a) As milk yield per ewe increases the percent of fat and protein decreases. b) Change from first four week suckling to milking is accompanied by a rapid reduction in milk yield of 30 to 40% (Treacher 1989). Thus, milk yield in the second month of milking is likely to be no more and probably less than a ewe suckling a single lamb. However, milk production during the first month strongly affects milk yield during mid and late lactation. Both lactation length and total production are positively influenced by high yield at the peak of lactation (Cannas 1996). In short, when ewes switch from suckling to milking a 40% milk yield reduction among ewes producing 6 lb. milk (6.0 - 2.4 lb = 3.6 lb) results in greater daily milk yield over a longer period of time than a 30% reduction in yield among ewes producing only 3 lb during early lactation. Some breeds of ewes machine milked have a disproportion decline in milk yield. Finn and Romanov suckled lambs grow at about the same rate, but when machine milked Finn ewes yielded twice as much milk (Boylan 1989).

Despite the problems cited as to specific nutrient requirements of dairy ewes Cannas (1996) provides daily metabolizable energy (ME data) from French, Australian, and British sources that are in good agreement with one another and are the best available. I’ve taken the liberty to calculate how much energy is required for each additional kg (qt) of milk produced (Table 1) along with the total amount.

Useful conversion values from feeds to metabolizable energy may be helpful in understanding the data in Table 1. Feedstuffs > gross energy (GE) > to digestible energy (DE) > metabolizable energy (ME) > net energy (NE). In the USA, we frequently use total digestible nutrients (TDN) interchangeably with DE with the value of 1 lb TDN being equal to 2 megacalories (Mcal) of DE. ME is equal to 82% of DE. One lb hay has about 50% TDN (.5 lb) or 1 Mcal DE. Corn has 80% TDN or about 60% more DE than hay.

The Australian data in Table 1 shows an increase for maintenance of .17 Mcal ME for each 1 kg increase in milk yield. Note also that for each increase of 1 kg of milk yield the amount of ME required is about 93 to 100% of the amount of ME required to maintain the ewe.

Lactation energy requirement suggested by NRC (1985) are not as specific as to milk yield and don't agree very closely with the English, French, and Australian data. However, they have been included as they are most available to US producers. NRC maintenance requirements for 60 and 70 kg ewes exceed 2.2 Mcal ME whereas other sources suggest less than 2.0 Mcal ME for maintenance. In order for NRC data to agree more closely with the French, English and Australian data, the NRC maintenance requirements would need to be reduced about 15% (from 2.2 to 1.87 and 2.4 to 2.04 Mcal ME for a 60 kg and 70 kg ewe, respectively). In estimating milk production of a suckling ewe that you intend to commence milking assume that a month old lamb requires about 5 units of milk for each unit of lamb gain. Thus, 2 kg milk (4.4 lb) should result in .88 lb lamb gain on a single lamb or .44 lb ADG on each twin lamb (Bocquier and Caja, 1992).

Protein Requirements:

Specific protein requirements for dairy ewes are very elusive and what values are available are largely from dry ewes, ewes nursing lambs, or from dairy cow data. The amount of protein required daily is influenced by the amount fermented in the rumen (degradable intake protein) and used by the rumen bacteria for growth and subsequently utilized by the ewe and undegradable intake protein is that digested in the intestines. The ability of bacteria to use protein is influenced by type and amount of feed eaten, frequency of feeding, and the amount of energy fermented in the rumen.

For dry ewes NRC (1985) suggests 104, 113, and 122 gms protein daily for 60, 70, and 80 kg ewes, respectively. Crude protein requirements for lactation are about 120 to 125 gms per kg of milk containing 4% CP. NRC (1985) suggests 13% CP for 90 kg ewes and 14.5% for 50 kg ewes producing 1.74 kg milk daily and 14% (90 kg ewe) and 16.2% (50 kg ewes) for ewes producing 2.6 kg milk daily. Ewes fed 18 to 18.5% CP have also increased milk yield, especially if the additional protein is of low rumen degradability (fishmeal, feathermeal, bloodmeal, etc). Microbial protein may not be able to completely meet the protein demands of high producing ewes. However, low rumen degradable protein seem less beneficial when fed in conjunction with corn than with barley (Hussein et al, 1991).

Practical Feeding:

The data in Tables 1 and 2 are rather removed from practical feeding of so many scoops of silage, flakes of hay or pounds of grain and supplements, but my following remarks will use them as the basis for constructing some farm rations for producers to use.

Preparing the Dairy Ewe:

Correct feeding of the dairy ewe should start at least 30 days prior to lambing at energy and protein intakes that a) enhances udder development; b) assure fat and protein reserves on the ewe and c) prepares or accustoms the ewe's digestive tract to the intake of 1.7 to 2.0 times more nutrients than were fed during late gestation. Furthermore, the increased nutrient intake will usually be provided by two to three times more grain than was fed during gestation which can easily cause acidosis (resulting in off-feed, scours and even entero-toxemia). A body condition score of 3.5 to 3.8 (one is thin, five is fat) should provide a body reserve during the first 2 to 3 weeks when energy and protein produced in the milk exceeds the amount contained in the feed eaten. Thus ewes are invariably in negative balance in the first two to three weeks of lactation. Ewes with low body fat reserves will produce about 50% less milk from fat reserves than ewes with adequate fat reserves (Robinson, 1987). Fat ewes (body condition scores of 4.5 to 5.0) normally eat less feed which adversely affects milk yield.

Grinding forage or feeding pelleted rations will increase dry matter intake appreciably, however, it increases ration costs 40 to 60% which no dairy sheep producer can stand. Some sheep producers believe high grain diets reduce milk yields and increase body fat deposition. Grain does increase propionate production in the rumen which tends to produce more body fat than acetic acid production which is more prevalent in high forage diets. However, practical data suggests that milk yield may actually be increased during early lactation and only during late lactation do ewes become fat when fed high grain rations. To minimize proprionic acid production in the rumen, feed very coarsely ground grains or whole corn (Barillet, 1995).

Lactating ewes respond to somatatropin (bST) treatment to about the same degree as dairy cattle (Jordan and Shaffhausen, 1954; Fernandez, 1995) and tends to cause partitioning of more nutrients for milk production than body fat deposits. This hormone treatment has increased milk yield 20 to 30% (Jordan and Shaffhausen, 1954; Fernandez, 1995) and may be a practical way to increase yield of a valuable product.

Assume that other than the ewes inherent capacity to produce milk, the amount produced is going to be influenced greatly by nutrient intake. Just how much and what kind of feed intake is equivalent to 5 to 7 Mcal ME intake (Table 1)? My experience with lactating ewes suggest that the ration should consist of a minimum of 30% and a maximum of 70% grain. The metabolizable energy and protein values in Tables 1 and 2 enables one to calculate compositions of the ration but not total intake. ME intake per day obviously is greatly affected by the amount fed daily. If your hay contains two Mcal ME per kg of DM or .9 Mcal ME per pound then a 30% corn and 70% hay ration would contain 2.345 Mcal ME per kg of ration (30 kg times 3.15 Mcal ME in corn = 94.15 Mcal ME and 70 kg times 2.0 Mcal ME in hay = 140 Mcal ME from the hay. Thus, 94.5 + 140 = 234.5 or 2.35 Mcal ME per kg of ration dry matter). For a 40:60; 50:50; and a 60:40 corn/hay ration the Mcal ME per kg of feed would be 2.46, 2.58, and 2.69 Mcal ME per kg dry matter, respectively. To convert ME per kg to ME per pound, divide each value by 2.2.

The amount of feed per ewe should be based on ewe weight. A 200 lb ewe needs more and will eat more than 140 lb ewe, but when feed is provided as a percent of ewes body weight nutrient intake per 100 lbs will be the same. We have fed ewes nursing twin lambs as little as 3% of their body weight of a 50:50 corn/hay ration and ewes nursing triples as much as 4.5 percent or their weight. A 50:50 corn/hay ration is and has been for some time less costly per pound than a 30:70 corn/hay ration and virtually eliminates feed refusal. When more than a 70:30 corn/hay ration is fed, you are more apt to encounter acidosis and you usually must add considerable protein supplements, thus adding to ration costs.

If you are milking 160 lb ewes and feeding 3.5 percent of their body weight of a 50:50 corn/hay ration you are giving them 5.6 lb dry matter x 1.17 Mcal ME per lb or 6.55 Mcal ME intake per day. Referring to Table 1, 70 kg ewes (154 lb) need about 5.53 Mcal ME to produce 4.4 lb milk or 7.37 Mcal ME to produce 6.6 lb milk. At this level of feed intake, would the protein intake be adequate?

A 50:50 corn/alfalfa hay ration would contain 13.5% protein. 5.6 lb of the corn/hay ration x 13.5% protein would provide .856 lb protein divided by 2.2 = .389 kg or 389 gms protein. Referring to Table 2, one notes 70 kg or 154 lb ewes require 113 gms protein for mere maintenance and an additional 123 gms for 1 kg of milk, and 246 for 2 kg of milk or a total of 236 or 359 gms protein daily for maintenance and either one or two kg milk, respectively. Based upon these calculations a 70 kg ewe producing 3 kg (6.6 lb) milk could be fed a 50:50 corn/hay ration containing at least 13-14% protein and at about 4% of body weight (4.0% x 70 kg = 2.8 kg corn/hay dry matter). Now 2.58 Mcal ME/kg, the energy in a 50:50 corn/hay ration, x 2.8 kg ration = 7.22 Mcal ME that the ewe would be consuming daily or enough nutrients for 3.0 kg (6.6 lb) of milk daily. Protein content 2.8 kg ration times 13.5% protein = 379 gms or .83 lb protein.

Feeding 154 lb ewes about 6.2 lb of 50:50 corn/hay diet to provide 7.22 Mcal ME or 8.8 Mcal DE or 4.4 lb TDN may seem like a great deal to many of you. Hogue (1994) fed ewes nursing triplet lambs about 7% of body weight of a pelleted ration containing 70-75% TDN with excellent lamb growth and about .5 lb ewe gain daily (too much). Benson (1998) fed 175 lb mature ewes nursing twin lambs and producing 8.5-9.5 lb milk daily (oxytocin induced) rations containing 70% TDN and 14% protein at levels to provide 8.5 lb dry matter, 1.22 lb protein and 5.95 lb TDN (9.76 Mcal ME). These data indicate that intake of sufficient feed to produce 6-8 lb milk is no problem. However, getting a machine milked ewe to yield that amount of milk is likely to remain unsurmountable. Feeding a ewe at a level to produce 6-8 lb milk and extracting only 2-3 lb milk daily will obviously make for obese ewes and extremely high milk production costs. Benson (1998) believes US ewes are producing more milk daily and are more efficient than we give them credit for. Hopefully, further research will focus on this point.

The problem of getting ewes to produce milk in accordance to their nutrient intake was addressed by Windels (1991) and is presented in Table 4 and 5. He used mature ¼ Finn, ½ Suffolk and ¼ Targhee ewes weighing 170-210 lb with sound and capacious udders. The ewes were individually fed for the first two (twins) to three weeks (triplets) and 2cc oxytocin was administered IM when ewes were hand milked. Other than when the ewes were hand milked the twin or triplet lambs had access to their mothers. A 50:50 corn-SBM and alfalfa haylage DM ration was fed once daily. The levels of ration fed daily were 90%, 100%, 110% and 120% of the daily amount of energy suggested by NRC (1985) for ewes suckling twins. Level of feed intake affected ewe weight change, condition score and time taken to consume their daily ration but had little affect on lamb weight gains or milk production. This study and several others conducted at Minnesota (Jordan, 1982; Jordan, 1985 and Jordan, 1986) point out the problems encountered in attempting to get non-dairy ewes to increase milk yield when stimulated with increases in nutrient intake. Hopefully dairy ewes will be more responsive than conventional mutton type sheep.

Pasture Feeding Dairy Ewes:

Your concern with pastured dairy ewes should be daily forage intake and forage quality. If the energy requirements of 70 kg ewes producing 2 kg milk are 5.9 Mcal ME or 7.2 Mcal DE that’s equivalent to 3.6 lb TDN or 7.2 lb of forage dry matter or 14.4 lb of pasture forage containing 50% dry matter or 20.5 lb if the forage contained only 35% dry matter, a more likely percentage. Daily intake of pasture forage is affected not only by the need of the ewe and availability but by pasture freshness. Daily forage intake is usually less the third or fourth day of grazing than it was the first day. Thus pasture rotation two or three times per week should encourage intake. During the first 10 weeks of lactation supplementing the pasture with 1.2 lb grain or about 25% of the 5.9 Mcal ME requirement or 1.48 Mcal ME or 1.8 Mcal DE should sustain yield. Thus if the ewe required a total of 5.9 Mcal ME or 7.2 Mcal DE she would acquire 5.4 Mcal DE from the pasture and 1.8 Mcal DE from the grain. Her pasture forage intake at 35% dry matter would be 15.4 lb. After 10 weeks lactation if the pasture is still of good quality the grain could be replaced with good quality hay so as to minimize propionic acid production that tends to over condition the ewe.

What kind (species) of pasture should you use? Initially use what you have, but fertilize it with 50 lb N in the spring and 50 lb N about July 15. If you intend to reestablish pastures Aug 10 seeding works best for us. Bromegrass, orchardgrass and low alkaloid canarygrass (palatin) are much more productive than timothy or bluegrass. Red clover can be frost-seeded at very low cost and will tolerate soils with pH of 5.5 to 6.0.

Summary of Factors Affecting Milk Yield

Pro

- Grinding and pelleting increases feed intake and possibly milk yield.
- High quality forage contributes more to total digested DM intake than pelleting.
- Adequate body fat at lambing.
- Adequate energy and protein intakes, health status and dairy temperment encompass 98% of factors influencing milk yield.
- Have silage finely ground to enhance feed intake.
- Quality pasture forage is crucial to nutrient and DM intake.
- Body condition, milk yield and feed intake are indicative of adequate nutrient intake.
- Cull about 25% of low milk producers the first 2-3 years.
- Repeatability of milk production is high. The top 20% of the producers in year one are apt to be in top 20% the 2^{nd} year.
- Breed or strain of ewe definitely affects oxytocin release, thus milk surge and udder evacuation.
- On average, ewes with 15 to 50% Friesland blood will prove more suitable than non-Friesland ewes for milking.

Con

- Grinding and or pelleting increases ration costs.
- Haphazard ration formulation and feeding levels has no place in a dairy sheep enterprise.
- Irrespective of breed some ewes are “Losers” for the same reason beef cows aren’t a part of productive dairy farms.
- High grain intakes during first 8 weeks of lactation are beneficial.
- Thereafter high grain rations increase body fat deposition and decrease milk yield.
- Grinding grain increases fermentation and increases propionic acid production and thus body fat deposits.
- Corn ferments slower than barley, oats or wheat and response from feeding low degradable protein will be less.
- If hay has a relative feed value below 100 expect 25-35% refusal.
- Liquid or loose feces suggest excess protein intake, too low fiber, excess starch and acidosis. Dry pellet like feces suggest inadequate degradable protein.
- Parlor grain feeding should not exceed .75 lb. at one time to mininize propionate surges. Fat in excess of 10% in concentrate is counter productive.
- Grazing increases maintenance requirements 20% on good quality flat pasture and 35-40% on extensive hilly pastures.

Table 1. *Energy Requirements for Housed Lactating Ewes (Mcal ME/day)*

	60 Kg Ewe						70 Kg Ewe					
	British		French		Australia		British		French		Australia	
F.C.M.(6.5%) Kg/day	Total	Per Kg	Total	Per Kg	Total	Per Kg	Total	Per Kg	Total	Per Kg	Total	Per Kg
0	1.76		1.66		1.83		1.96		1.87		2.05	
1	3.51	1.75	3.40	1.74	3.71	1.71	3.73	1.74	3.60	1.73	3.94	1.71
2	5.31	1.78	5.13	1.74	5.60	1.71	5.63	1.77	5.34	1.74	5.32	1.71
3	7.18	1.81	6.87	1.74	7.40	1.71	7.37	1.79	7.07	1.73	7.70	1.71
4	9.10	1.83	8.61	1.74	9.36	1.71	9.27	1.82	8.81	1.73	6.59	1.71

USA (NRC)

	60 Kg Ewe			70 Kg Ewe		
F.C.M.(6.5%) Kg/day	Total Mcal	Per Kg Milk	15% Maintenance Reduction	Total Mcal	Per Kg Milk	15% Maintenance Reduction
0	2.20		1.87	2.40		2.04
1	6.40	2.20	3.69	6.00	3.66	3.86
2	5.40	1.50	1.78	5.50	1.75	1.93
3	6.10	1.90	2.12	6.60	2.10	1.53
4	6.10	1.30	1.41	6.60	1.40	1.19

Table 2. *Crude Protein Requirements for Dairy Ewes*

Body wt., Kg	60	70	80	90
Maintenance g/d	104	113	122	131
1 Kg Milk	125	123	121	120
2 Kg Milk	250	246	242	240
3 Kg Milk	375	369	363	360

Table 3. Energy and Protein Contents of Typical Sheep Feeds. (DM basis).

	TDN %	Mcal./Kg DM DE	ME	Protein %
Alfalfa				
Midbloom	56	2.47	2.03	17.0
Early bloom	56	2.47	2.03	18.0
Bromegrass	55	2.43	1.99	9.7
Canarygrass	49	2.16	1.77	10.3
Red Clover	62	2.73	2.24	16.1
Orchardgrass	59	2.60	2.13	12.8
Corn silage	70	3.09	2.54	8.1
Barley	86	3.70	3.11	13.5
Beet pulp	77	3.48	2.78	10.1
Corn	87	3.84	3.15	10.1
Fishmeal	77	3.40	2.78	66.0
Oats	77	3.40	2.78	13.3
Soybean	94	4.14	3.40	42.8
Soybean meal	88	3.86	3.18	49.9
Wheat	87	3.84	3.15	16.0
Alfalfa, fresh	58	2.56	2.10	19.7
Bluegrass, early	69	3.04	2.50	16.6
Brome, vegatative	80	3.53	2.89	18.0
Rape, vegetative	75	3.31	2.71	23.5
Trefoil, fresh	63	2.78	2.28	21.0

Table 4. Energy Requirements of Ewes Nursing Twins or Triplets.

	Triplets				Twins			
	Energy as % NRC (Twins)				Energy as % NRC (Twins)			
	90	105	110	120	90	100	110	120
Ewe wt chg, lb	-13.20	-7.60	-10.50	-3.00	-15.00	-4.50	-7.20	-6.00
Daily intake, lb								
TDN/100 lb BW	2.24	2.53	2.67	3.09	2.20	2.39	2.45	2.55
DM/% BW	3.04	3.43	3.60	4.16	2.97	3.22	3.60	3.65
Protein/100 lb BW	.41	.42	.41	.47	.66	.69	.61	.62
No. Lambs	15	15	15	15	8	10	10	8
Birth wt, lb	10.10	11.45	9.80	10.1	11.60	11.70	13.50	12.90
ADG, 1st 8 wks, lb	.62	.52	.42	.53	.76	.63	.77	.70
lb wt lambs/ewe, lb	104.20	103.70	104.50	100.80	85.50	97.00	85.80	80.80
Creep DM/hd, lb	.67	.70	.45	.55	.56	.83	.65	.66
Milk yield, lb (oxytocin)								
Week 1	7.45	8.00	8.08	7.95	8.50	9.70	8.50	8.56
Week 2	7.60	7.80	8.74	7.80	7.40	8.10	8.20	7.58
Week 3	6.62	8.30	6.84	6.90	–	–	–	–
Time to consume								
Once daily fed ration, hr	1.88	2.20	5.51	5.57	2.20	2.50	3.50	5.60

H. Windels, 1990

Table 5. Effects of Feeding Four Energy Intakes to Lactating Ewes Suckling Twin or Triplet Lambs.

	Energy Intake As % of NRC (Twins)				Type of Rearing	
	90	100	110	120	Triplets	Twins
No. Ewes	9	10	10	9	20	18
Initial wt, lb	185.8	185.6	188.5	185.0	183.4	189.1
Wt. chg, lb	-14.1	-6.1	-9.0	-3.5	-8.7	-7.7
Body cond. chg	-1.5	-0.4	-0.3	0.0	-0.6	-0.5
No. Lamb	22	25	25	23	60	36
Birth wt, lb	10.6	11.3	11.1	10.9	10.3	12.1
ADG, 1st 8 wks, lb	.67	.70	.68	.68	.62[b]	.70[c]
Lamb gain/ewe 1st 8 wks, lb	97.7	98.7	97.1	99.2	104.6[b]	87.5[c]
Creep DM/d, lb	.64	.75	.56	.83	.52	.68
Milk yield, with 2cc oxytocin/d, lb						
Week 1	7.0	7.4	7.7	7.3	8.0[b]	6.6[c]
Week 2	7.5	7.8	8.5	7.7	7.9	7.8
Week 3					6.7	
Feed consump. time, once daily feeding, hrs	2.0	2.3	3.7	5.8	3.5	3.5

H. Wiedels, 1990

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MILK AND LAMB PRODUCTION OF EAST FRIESIAN-CROSS EWES IN NORTHWESTERN WISCONSIN

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Summary

Two ½ East Friesian (EF), one ¾ EF, one ⅞ EF, and several Dorset rams were mated to crossbred ewes from 1993 through 1996. Growth, reproduction, and lactation performance of their progeny were compared. EF-cross lambs had greater birth, weaning, and postweaning weights than Dorset-cross lambs. When lambing at one and two years of age, EF-cross ewes gave birth to and reared more lambs per ewe mated, had longer lactation lengths, produced more milk, fat and protein, and had a lower percentage of milk fat and protein than Dorset-cross ewes. With the levels of EF breeding evaluated in this study (up to 50%), EF-cross sheep are superior to Dorset-cross sheep for lamb and milk production in northwestern Wisconsin.

However, dairy sheep producers should be aware that in many other countries where the EF has been imported to improve commercial milk production of local sheep populations, sheep containing more than 50% EF breeding have had lower survival, lower lamb production, and, in some cases, lower milk production compared to local breeds. Countries that have reported poor performance of high percentage EF sheep are in the Mediterranean region, and it appears that the EF is poorly adapted to the high environmental temperatures of the region. They have also been shown to be more susceptible to some diseases than local breeds; most notably, pneumonia.

Therefore, there is a need for evaluation of pure EF or EF-cross sheep of greater than 50% EF breeding to determine the optimum amount of EF breeding for commercial dairy sheep farms in the north central U.S. Other dairy breeds also should be evaluated as they become available in the U.S.

Introduction

Consumers in the United States have developed a taste for sheep milk cheeses which has been reflected in the steady increase in the amount of imported product in recent years. In 1983, 25 million pounds of sheep milk cheese was imported by the United States, and twelve years later in 1995, sheep milk cheese imports had increased by 180% to 70 million pounds (FAO, 1997). U.S. consumers must rely on imported product because there is very little domestic production.

The United States is without a sheep dairying heritage, but a small domestic industry is developing with the hope of tapping into the growing demand for sheep milk cheeses. Growth in producer numbers has been constant but not dramatic because of limitations in production and marketing. The main production limitation has been low milk yields of domestic breeds. U.S. breeds of sheep have been selected for either lamb or wool production and are relatively poor milk producers. Sakul and Boylan (1992) have reported lactation yields of domestic breeds and their crosses to range from 110 to 175 lb. There are, however, European and Mideast sheep breeds which have been successfully selected for high levels of commercial milk production: 422 lb. for Assaf (Gootwine et al., 1980), 460 lb. for Awassi (Eyal et al., 1978), 484 lb. for Lacaune (Barillet, 1995), and 455 lb. for Lacha (Esteban Munoz, 1982).

The East Friesian is generally regarded as the highest milk producing breed in the world with yields of 1200 to 1400 lb. reported in northern Europe (Sonn, 1979; Kervina et al., 1984). The breed was developed in the East Friesland area of Germany. Its body size is medium to large with rams weighing 200 to 265 lb. and ewes weighing 145 to 165 lb., and they produce 11 to 13 lb. of white wool. Their face and legs are white and free of wool. A distinguishing characteristic is a long, thin tail which is free of wool - a "rat" tail. Over 90% of the ewe lambs will mate at seven months of age to lamb at one year of age. The ewes are very prolific with a 230% lamb crop expected from mature ewes (Kervina et al., 1984).

In the recent past, U.S. animal health regulations prevented the direct importation of sheep, sheep embryos, or ram sperm from most countries. In the early 1990's, Canada allowed importation of EF semen from Europe, and in more recent years, U.S. flocks enrolled in the Voluntary Scrapie Flock Certification Program have been allowed to import EF animals and semen from a few countries.

In 1993, the University of Wisconsin-Madison, along with the University of Minnesota and a few private breeders, imported the first EF-cross rams into the U.S. from Canada. The Canadian rams were the result of imported European semen. This paper reports the results to date of our evaluation of EF-cross sheep in northwestern Wisconsin. A portion of the data included in this report was summarized and reported in earlier reports by Berger and Thomas (1995, 1997).

Materials and methods

The study was conducted at the Spooner Agricultural Research Station of the University of Wisconsin-Madison located in northwest Wisconsin (latitude: 45˚49´, longitude: 91˚53´, average minimum temperature in January: -19.1˚C, average maximum temperature in July: 27.5˚C). Crossbred ewes of ½ Dorset, ¼ Romanov (or Finnsheep), ¼ Targhee breeding (commercial ewes) were mated to either EF-cross rams or Polled Dorset rams during the late summers or autumns of the four years from 1993 to 1996. Two ½ EF, ½ Rideau rams were used all four years, one ¾ EF, ¼ Rideau ram was used from 1994 to 1996, and one ⅞ EF, ⅛ Rideau ram was used in 1996. The four rams were the result of artificial insemination from semen imported into Canada from Switzerland from three different EF rams. Three polled Dorset rams were used each year, with one or two rams replaced each year. The Dorset rams were purchased from Wisconsin breeders from rams consigned to the Wisconsin Ram Test Station.

Lambs were born from the commercial ewes in the winters or springs of 1994 through 1997 and weaned at approximately 60 days of age. Most female lambs born from 1994 through 1996 were retained as replacements. They were mated to lamb first at approximately 12 months of age and annually thereafter, except ewes born in 1994 were lambed only in 1995. They were mated to ½ EF or ¾ EF rams in the autumn of 1994 and to Dorset rams in the autumns of 1995 and 1996. Lambs born from these ewes were weaned at approximately 60 days of age in 1995 and at approximately 30 days of age in 1996 and 1997. Many of the ewe lambs were retained as replacements.

Lambs were raised in confinement on high concentrate diets. Male lambs were not castrated and marketed at an average age of 140 days at an average live weight of 125 lb.

Matings of the commercial ewes and the Dorset-sired and EF-sired ewes resulted in production of EF crossbred lambs or ewes with a percentage of EF breeding ranging from 12.5% to 50% and of non-EF crossbred lambs and ewes with 75% or 87.5% Dorset breeding.

One- and two-year-old Dorset-sired and EF-sired ewes lambing in 1996 and 1997 nursed their lambs until approximately 30 days of age and were then milked twice per day in an automated milking parlor at 6 a.m. and 5 p.m starting on the day of weaning. Individual daily milk production was determined every 28 days at an evening milking and the milking the following morning. Individual milk samples were taken at the morning milking and analyzed for butterfat and protein percentage by a certified laboratory in both years and for somatic cells in 1997. An estimate of total milk, fat, and protein production for a lactation was calculated using the following formula:

Estimated lactation yield = [production 1st test day x no. days between start of milking and 1st test day] + [(prod. 1st test day + prod. 2nd test day)/2 x no. days between 1st and 2nd test day] + [(prod. 2nd test day + prod. 3rd test day)/2 x no. days between 2nd and 3rd test day] +.....+ [prod. next to last test day + prod. last test day)/2 x no. days between next to last and last test day]+ [prod. last test day x no. days between last test day and end of milking].

Milking was discontinued on a ewe after a testing when the total milk production from both evening and morning milkings fell below .45 lb. Estimated total milk production and lactation length was for the milking period only with no estimate of milk production during the nursing period.

This study included full production year data for the years 1993/94, 1994/95, 1995/96, and 1996/97. Data were analyzed using the GLM procedure of SAS (1995).

Results and discussion

Body weights of lambs sired by EF-cross or Dorset rams from commercial dams and of lambs from EF-sired and Dorset-sired dams born through 1997 are presented in Table 1. At all ages, lambs with an EF-cross sire or dam had heavier ($P < .05$) body weights than lambs with a Dorset sire or Dorset-cross dam. These data indicate that the direct effect of EF genes for growth rate are greater than the direct effect of Dorset genes for growth rate (breed of sire comparisons) and that the combined effect of the direct gene effects for growth and the maternal gene effects for growth through milk production are also greater in the EF compared to the Dorset (breed of dam comparisons). It is not possible to determine the relative magnitude of the EF direct and maternal effects from these data because the "breed of sire" and the "breed of dam" data were collected in different years, with different ages of ewes, and with different weaning ages.

In other studies, where EF genetics was introduced into local populations to increase milk production, crossbred lambs of EF breeding also had greater growth rates than lambs of local breeds (Ricordeau and Flamant, 1969a, in France with the Préalpes du Sud breed; Kalaissakis et al., 1977, in Greece with the Chios breed; Katsaounis and Zygoyiannis, 1986, in Greece with the Karamaniko Katsikas and Karagouniko breeds).

Table 1. Body weights of lambs.

Breed	Number of lambs born	Body weights (lb.) at: Birth	30 days	60 days	140 days (males)
Breed of sire					
EF-cross	420	11.04±.22[a]		54.3±.9[a]	131.3±2.9[a]
Dorset	216	9.92±.31[b]		47.7±1.5[b]	117.5±4.4[b]
Breed of dam					
EF-cross	546	10.30±.11[a]	30.8±.4[a]		131.6±2.4[a]
Dorset-cross	150	9.79±.15[b]	28.6±.7[b]		121.4±3.7[b]

[a,b]Within a column and breed of sire or breed of dam, means with a different superscript are different ($P < .05$).

Presented in Table 2 is the reproductive performance of ewes sired by Dorset or EF-cross rams and lambing at one year of age in 1995, 1996 and 1997, and at two years of age in 1997. Young EF-cross ewes had a greater ($P \leq .05$ or $P < .10$) prolificacy and number of lambs reared per ewe lambing and per ewe mated than did young Dorset-cross ewes. Fertility was similar between the two breed groups. The rearing figures do not include the lambs successfully reared on milk replacer (EF-cross dams = 45 lambs, Dorset-cross dams = 5 lambs). Accounting for these lambs would increase the number of lambs reared per ewe lambing and per ewe mated to: EF-cross - 1.83 and 1.76, Dorset-cross - 1.60 and 1.50, respectively.

Greater prolificacy of EF-cross ewes compared to local breed ewes also has been reported by Ricordeau and Flamant (1969a) and Gootwine and Goot (1996, local breed was the Awassi). Kalaissakis et al. (1977) reported that F1 EF-cross ewes were superior and ewes with greater than 50% EF breeding were inferior to local ewes for number of lambs reared per ewe mated.

Table 2. Reproduction of ewes lambing at one and two years of age.

Breed of ewe	**Number of ewes mated**	**Fertility, %**	**Prolificacy, no.**	**Lambs reared/ ewe lambing, no.**	**Lambs reared/ per ewe mated, no.**
EF-cross	338	96.2 ± 1.3^{a}	$1.93 \pm .04^{a}$	$1.69 \pm .05^{c}$	$1.62 \pm .05^{a}$
Dorset	146	93.5 ± 1.7^{a}	$1.66 \pm .06^{b}$	$1.56 \pm .06^{d}$	$1.47 \pm .06^{b}$

Within a column, means with a different superscript are different: ^{a,b}($P \leq .05$), ^{c,d}($P < .10$).

Presented in Table 3 is the lactation performance of one-year-old ewes in 1996 and 1997, and two-year-old ewes in 1997. The EF-cross ewes had lactations that were 34 days longer and produced 113 lb. more milk, 4.7 lb. more fat, and 4.9 lb. more protein compared to the Dorset-cross ewes ($P < .05$, Table 3). Fat and protein percentage of milk from Dorset-cross ewes was approximately .5 percentage units higher ($P < .05$) compared to milk from EF-cross ewes. Somatic cell counts were similar between the breed groups and averaged approximately 100,000 cells per ml. of milk.

Higher milk production of crossbred ewes with up to 50% EF breeding compared to local ewes has been reported by Ricordeau and Flamant (1969b), Kalaissakis et al. (1977), and Katsaounis and Zygoyiannis (1986). However, ewes of greater than 50% EF breeding have been reported to produce both less (Kalaissakis et al., 1997) and more (Ricordeau and Flamant, 1969b) milk than local breeds. Gootwine and Goot (1996) found that pure EF and EF-cross ewes were either inferior or similar to Awassi ewes for milk yield. The poor lactation performance of ewes of high percentage EF breeding in these Mediterranean environments is thought to be due to poor adaptability to high temperatures (Boyazoglu, 1991).

In Table 3 the EF-cross ewes were divided into those with ¼ or less EF breeding and those with ⅜ or greater EF breeding, and there was no significant difference between these two EF groups. This does not necessarily mean that increased EF breeding will fail to generate more milk production. What is being measured by this comparison is primarily single ram effects. All the ⅛ and ¼ EF ewes received their EF genes from one of two ½ EF rams, and the vast majority of the ⅜ and ½ EF ewes received their EF genes from one ¾ EF ram. If by chance, the ¾ EF ram had a set of milk production genes that were of similar genetic value to those of the ½ EF rams, we would get the results in Table 3. Given the results of most other studies, we would predict that if we had used a large number of EF rams in this study, the ewes with ⅜ to ½ EF breeding would have produced more milk than the ewes with ⅛ to ¼ EF breeding. The small number of rams used in this study is a major criticism, however, there were very few EF-cross rams available to us in 1993 when this study began.

Table 3. Lactation performance of young EF-cross and Dorset-cross ewes.

Trait	Breed of ewe: Dorset-cross	EF-cross, 1⁄8-1⁄4 EF	EF-cross, 3⁄8-1⁄2 EF
Number of lactations	76	148	98
Lactation length, d	92.7±4.2[a]	125.9±3.2[b]	126.7±4.4[b]
Milk yield, lb.	125.2±12.1[a]	245.7±9.2[b]	231.4±13.0[b]
Fat, %	5.54±.07[a]	5.04±.06[b]	5.00±.08[b]
Fat yield, lb.	7.3±.7[a]	12.3±.4[b]	11.7±.7[b]
Protein, %	5.42±.05[a]	4.96±.04[b]	4.98±.05[b]
Protein, lb.	7.0±.7[a]	12.1±.4[b]	11.7±.7[b]
Log somatic cell count	4.99±.09[a]	5.03±.05[a]	5.00±.07[a]

[a,b]Within a row, means with a different superscript are different (P < .05).

Lactation performance of ewes of different ages is presented in Table 4. The effects of production year and age of ewe are confounded since one-year-old ewes were present in both 1996 and 1997, and two-year-old ewes were only present in 1996. It appears that ewe management may have been somewhat better in 1997 than in 1996 because one-year-old ewes had higher production in 1997 than in 1996. This may be expected since 1996 was our first year of milking, and the knowledge gained that first year should have resulted in greater production in the second year. Therefore, the production of the two-year-old ewes compared to the average of the one-year-old ewes may be somewhat of an overestimate of the actual age effect. However, given this limitation of the data, the two-year-old ewes had lactations that were 19 days longer and produced 80 lb. more milk, 2.8 lb. more fat, and 4.2 lb. more protein than one-year-old ewes.

Table 4. Lactation performance of one- and two-year-old ewes.

Trait	1996 1-year-olds	1997 1-year-olds	1997 2-year-olds
Number of lactations	127	81	114
Lactation length, d	110.0±3.4[a]	111.0±4.2[a]	129.4±3.8[b]
Milk yield, lb.	170.1±9.7[d]	198.6±12.1[e]	264.1±11.0[f]
Fat, %	5.30±.06[a]	5.35±.07[a]	4.82±.07[b]
Fat yield, lb.	9.1±.5[a]	10.7±.6[b]	12.7±.6[c]
Protein, %	5.05±.04[a]	5.18±.05[b]	5.22±.04[b]
Protein, lb.	8.6±.5[a]	10.1±.6[b]	13.6±..5[c]
Log somatic cell count		4.95±.07[a]	5.06±.06[a]

[a,b,c]Within a row, means with a different superscript are different (P < .05).
[d,e,f]Within a row, means with a different superscript are different (P < .10).

A note of caution

The results of this study show that EF breeding increases lamb growth, improves ewe reproduction, and increases milk, fat and protein production compared to Dorset breeding. The only negative effect of EF breeding is a lowering of fat and protein percentage. Even though the sample of EF-cross rams was very small, the results are in good agreement with studies conducted in other countries that have compared sheep with up to 50% EF breeding with local breeds. However, producers should not extrapolate these results to sheep of greater than 50% EF breeding. There are a number of reports in the literature of poor viability of pure EF and EF-cross sheep of over 50% EF breeding. Katsaounis and Zygoyiannis (1986) report especially poor viability of EF sheep in Greece. They imported a total of 52 ewes, 10 rams and 18 lambs of EF breeding in the three years of 1956, 1960, and 1965. They were run on their experimental farm along with sheep of the two local breeds. Of these imported animals, all the lambs died within two months, and all the adults had died by 1970. Of the pure EF lambs born in the flock in Greece, 38.3% were stillborn or not viable at birth, 29.6% died before the age of two months, and of those weaned, 69.2% died before one year of age. Ewes of ½ EF breeding lived for a respectable 5.1 years, but ewes of higher percentages of EF breeding had very short lifespans: ¾ EF = 2.6 years, ⅞ EF = 2.7 years, $^{15}/_{16}$ EF = 2.5 years, $^{31}/_{32}$ EF = 2.5 years, and pure EF = 2.0 years. The most common cause of death was pneumonia with a high incidence of Maedi (OPP-like disease) in adult ewes. Ricordeau and Flamant (1969) also reported an increased death loss to respiratory disease of EF-cross lambs in France. In different years and with percentages of EF breeding varying from 50% to 87.5%, they reported a 2.2% to 22.2% increased death loss in EF-cross lambs from pasteurellosis and pneumonia compared to Préalpes du Sud lambs.

Kervina et al. (1984) state; "The East Friesian sheep is not a flock animal. It prefers to be alone and needs individual care. Small flocks of 3 to 8 animals are optimal and a herd should never be larger than 40 head. Larger herds require plenty of space so that the individuals or small families can keep by themselves. They are not suitable to be kept with other breeds." While this statement was not referenced with scientific studies, it indicates a concern on the part of the authors of the lack of adaptability of the EF to large-flock conditions that probably was the result of their observations or research studies.

The studies where poor performance of sheep of high percentage EF breeding were observed were conducted in Mediterranean environments which are considerably different from the environment of the northcentral U.S. Therefore, similar problems may not arise in our environment. At the Spooner Station we have a small group of ewes that are being upgraded to higher percentages of EF breeding, so we will be able to determine if viability decreases as EF breeding goes beyond 50%.

Future work

In addition to the two ½ EF rams, the ¾ EF ram, and the ⅞ EF ram used to produce the animals discussed in this report, we have purchased a pure EF ram of Dutch breeding via Canada, a pure EF ram of Swedish breeding via New Zealand and New York, frozen semen from three Swedish EF rams via New Zealand, and frozen semen from three Dutch EF rams. We will continue our comparison of EF-sired and Dorset-sired lambs and ewes for two or three more years with the improvement to the study of a larger sample of EF rams and the production of true F1s from both the EF and Dorset sires. We also will have a comparison of three of the major sources of EF bloodlines in North America. In addition, we hope to have frozen semen from three Lacaune rams at the University of Wisconsin-Madison in time for the 1998 breeding season. Our intention is to conduct a comparison of F1 EF and Lacaune lambs and ewes over two or three years.

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MILKING PARLOURS AND MILKING MACHINES FOR DAIRY EWES

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Introduction

In France, milk sheep are produced in three main areas :

- the largest and most popular is the Roquefort area in the South West of France. 800,000 ewes are bred (Lacaune breed exclusively) in 2,600 flocks. They produce about 171 million litres of milk per year.
- the second area is located in the West Pyrenees mountains. 470,000 ewes are bred (Manech and Basco-bearnaise breeds) in 2,600 flocks, and they produce about 38 million litres of milk per year.
- the third one is located in Corsica Island where 100,000 ewes are breed (Local breed) in 560 flocks and produce about 11 million litres per year.

Milk production is very different between breeds, and average number of ewes per flock show that the Roquefort area has a very intensive milk production (Table 1).

Table 1 - Dairy sheep and milk production in France (1997)

Area	Number of ewes	Average number/flock	Milk yield, 1	Days of lactation
Roquefort	800,000	307	270	165
West Pyrenees	470,000	180	120	138
Corsica Island	100,000	178	103	164

This also means that milking systems are different between the three areas and are surely bigger and more automated in the Roquefort area.

Different kinds of milking systems

1. Hand milking

Hand milking is now very rare in France, except in Corsica Island where only 50% of the farms were equiped with a milking machine in 1993. Hand milking is located in very small flocks of less than 50 ewes or in larger flocks managed under very extensive conditions in the mountains. Hand milking is very popular in many Mediterranean countries. A shepherd can hand milk from 20 to 60 (sometimes more) ewes per hour, depending on the breed (milking ability) and the milk yield of ewes. Up to the 1950's, a man could only milk 20 ewes per hour with Lacaune breed which did not have a good milking ability, but could milk 80 ewes per hour on Corsica Island because local breeds are easy to milk.

2. Sheds: buckets and pipelines

Only a few buckets and pipeline systems are now working in France; for example only 10 sheds have been counted in the Roquefort area in 1997. Probably more are to be found in other areas and other countries. They resulted in bad working postures, heavy weight transports, and more movement for milkers. Two ewes are milked together with one bucket.

Buckets were the first type of milking system adopted in France just after World War II. At that time, one milker could only milk 40 ewes per hour in bad conditions. Literature gives more information about buckets used in Corsica, Sardinia, and other Mediterranean countries where about 80 ewes/hour could be milked by one milker.

Pipelines are also now very rare in France because this kind of milking system is more suitable for milking cows in stanchion barns. The number of ewes per flock is always more important than cows in a shed and they are never attached with yokes, so this kind of milking system can be only found in small herds, where farmers have built a simple platform in a part of the shed where ewes can be milked with a small pipeline.

3. Milking parlours

The Roquefort area was the first area where labour organization in milk sheep production, especially labour at milking, had been studied. The first studies had been carried out during the 1950's, and a special parlour called « Casse System » had been developed directly from the conclusions of these studies.

3.1. The « Casse System »

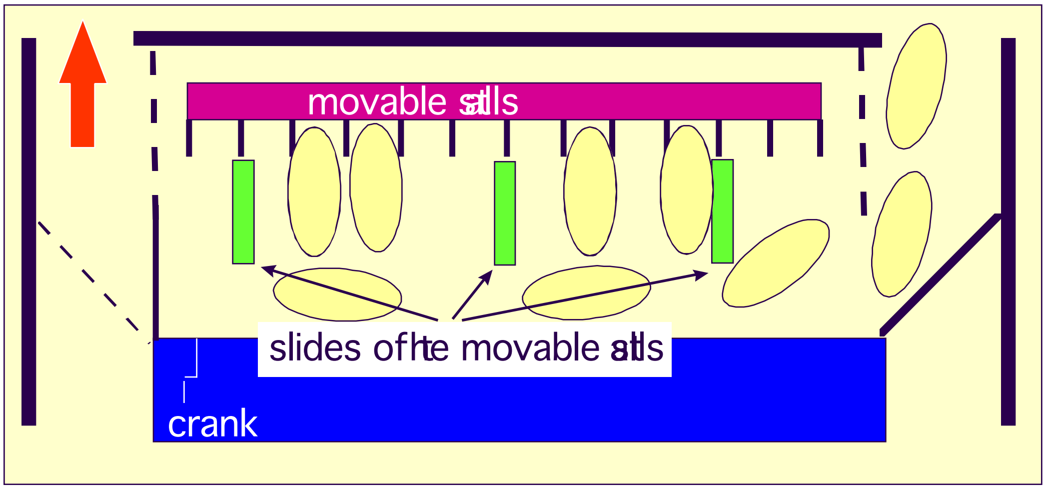
The « Casse » parlour was born in 1961 in an experimental farm in the Roquefort area named Casse farm. This parlour had been adapted for the Lacaune breed and the special working routine coming from the bad milking ability of the ewes. The typical routine during milking used at that time can be described as follows:

- attaching clusters on teats without hygiene,
- hand massaging after one minute of milking,
- machine stripping and detaching after 180 seconds of milking, and
- re-milking by hand for 10 or 20 seconds.

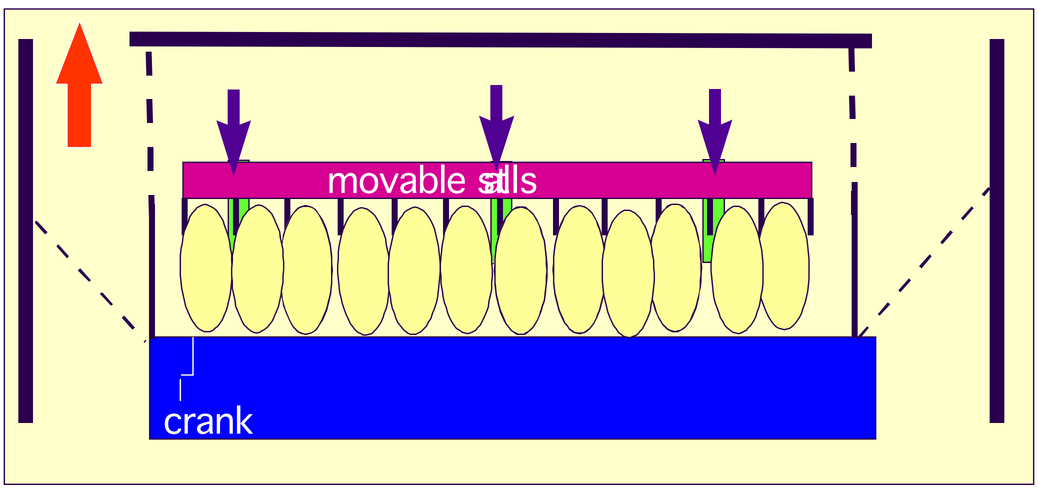
At the beginning of the 1960's, only 80 ewes per hour could be milked with this poor routine by two milkers in a 12 units and 24 places parlour.

The « Casse System » is a side by side parlour which had been developed from the herringbone parlour which was at its very beginning in the latter part of the 1950's. In a « Casse » parlour, ewes enter and walk to a manger where concentrates are distributed. First manually and now automatically, they are locked by their necks in special yokes. They go to any headlock they want; the other ewes can move on the platform behind those which are always locked and eating concentrates (Picture 1).

When the platform is full, the milker moves back ewes, manger, and stalls to the edge of the pit, manually with a crank or automatically with a pneumatic device (Picture 2).



Picture 1 - « Casse System » with ewes entering the platform



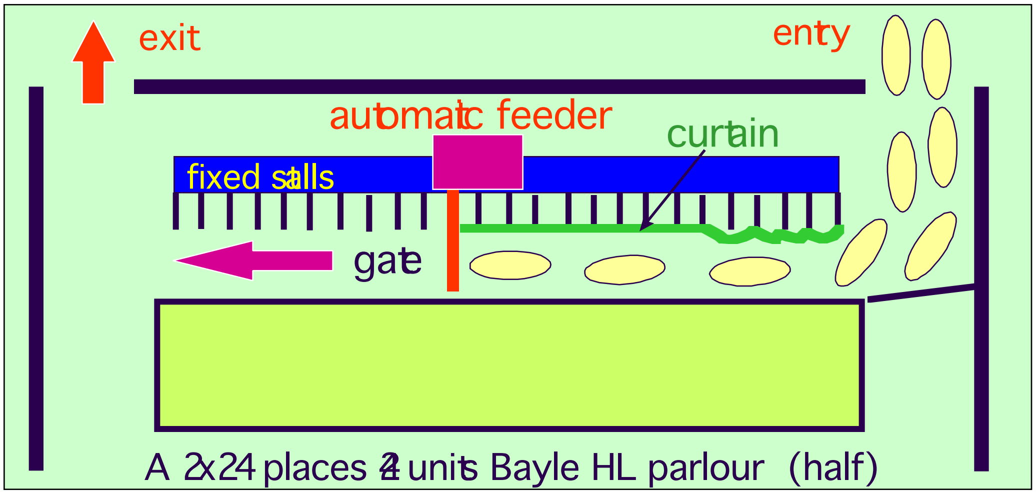
Picture 2 - « Casse System » with ewes ready to be milked

During the 1970's, genetic improvement, especially for milking ability of the Lacaune breed, allowed farmers to quit the manual re-milking operation. The throughput increased up to 120 ewes/ hour with one milker in a typical « Casse System » (12 units - 24 places).

3.2. Modern milking parlours

Nowadays, modern milking parlours are working in big flocks with a very high efficiency. The first system is also coming from the « Casse System » but with fixed stalls.

A gate moves on the platform when ewes are entering, it stops at the first place, an automatic feeder distributes concentrates, and the gate opens. The first ewe enters the first place which is equipped with an automatic headlock. When it's locked, the gate moves back one place, same operations are made and the second ewe enters the second headlock and so on... The gate carries a special curtain bent or coming from the other side of the fixed stalls refraining ewes from going to the unoccupied headlocks.



Picture 3 - New parlours with ewes entering

Most of these parlours, now very popular in France, have 2x24 places with 24 units and a high milkline. Two milkers are working in these parlours except when automatic teat cup removal (ACR) are set up; in such a case only one milker is working. Usually a dog helps with ewes entering the platform, and changing batches in the shed is made by a pusher (the grandfather or kids for example) or by the milker himself.

Other popular milking parlours in France are rotary parlours. They generally have 30 units or more (from 30 up to 48 places, sometimes 60) and are only used in big flocks of more than 500 to 600 ewes with two milkers. Most of them are now equipped with ACR .

Table 2 gives a survey of the different milking parlours used in the Roquefort area in 1997.

Table 2 - Number of milking parlours used in the Roquefort area in 1997

Type	**Number**	**%**
Shed	10	0.4
Classical Casse	1 725	75.0
New Casse	230	10.0
Rotary	335	14.6
Total	2 300	100.00

4. Throughputs in different parlours

Nowadays the most popular milking parlours in France are « Casse System », old and new, with 2x12 places with 6 or 12 units and 2x24 places with 12 or 24 units. Farmers are raising bigger and bigger flocks because of economical problems, but they need equipment and particularly parlours with a very high degree of efficiency. The main parameter to consider when choosing a new parlour is its potential throughput. Many field studies and enquiries have been made or are regularly made to give information to the farmers as guidelines for the choice of their parlours.

In old « Casse » systems, the average throughput observed in field studies is between 100 and 350 ewes/hour depending on the number of units, the number of milkers, the daily milk yield, and the number of ewes per unit.

Table 3 - Average throughput in most popular « Casse » parlours

Nb places	Nb units	Milk line	Nb milkers	Nb pushers	Avg. throughput
2x12	6	LL	1	0	100-140
2x12	12	HL	1	0	180-250
2x12	12	LL	1	1	140-200
2x24	24	LL	2	0	220-300
2x24	24	HL	2	1	270-350

Field studies in the Roquefort area had shown that efficiency of units is better in high line parlours than in low line parlours. Doubling the number of units only increases the throughput by about 20 to 25%. This is the reason why most parlours in the Roquefort area have high milklines but low line parlours also exist.

For small flocks, it is possible to build only one platform to limit costs. Efficiency of such parlours is from 100 up to 200 ewes/hour with only one milker (Table 4).

Table 4 - Average throughput in one platform « Casse » parlours

Nb places	Nb units	Milk line	Nb milkers	Throughput
1x12	6	HL	1	100-120
1x12	6	LL	1	90-110
1x24	12	HL	1	140-200
1x24	12	LL	1	120-180

Modern « Casse » parlours have a better efficiency. Table 5 shows that in a 2x24 places, 24 units parlour, average throughput could be between 320 and 420 ewes/hour with two milkers. Most of the parlours with 2x24 places and 24 units are now equiped with ACR. In such parlours, one milker can milk between 350 and 400 ewes/hour (Table 5).

Table 5 - Average throughput in modern « Casse » parlours

Nb places	Nb units	Milk line	Nb milkers	Nb pushers	Avg. throughput
2x24	24	HL	2	0	360-420
2x24	24	LL	2	0	320-400
2x24	24	HL	1*	1**	350-410

* with ACR
** the pusher can be a dog

Finally, rotary parlours with a very big number of units are certainly the most efficient parlours ... but they also are more expensive. They are only bought by farmers with more than 500 to 600 ewes. Table 6 shows that it is possible to milk from 420 up to 650 ewes per hour depending on the number of units, the number of milkers, and the daily milk yield of ewes.

Table 6 - Average throughput in rotary parlours

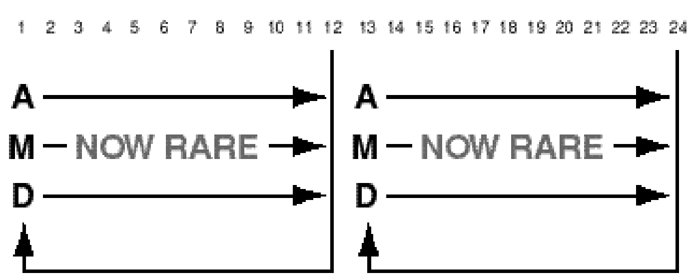
Nb units	Nb milkers	Nb pushers	Average throughput
32	2	1**	420-460
36	3	1**	450-500
48	2-3*	1**	600-650

* 1 milker less with ACR
** the pusher is often a dog

Labour Organization

First of all, the « Casse System » was developed on the idea that the number of units must depend on the time spent by the milker to attach all clusters at each ewe, plus miscellaneous and idle time, and coming back to the first one without overmilking. Nowadays, average milking time of Lacaune breed ewes is about 3 minutes depending on milk yield (2.5 minutes in mid lactation and 2 minutes at the end of lactation). That means that a milker can work in good conditions only with 12 units. For parlours with more than 12 units, a second milker is needed but he can be replaced by ACR.

Picture 4 shows a typical working routine in a 2x24 places with 24 units and a high milkline.



Picture 4 - Labour organization in a 2x24 places, 24 units high line parlour with 2 milkers and one pusher

Each milker works in half the pit on one side of the parlour. For example, milker no. 1 attaches (A, Picture 4) clusters number 1 to 12, and during the same time milker no. 2 attaches clusters number 13 to 24. Then returning to the first ewe, milkers can carry out massage (M, Picture 4) of udders in the same order the clusters were attached (1-12 and 13-24). Nowadays, massaging is very rare because of genetic improvement. Then milkers only strip ewes if needed and detach (D, Picture 4) clusters in the same order. After detaching the cluster from the last ewe, the platform is emptied, and milkers cross the pit to work in the same manner on the other side of the parlour. Then the pusher (it can be a dog) fills the platform so milkers will have ewes to milk when they have finished the other side. In these conditions, farmers can milk more than 350 ewes per hour with a steady throughput of about 450 ewes/hour.

Working Postures

A milker who wants to milk a high number of ewes in a very short time, twice a day during 6 to 7 months, must have good labour organization but also a comfortable working posture. If not, when he becomes older, he can have arm-aches, back-aches with spine problems, and other troubles which can be unpleasant for his work and also for his own life.

The rules of thumb can be described in the four following points :

1. Stand up as straight as possible when working.
2. Avoid bending forwards when attaching or detaching clusters or working on udders.
3. Never work under the level of the elbows.
4. Never work above the level of the shoulders.

Good working postures and good working conditions are dependent upon proper dimensions in the parlour. One of the most important dimensions, which shall be as well-adjusted as possible, is the height of the pit.

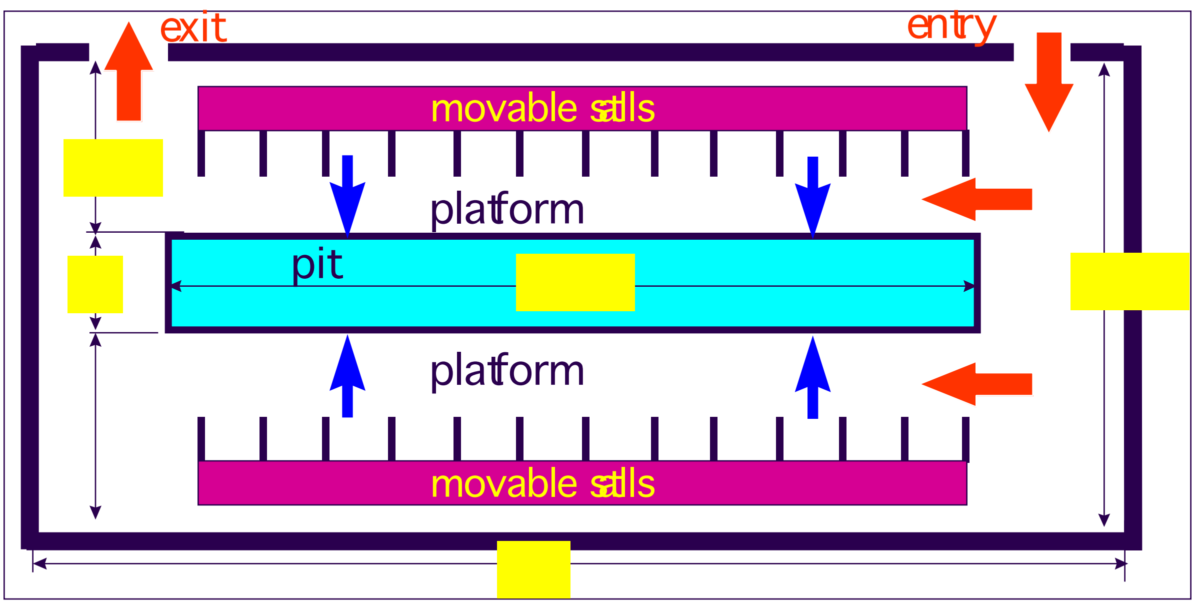
In addition to the rules listed above, the milker must know the average height of the teats of ewes he has to milk. For example in the Lacaune breed, the base of the teat is about 32 cm (12.6 in.) high for ewes with two or more lactations and 30 cm (4.8 in.) for ewes during their first lactation. When ewes are standing on the platform ready to be milked, udders must be located in an area that is easy to reach with the hands of the milker in respect to ergonomic rules and comfortable working angles for body and arms. That means about 10 cm (3.9 in.) above the level of elbows with a maximum variation of 20 cm (7.9 in.).

For example, if a milker is 5′9″ tall, his elbows are located at about 3′5″, and height of the pit should be 2′10″ (± 1 inch). Table 7 presents the height of the pit for milkers of different heights.

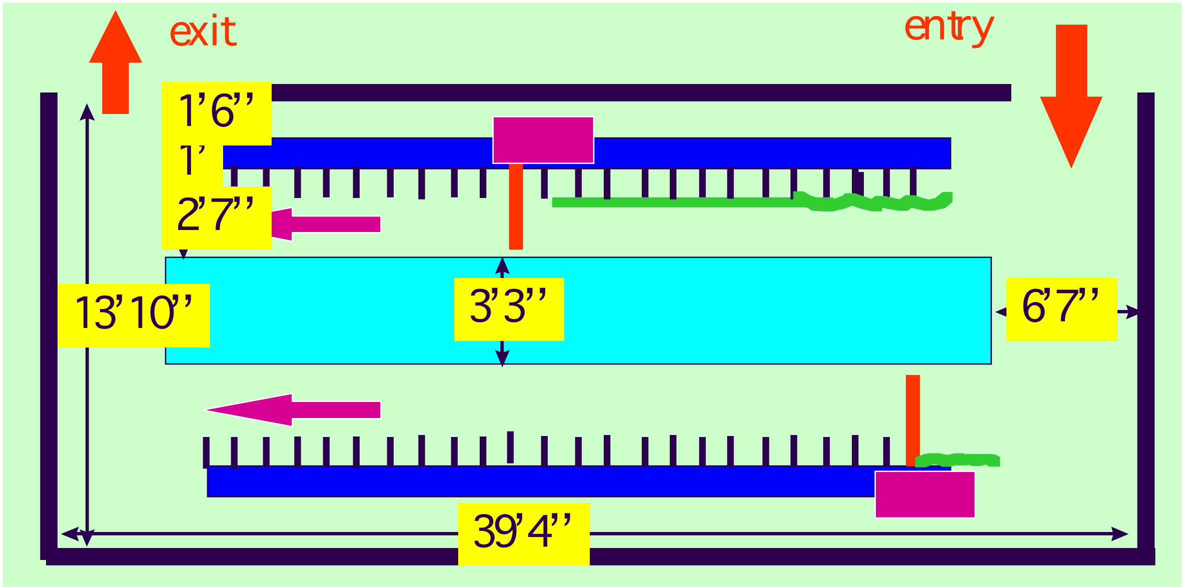
Table 7 - Height of the pit in a milking parlour

Height of the milker	Height of the pit
< 5′	2′6″
from 5′ up to 5′5″	2′8″
from 5′5″ up to 5′9″ from 5′9″ up to 6′1″	2′10″ 3′
from 6′1’’ up to 6′5″	3′2″
> 6′5″	3′4″

Pictures 5 and 6 give examples of dimensions in a 2x12 places and 12 units with movable stalls (Casse System) and in new milking parlours with 2x24 places and 24 units with fixed stalls but movable gate on the platform.



Picture 5 - Parlour with 2x12 places and movable stalls (Casse System)



Picture 6 - Parlour with 2x24 places and fixed stall (new Bayle parlour)

Some Aspects Of Milking Machines

Only four parts of the milking machine will be described :

- effective reserve and vacuum pump capacity,
- size of milklines,
- pulsation characteristics,
- vacuum level.

1. Effective reserve and vacuum pump capacity

ISO Standards 3918 give the following definition of the effective reserve of a milking machine:

- Air flow that can be admitted into an installation (near the receiver), to induce a vacuum drop of 2 kPa (0.6 inch of Hg), measured with all units plugged at or near the receiver.

In fact, it is the difference between vacuum pump capacity and total air consumption of the different components of the machine needed by milkers when attaching or detaching clusters or to compensate for the fall-off of one or more clusters.

Literature shows a good relationship with low effective reserve and mastitis for dairy cows. There is probably no reason to have a different situation with ewes, but only a few studies have been made till now. There are no international standards for effective reserve. Countries where a number of ewes are milked with milking machines have developed their own standards.

Table 8 gives an idea of differences in four countries which are applying special formula or only ISO Standards for .... cows ! !

Table 8 - Effective reserve in parlours with milklines (cfm)

Nb units	Holland 1	Holland 2	France	UK	Italy
6	11.2	18.2	11.4	9.6	21.0
12	15.4	22.4	15.8	13.0	31.5
24	21.7	28.7	26.3	17.1	58.7
30	22.8	29.8	31.5	19.3	71.3
36	23.8	30.8	36.8	21.3	83.9
48	25.9	32.9	47.3	25.6	109.1

For example a 24 units parlour needs 21.7 or 28.7 cfm in Holland, depending on the type of clusters, 26.3 cfm in France, 58.7 cfm in Italy, and 17.1 cfm in the U.K. These large differences only show the need of standardization. Think that these parlours could be designed by the same manufacturer with the same components!

Table 9 shows that differences mentionned for effective reserve are also available for vacuum pump capacity.

Table 9 - Vacuum pump capacity for machines with milklines (cfm)

Nb units	Holland	France	UK	Italy
6	22.8	21.4	17.9	29.7
12	36.8	34.0	30.4	50.7
24	52.5	59.2	55.7	83.9
30	68.3	71.8	68.3	113.6
36	73.5	84.4	80.9	134.6
48	87.5	109.6	106.1	176.6

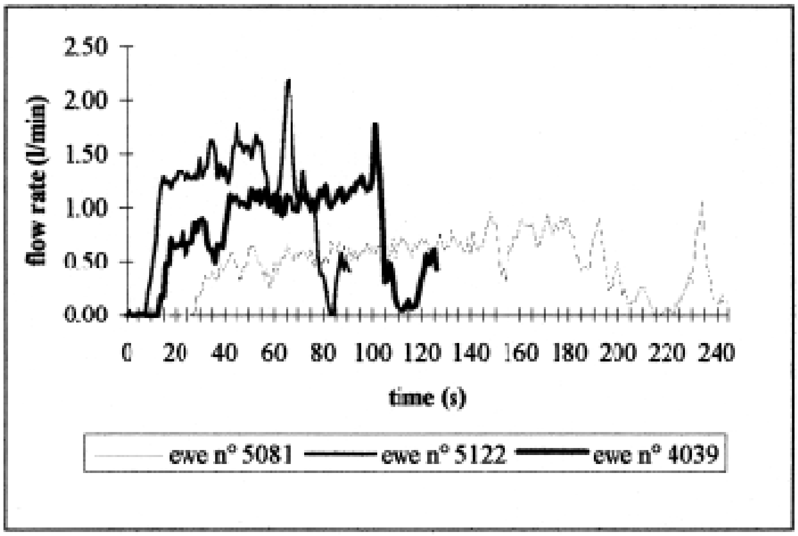
The same 24 units parlour needs a pump of 5â^5 cfm in Holland, 59.2 cfm in France, 83.9 cfm in Italy, and 55.7 cfm in the UK!

2. Size of milklines

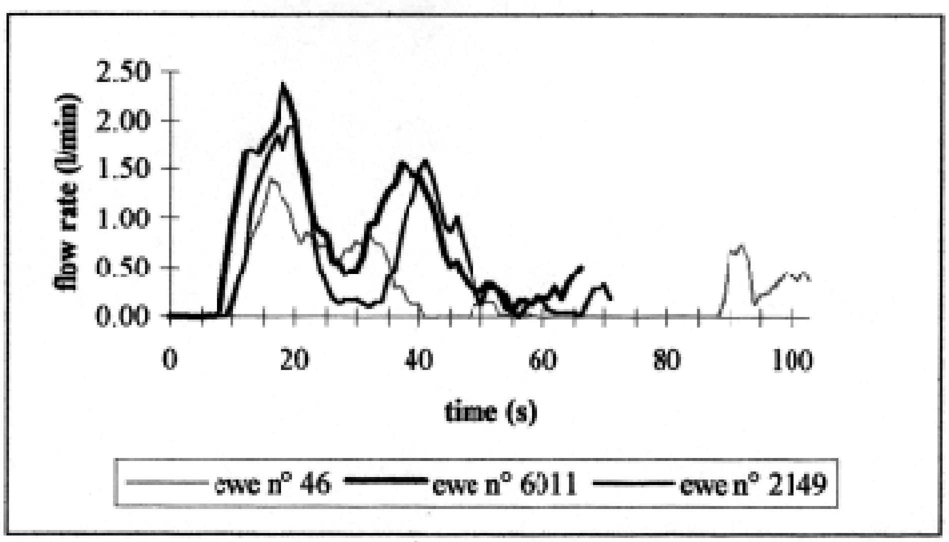
ISO Standards 5707 for cows in annexe C describe a new method for sizing milklines. Stratified or waved milk flow in milklines should be the normal flow of the milk. Slugged milk flow which induces vacuum fluctuations in milklines greater than 2 kPa must be avoided.

Literature shows good relationships between large vacuum fluctuations under the teat and mastitis. U.W.-Madison studies (G Mein and D Reinemann) showed that a vacuum fluctuation of 2 kPa or less in a milkline has no effect on vacuum beneath teats. These studies gave the maximum milk flow rate to keep vacuum fluctuations not greater than 2 kPa in the milkline.

It is also possible to predict the maximum milk flow rate through the milkline with some information about kinetics of milk ejection of ewes. For example, Pictures 7 and 8 are typical curves of milk ejection of Lacaune breed.

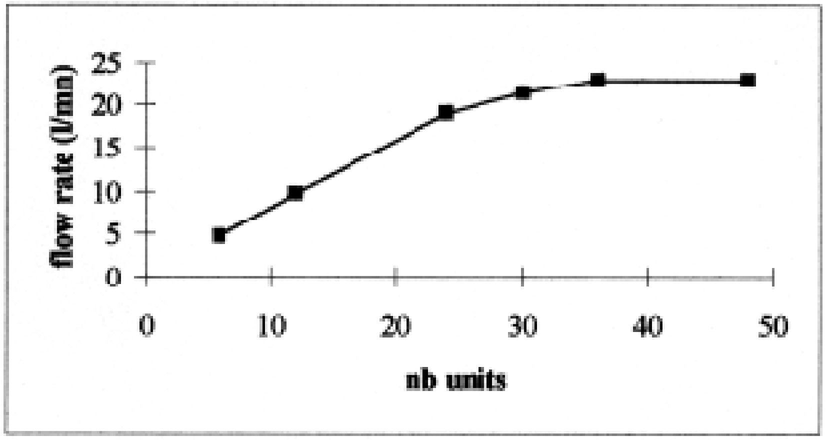


Picture 7 - Typical milk ejection curves of Lacaune breed ewes (1 peak)



Picture 8 - Typical milk ejection curves of Lacaune breed ewes (2 peaks)

With a 5 seconds attachment rate and a peak flow of 0.8 l/min and 200 l/min transient air admission, the maximum milk flow rate can be easily predicted (Picture 9).



Picture 9 - Maximum predicted milk flow rate in milklines (peak flow: 0.8 l/min)

Criteria to be taken into account for sizing milklines in parlours are the following:

- slope (1% or more if possible),
- transient air admission (200 l/min),
- milkline looped or deadlined (looped is better),
- attachment rate (depending on the milker, milking routine and of the number of milkers: generally 5 seconds with two milkers and 10 seconds with one milker).

Table 10 gives examples of diameters of milklines for dairy sheep parlours which could be calculated according to the new method of ISO 5707: (attachment rate: 5 seconds, maximum milk flowrate 0.8 l/min, transient air admission: 200 l/min).

Table 10 - Diameter of milklines: example of calculations for a 1% slope

Nb units/slope	Flow rate (l/min)	Diameter
6	4.8	2″
12	9.6	2″
24	19.2	2.5″
30	21.5	2.5″
36	22.8	2.5″
48	22.8	2.5″

Take care! This is not a standard, this is only an example of calculation.

3. Other features

3.1. Pulsation characteristics

In France ewes and most of them around the world, are milked with a high level of pulsation rate from 120 up to 180 pulsation/min. French studies showed that ewes milked with a lower pulsation rate have a lower milk production, more strip yield, and probably more mastitis problems.

Pulsation ratio has not been studied precisely (only few results are available). In France, 50/50 is the most popular ratio, but sometimes an inversed ratio of 45/55 can be found .

3.2. Vacuum level

Vacuum level for dairy cows has been decreasing for the last 20 years because of sanitary and mastitis problems. In France, it is also true for dairy sheep. Nowadays, most milking parlours have the following adjusted vacuum level:

- low line parlours: 34 to 36 kPa (10 to 10.6 inches Hg)
- high line parlours: 36 to 38 kPa (10.6 to 11.2 inches Hg)

COSTS

When a farmer builds a new parlour, he pays for the milking machines, the building itself corresponding to the parlour, the milk room, the sanitary room, the engine room, and sometimes for the bulk tank. Table 11 gives some prices of new milking parlours recently built in France. It is only a translation of French prices into US currency (1 US $ = 6 FF). It is surely not the reality of the US market, but it shows a comparison of the cost of different types of parlours.

Table 11 - Cost of milking parlours in France (US $)

Equipment	Casse 24 p 12 u	New Casse 48 p 24 u	Rotary 36 u
Building	21,700	28,300	31,700
Milking machine	23,300	33,300	65,000
Automatic cleaning	1,700	3,300	4,200
Cleaning bulk tank	4,700	7,700	7 700
Total	51,400	72,600	76,900

Conclusion

Milking parlours for sheep must be designed taking several criteria like milking ability and morphology of ewes and labour goals of farmers into account. A milker must always bear in mind that dimensions of a parlour, especially the height of the pit, must fit his own morphology as well as possible. Milking machine components, rules of construction and of performance need standardization.

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AN ECONOMIC COMPARISON BETWEEN A DAIRY SHEEP AND A NON-DAIRY SHEEP OPERATION

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It is always difficult to present any kind of dollar amount in a financial analysis because it seems that nobody ever agrees on the same thing. This is quite normal because there are many ways of doing the same thing and many different possibilities that would greatly affect the outcome and profitability of the operation. Therefore, numbers have to be taken with caution and adapted to present conditions, resources, and management skills.

In the tables presented in this article, we tried to give accurate figures that reflect a particular management that we know well. We also tried to be as complete as possible. When figures were unavailable we took an average of 5 year expenses presented by Mr. Jim Schultz, sheep producer at Clintonville, WI, or by R.J. Vatthauer and D.L. Thomas in “Sheep Production Systems for Wisconsin” (ETN series 12/12/97).

In our example we chose a dairy operation lambing once-a-year in February-March and milking from February through September, and a commercial lamb and wool operation lambing 1.24 time a year in January, March-April, and August-September. A detailed description of the two systems is necessary.

General Management

Dairy

The flock is composed of 300 East Friesian crossbred ewes of which 250 are milked twice a day. Lambing occurs in February and March with milking starting once a day 2 to 3 days after lambing. Lambs are separated from their dams overnight, the ewes are milked in the morning, and the lambs are returned with their mothers. All lambs are weaned at 30 days of age, and ewes are milked twice a day thereafter. Early results (1998) show that an average of 110 lbs of milk can be collected from the ewes during the first month while suckling their lambs without affecting greatly the growth of lambs.

About 8% of all lambs born are raised on milk replacer (quadruplet, some triplet, lambs rejected, etc.). These lambs consume an average of 18 lbs of milk powder before being weaned at an average age of 26 days (1998 price of lamb milk replacer is $1.14/lb.).

Lambs from non-milking ewes are weaned at 60 days of age. Ewes are then dried off and turned onto low quality pasture for the rest of the season.

The expected lamb crop of East Friesian crossbred ewes is 220% with a mortality not exceeding 5% (Spooner Agricultural Research Station lambings of 1997 and 1998). The total number of lambs available for market is 533 and 69 ewe lambs (replacement rate of 25%) will be kept for replacement. All lambs are fed with an all-grain ration to 120 lbs. Ewe lambs are bred to lamb at 12 months of age.

One East Friesian ram (either pure blood or half blood used alternatively every other year) and three Texel rams will be used. The East Friesian ram and one Texel ram will be replaced every year. The East Friesian ram (pure or crossbred) is used on the best milking ewes to provide replacement ewe lambs.

The average milk production for the whole flock (including ewe lambs) is 400 lbs for the total lactation. The value of sheep milk in 1998 is $60/cwt.

Commercial

The flock is composed of 300 Romanov x Dorset (or ½ Targhee). Lambings occur in January, March-April, and August-September for an average of 1.24 lambings per ewe per year (Spooner Sheep Day Proceedings 1995).

Lambing and breeding cycles are as follow:

Lambing in January ——— Breeding in March

Lambing in April ——— Breeding in August

Lambing in September——— Breeding in November

The number of lambings per ewe per year is 1.24 with a 270% lamb crop in January, 306% in April, and 214% in September for a total number of lambs born of 966. Total mortality of lambs does not exceed 14%. Therefore the total number of lambs marketed in this operation is 831.

Results have shown that in such a system with a high birth rate, 15% of all lambs born in January and April are raised on milk replacer. Each lamb will consume 18 lbs of lamb milk replacer before being weaned at an average age of 26 days. All other lambs are weaned at 60 days.

Ewes are replaced at a rate of 20%. The system uses only terminal sires (Hampshire for example). All replacement ewe lambs are purchased.

A total of four rams is used with two rams replaced every year by young ram lambs purchased from a Sire Reference Scheme selecting for growth rate and conformation. (Unfortunately there is no such scheme existing in the US).

In both systems, dairy and commercial, lambs, after weaning, are placed in a feed lot system with a 21% crude protein grain ration until 60 to 70 pounds and then with an all grain 12% crude protein ration until slaughter weight of 120 lbs. In the commercial operation, April born lambs are raised on pasture after weaning.

The amount of 21% crude protein grain ration consumed is 104 lb./lamb when weaned at 30 days and 70 lb./lamb when weaned at 60 days. The average consumption of 12% crude protein grain ration is 270 lb./lamb in the dairy operation and only 200 lb./lamb in the commercial operation since April lambs are raised on pasture.

Pasture

For both systems we consider a farm with 60 acres of permanent pasture. Part of the hay or all hay and feed is purchased.

In the case of the dairy operation, all ewes are put on pasture as soon as sufficient growth permits it. Milking ewes still receive a supplement of a 16% crude protein grain ration at milking time. All lambs are raised in a feed lot system.

In the commercial operation, all ewes and April-born lambs are put on pasture as soon as possible. April lambs are weaned before pasturing and are put on the best pastures. Some lambs are sold directly from pasture, and some are finished with grain in October-November.

Labor

Dairy

We consider that one full-time person is necessary with a high labor input between the start of lambing and the end of lactation.

A part-time person is necessary during the milking season. We allowed 900 hours (5 hours/day for 180 days) at $8/hour. This hired help could be another member of the family, thus increasing the total income of the household.

Commercial

We consider that a 300 ewe commercial operation needs one person ¾ time (1500 hours) with some part-time help during the intensive lambing periods of January and April (315 hours). September lambing does not require supplemental help because the lambing rate is much lower as well as the number of ewes lambing. Moreover, September lambing occurs on pasture.

Equipment and buildings

For both operations, we gave a total value of $15,000 with a depreciation over 10 years for general sheep equipment (scale, cutting chute, feeders, used small tractor, electric fencing, etc.), as well as $30,000 for buildings depreciated over 30 years and $50,000 for livestock.

A dairy operation requires an additional $50,000 with a depreciation over 15 years for the milking parlor (2x12 high-line pipeline indexing stanchion) and its equipment including a 12x12x8 walk-in freezer.

Both enterprises are very intensive operations requiring excellent management skills and from which the operator is trying to make a complete living rather than to get a supplemental income.

Income-Expense report for the dairy and commercial operations is presented in Table 1. The dairy operation clearly has a definite advantage because of the production of a high value product. The return to labor and management is enough to justify full time employment. Although the operation is less dependent on the price of lambs (Table 2) than the commercial operation, it will be dependent, of course, on the price of milk. The price of milk is actually $60/cwt in northern Wisconsin. One can very well imagine the price going down as soon as the overall production reaches a certain amount either through an increase in the number of producers or through a higher milk production per ewe or both. With the price of milk at $45/cwt and price of lambs steady at $70/cwt, the return to labor and management of the operation would be roughly $20,800, only slightly better than a commercial sheep enterprise, meaning that the break-even price of milk is around $45/cwt for this particular operation.

The dairy sheep producer may wish to sell all of his lambs as feeders. If all lambs are sold at a weight of 80 pounds and a price of $80/cwt, his return to labor and management would be practically the same as feeding the lambs to slaughter weight (Table 3). By selling his lambs as feeders, the dairy sheep producer saves labor and can put all his effort into milk production.

In the commercial operation, at the current price of lamb, the return to labor and management is not quite high enough for the producer to make a complete living off his flock, although his work load is only ¾ time. Some management decisions need to be taken to reduce overall cost and/or to increase receipts. Possible solutions could be to sell all January lambs for the Easter market and all September lambs for the Christmas market at a higher price, and reducing feed expenses. The producer could also look at other types of production systems. For example, Janet McNally (Spooner

Sheep Day Proceedings, 1997) has demonstrated the possibility of raising highly prolific sheep and their lambs on pasture only, thus reducing feed and operation cost while maintaining a high level of production. Jim Schultz, sheep producer in Clintonville, WI, with a 226 ewe operation raised extensively on pasture and weaning 1.6 lambs per ewe, shows a 5 year average return to labor and management of $6,300 with a labor input of only 625 hours. Many other combinations of production systems can be used, but few will result in a sufficient income to justify full employment.

In contrast, milking high-producing ewes appears to be a worthwhile operation, and a producer could certainly make a fairly good income. However, in order to obtain the quantity of milk necessary to provide a sufficient income, the investment in equipment and animals is high and can be a deterrent to some producers. Smaller-scale dairy operations are certainly a possibility, but producers would have to add some value to their milk by processing it on their farm into cheese, yogurt, ice cream, or fluid milk.

Table 1.
Income-Expense Report for a 300 ewe sheep dairy and a commercial operation selling slaughter lambs.

RECEIPTS

		DAIRY		**COMMERCIAL**
Slaughter lambs $70/cwt	533	44,772	831	69,804
Sale of ram lambs (East Friesian)	4	2,000		
Culled ewes	69	3,312	54	2,592
Sale of used rams	2	1000	2	600
Wool	2700 lbs	1,880	2700 lbs	720
Milk 100,000 lbs @ 60/cwt		60,000		
Credit for manure	400 tons	1,080	200 tons	540
TOTAL RECEIPTS		**114,044**		**74,654**
		380 per ewe		**249** per ewe

VARIABLE EXPENSES

		DAIRY		COMMERCIAL
EWE FEED				
ewes not milked				
6 months pasture @ $1.5/ewe/month		450		2,700
3 months 4lbs hay @ $80/ton		720		4,320
1 months 6lbs hay @ $100/ton		450		2,700
1 month 4lbs hay @ $80/ton		240		1,440
1 month 1 lb corn @ $6/cwt		90		540
1 month 2 lbs corn @$6/cwt		180		1,080
ewes milked				
6 months pasture @ $1.5/ewe/month		2,250		
3 months 4 lbs hay @ $80/ton		3,600		
3 months 6 lbs hay @ $100/ton		6,750		
1 month 1 lb corn @ $6/cwt		450		
3 months 2 lb 16%CP dairy ration @ $7/cwt		3,150		
2 months 1 lb 16%CP dairy ration @ $7/cwt		1,050		
TOTAL EWE FEED		19,380		12,780
LAMB FEED				
Creep feed @ $9/cwt	104 lb/lamb	5,634	60 lb/lamb	4,487
Finish ration @ $7/cwt	270 lb/lamb	10,073	200 lb/lamb	11,634
Hay replacement ewes		2,700		
TOTAL LAMB FEED		18,407		16,121

Table 1. continued

OTHER FEED		
Salt & minerals	970	970
Milk replacer @ $28.50/25 lb bag	1,000	2,230
TOTAL OTHER FEED	1,970	3,200
TOTAL FEED	**38,757**	**32,101**
	133 per ewe	**107 per ewe**
LIVESTOCK EXPENSES		
Shearing	700	350
Marketing-trucking	1,332	2,087
Vet-Med	1,000	1,500
Supplies	2,000	500
Bedding	1,500	900
Utilities	2,500	750
Machine operation cost	1,000	1,000
Rent cost	2,000	1,000
Purchase of ewe lambs @$130/ewe		7,020
Hired labor $8/hour	7,200	2,520
Maintenance and repairs	1,000	700
Wisconsin Sheep Dairy Coop cost	3,000	
Operating loan interest	2,000	1,000
TOTAL LIVESTOCK EXPENSES	25,532	19,327
TOTAL VARIABLE EXPENSES	**65,289**	**51,428**
	218 per ewe	**171 per ewe**
FIXED EXPENSES		
Sheep equipment 10% of value	1,500	1,500
Livestock (4% of original cost of $50,000)	2,000	2,000
Building (7% of new cost of $30,000)	2,100	2,100
Milking parlor $50,000 @ 8%	5,449	
Property taxes	900	900
Insurance	1,000	400
TOTAL FIXED EXPENSES	**12,949**	**6,900**
	43 per ewe	**23 per ewe**
RETURNS		
Total income	**114,044**	**74,656**
Less variable expenses	65,289	51,428
RETURN TO LABOR AND CAPITAL	**48,756**	**23,228**
Less fixed expenses	12,949	6,900
RETURN TO LABOR & MANAGEMENT	**36,808**	**16,328**
	119 per ewe	**54 per ewe**

Table 2.
Effect of lamb prices on Return to Labor and Management

Price of Lambs	Dairy	Commercial
$60/cwt	29,410	6.356
$65/cwt	32.608	11,342
$70/cwt	35,806	16,328
$75/cwt	39,004	21,314
$80/cwt	42.202	26.300
$85/cwt	45.400	31,286
$90/cwt	48.598	36,272

Table 3.
Income-Expenses Report for an operation of 300 ewes selling feeder lambs

RECEIPTS

		DAIRY		COMMERCIAL
Feeder lambs 80 lbs @ $80/cwt	513	34,112	831	53,184
Sale of ram lambs (East Friesian)	4	2,000		
Culled ewes	65	3,312	54	2,592
Culled rams	2	1000	2	500
Wool	2700 lbs	1,080	2300 lbs	720
Milk 100,000 lbs @ 60/cwt		60,000		
Credit for manure	400 tons	1,880	200 tons	940
TOTAL RECEIPTS		**103,384**		**58,036**
		345 per ewe		**193 per ewe**

VARIABLE EXPENSES

		DAIRY		COMMERCIAL
EWE FEED		19,390		12,783
LAMB FEED				
Creep feed @ $9/cwt	104 lb/lamb	5,634	60 lb/lamb	4,487
Hay replacement ewes		2,730		
TOTAL LAMB FEED		8,364		4,487
OTHER FEED		1,970		3,200
TOTAL FEED		**29,694**		**20,467**
		99 per ewe		**68 per ewe**
LIVESTOCK EXPENSES		25,532		19,327
TOTAL VARIABLE EXPENSES		**55,216**		**39,794**
		184 per ewe		**133 per ewe**

FIXED EXPENSES

	DAIRY	COMMERCIAL
TOTAL FIXED EXPENSES	**12,940**	**6,900**
	43 per ewe	**23 per ewe**

RETURNS

	DAIRY	COMMERCIAL
Total income	103,394	58,036
Less variable expenses	55,216	39,794
RETURN TO LABOR AND CAPITAL	**48,168**	**18,242**
Less fixed expenses	12,940	6,900
RETURN TO LABOR & MANAGEMENT	**35,218**	**11,342**
	117 per ewe	**38 per ewe**

MAKING AND MARKETING SHEEP MILK CHEESE
(OR HOW TO START A SHEEP DAIRY AND LIVE TO TELL ABOUT IT)

Cynthia L. Callahan
Bellwether Farms
Petaluma, California

I. Introduction

II. Brief History of Sheep Milk Cheese
- A. 8000 BC – Sheep becomes second animal domesticated by the nomads
- B. The first cheese – ancient legend
- C. Cheesemaking brought to Europe by travelers from Asia
  1. Middle ages
     a) Cheese made in monastaries in Europe
     b) Cow replaced ewe as the major milk producers in the world
  2. Major sheep milk cheeses
     a) France – Roquefort
     b) Italy – Pecorino Romano
     c) Spain – Manchego
     d) Other

III. Bellwether Farms – a Chronology
- A. 1986 – moved to Sonoma County
- B. 1988 – Began selling lambs
  1. Start accelerated lambing program
  2. Direct marketing to Bay Area restaurants
- C. 1990 – Built sheep dairy
- D. 1992 – Began making sheep milk cheese
- E. 1996 – Added cow milk cheese

IV. Sheep Dairying at Bellwether Farms
- A. How it started – 1990
  1. Original flock
     a) Dorset vs. Polypay
     b) Raised market lambs
  2. Visit from Olivia Mills
- B. Management of lambs
  1. Creep-fed from the start
  2. Weaned at 35 days of age
  3. Most sold as “milk-fed” to Bay Area restaurants
- C. Milking of ewes
  1. Dairy set-up
  2. Milking schedule
  3. Care and feeding of ewes
  4. Length of lactation and milk volume
- D. Recent improvements

   1. Better genetics
   2. New dairy

V. Making Cheese
   A. How we learned
      1. Short courses – very valuable for learning the scientific aspects of making cheese
      2. Travel to Italy – Tuscany and Umbria
   B. Deciding what cheese to make – some considerations
   C. Building a cheese plant on the farm
      1. Consult State regulations at the outset
         a) State will require a plan
      2. Cheese room
         a) Epoxy floors
         b) Walls – how covered?
         c) Drainage
      3. Cheese making equipment
         a) Pasteurizer
         b) Cheese vat
         c) Stainless tables, sinks, etc. – Where to obtain
         d) Cheese forms – determined by the type of cheese you are making
         e) Other
   D. Cheesemaking process
      1. Proper care of the milk
         a) Fresh vs. frozen
      2. Pasteurization process
         a) Whether to pasteurize
         b) Batch vs. HTST
      3. Steps in cheesemaking
         a) "The Recipe"
            Each cheese has its own make procedure. To make a specific cheese, it must be followed exactly (or you could make your own recipe)
         b) Cultures
            1) Depends on type of cheese
            2) Direct set – best for small producers
            3) Readily available
         c) Rennet
            1) Animal vs. vegetable
            2) How long to set
         d) Cutting the curds
            1) Determining the correct time to cut
            2) What size to cut
         e) Draining the curds
            1) Curds put in cheese forms
            2) Whey drains off (used for Ricotta)
            3) Turning cheese
         f) Salting and ripening cheese
            1) Brine vs. hand salting
            2) Natural rind ripening
            3) Proper temperature and humidity

4) Waxing

E. Recent Developments at Bellwether Farms
   1. Cow milk cheese
   2. New cheese room
   3. Additional ripening rooms

VI. Marketing

A. Establish Identity
   1. Name
   2. Logo
   3. Stationary, business cards, brochure, product list, etc.

B. How we started – lambs
   1. Bay area location
   2. Selling direct to restaurants

C. Types of markets
   1. Farmers markets
      a) Lamb and cheese
      b) Originally 70% of cheese sales. Today under 1%
      c) Advantage – retail price
      d) Disadvantage – time and labor intensive
   2. Restaurants
      a) Direct
      b) Distributor
   3. Retail stores
      a) Mainly distributors
   4. Mail order
      a) Advantage – retail
      b) Disadvantage – time, packaging
      c) Credit cards
   5. The future – the Internet

D. How to market – depends on budget
   1. Restaurants
      a) Letters
      b) Sales calls with samples
   2. Participate in food tastings
      a) Wine auctions
      b) Benefits
   3. Fancy Food Show/Trade Shows – When you are ready to expand
   4. Free advertising
      a) Press releases
      b) Articles in newspapers and magazines
   5. Hire a food broker

VII. Economics – General observations

A. Start up costs
   1. Depends on many factors
      a) Size, State regulations, labor costs, etc.

B. Operating expenses
   1. Labor is a major expense

C. Develop a plan
   1. Consult the experts – University, dairy advisor, CPA, etc.
   2. Determine State requirements
D. Develop a budget and update on a regular basis
   1. Analyze monthly sales and expenses
   2. Respond to new developments
E. Respond to new developments
   1. Competition

VIII. Closing remarks

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MASTITIS OF DAIRY EWES: ETIOLOGY, DETECTION, AND CONTROL

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Intra-mammary infections of dairy ewes

1. Etiology

In milk sheep production, intra-mammary infections (IMI) (clinical and subclinical mastitis) are mainly due to Staphylococci bacteria. Frequency of clinical mastitis is generally not greater than 5%. The main isolated bacteria is *Staphylococcus aureus* (from 16.7 up to 57.5% of clinical mastitis). Bacteria considered as minor pathogens when isolated in dairy cows, mostly CNS [*], are responsible for 10.3 to 59.6% of clinical mastitis. Frequency of other bacteria: Streptococci, Pasteurella, or *Escherichia Coli* is very low (Marco Melero, 1994).

Nowadays, prevalence of mastitis in dairy ewes is not well known and can vary considerably, but it can be estimated with somatic cell count (SCC) in bulk tanks. Early results coming from studies carried out in France show that about 20 to 30% of new infections occurring during a year are associated with SCC values within the range of 600,000 to 800,000 per ml.

Etiology of sub-clinical mastitis is the following:

- most infections are principally due to minor pathogens (CNS) and particularly *Stapholococcus epidermidis*;
- low infection rate due to Streptococci bacteria;
- low infection rate due to environmental bacteria, especially *Escherichia Coli*.

During lactation, persistence of mastitis is high because of their origin (Staphylococci).

During the dry period, the rate of spontaneous recovery is estimated around 60 to 67% of half udders including cases of substitution of infections. In fact, it can be estimated that only about 45% of half udders are sterile.

2. Transmission and risks

Staphylococci bacteria come from the skin of teats where they live and spread out. The main factors of transmission are milking machines, especially liners, and sometimes milkers (hands). Risks of transmission occur during milking when vacuum level and/or pulsation characteristics are not well adjusted and when milkers have a poor routine with overmilking.

Transmission also occurs when milkers strip ewes at the end of milking and remove clusters without shutting the vacuum off; then, likelihood of impacts of infected milk droplets against teats is very high. It is now well known that impacts are one of the main causes of mastitis in dairy cows and there is probably no reason to think that the same physical phenomena does not induce the same effects in dairy ewes.

[*] Coagulase Negative Staphylococci

Discovering infected animals

In dairy sheep production, effect of non-infection factors such as stage and number of lactation on SCC is very low; so, since the number of somatic cells in milk is indicative of a degree of udder infection, SCC should be reliable to predict IMI infections.

Only a few studies trying to evaluate the accuracy of a presumptive diagnostic test based on SCC in predicting infection status of the udder have been made till now.

Authors have suggested that the difference in SCC between healthy and infected udders should be within 200,000 to 500,000 cells/ml (Beltran de Heredia and Iturritza, 1988; Fthenakis, 1994; Romeo and al., 1994). Most authors suggested punctual thresholds within 200,000 to 800,000 for diagnosis of IMI infections (discrimination between infected and non-infected udders or halves).

French studies (Bergonier et al., 1997) suggest to divide the population into 3 categories instead of 2 in respect of individual data of ewes during the whole lactation:

- An udder is considered as uninfected, if every SCC measurement except two do not exceed 500,000 cells/ml during the whole lactation.
- An udder is infected if at least two SCC measurements during the lactation exceed 1,000,000 cells/ml.
- Infection status of the udder is uncertain in all other cases.

Accuracy of this prediction is about 80%.

Different authors (Zivet et al., 1968; Deutz et al., 1990; Regie et al, 1991; Baumgartner et al., 1992; Marco Melero, 1994; Gonzales-Rodriguez et al., 1996) found a good correlation between SCC and California Mastitis Test. This is why CMT appears to be a good tool to detect infected animals when individual SCC cannot be regularly checked.

Using SCC data of bulk tank

In France, farmers' organizations and dairy manufacturers in the Roquefort and the West-Pyrenees areas, have defined a method to follow changes in SCC in the bulk tank (2 to 3 samples per month from every farm). In the Roquefort area, SCC is one of the criteria involved in determination of the milk price since 1993.

From 1991 until 1996, fluctuations in average SCC have been relatively low: from 570,000 up to 800,000 cells/ml (Table 1). The two areas do not have different results even though there are different breeds and different management conditions in the two areas. SCC in dairy sheep are greater than those of dairy cows but lower than those of dairy goats (Table 1).

Table 1 - Average SCC in bulk tanks from 1991 until 1996

	Averages (x 1000 cells/ml)					
Area	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Roquefort	757	701	685	714	569	675
West Pyrenees	751	737	802	741	674	734

In the Roquefort area, a penalty of 0.20 F (3 cents) and 0.45 F (8 cents) is respectively applied when bulk tanks have more than 1.0 million and 1.5 million cells/ml, respectively. Introducing SCC as a criteria in determining the price of milk has considerably increased interest of farmers to improve management of ewes and especially milking machine efficiency related to mastitis. Figure 1 gives the frequency of different categories of SCC in the two main areas of sheep milk production in France.

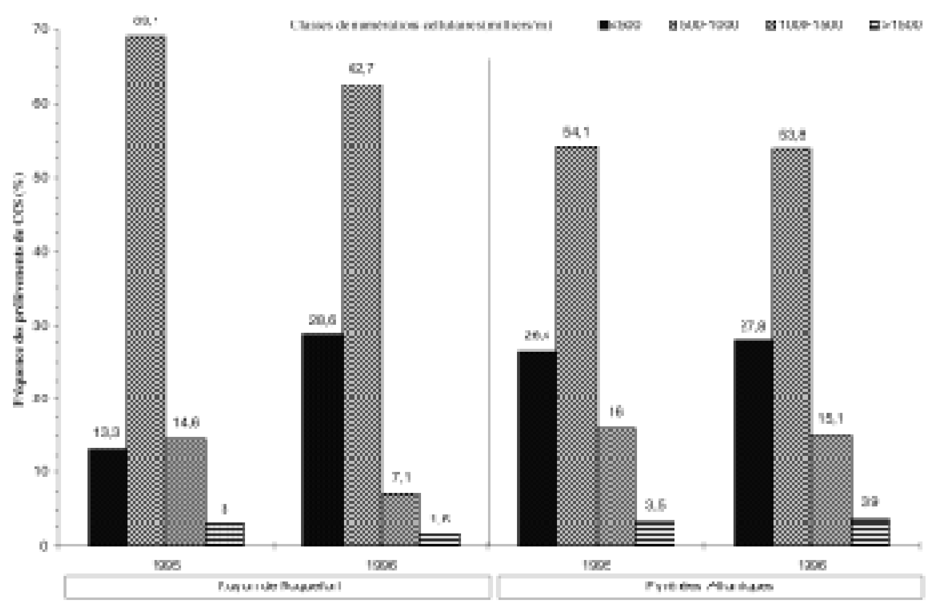

Figure 1 - Frequency of categories of SCC in Roquefort and West Pyrenees areas

SCC in the bulk tank are relatively high at the beginning of the campaign (lactation), decrease, and then slowly raise up to about 900,000 cells/ml at the end of the milking campaign (Figure 2).

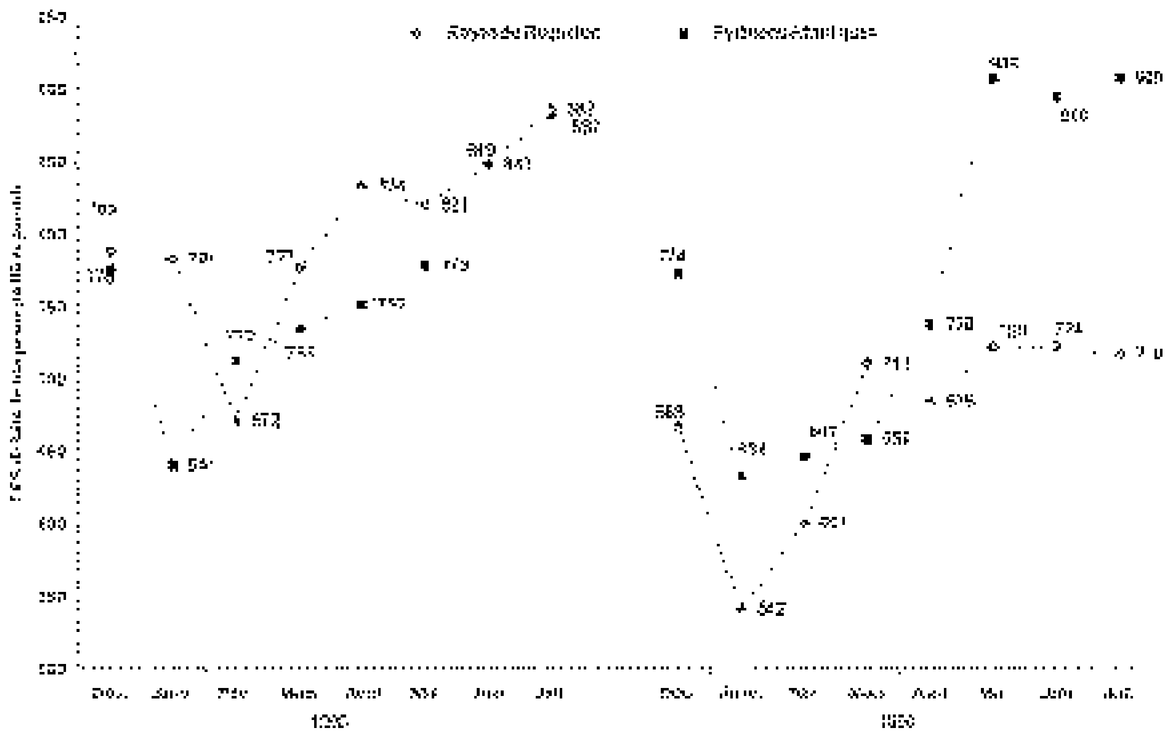

Figure 2 - Monthly variation of SCC in sheep flocks

Monthly variation of SCC can easily be related to the seasonal production of milk. In France, milk production traditionally begins in November-December and finishes in July-August; 60% of the milk production is collected from January until April. Variations in SCC are also correlated with management breeding conditions. It is possible that the beginning of the pasture period in March-April in the Roquefort area and the reproduction period may have some effects on bulk tank SCC.

Actual studies (European programme FAIR) are being conducted to have a better idea of possible relationship between individual SCC and bulk tank SCC. SCC (individual and tank) and milk production have been recorded for 4 to 6 years. Distribution of individual data has been recorded for each category of bulk tank SCC to estimate the relative rate of individual SCC to bulk tank SCC. On average, milk from a bulk tank with 440,000 cells/ml is constituted of 6.5% of ewes with individual SCC exceeding 2 million cells/ml which produce 5.5% of the milk and provide 76.6% of the cells in the tank (Figure 3).

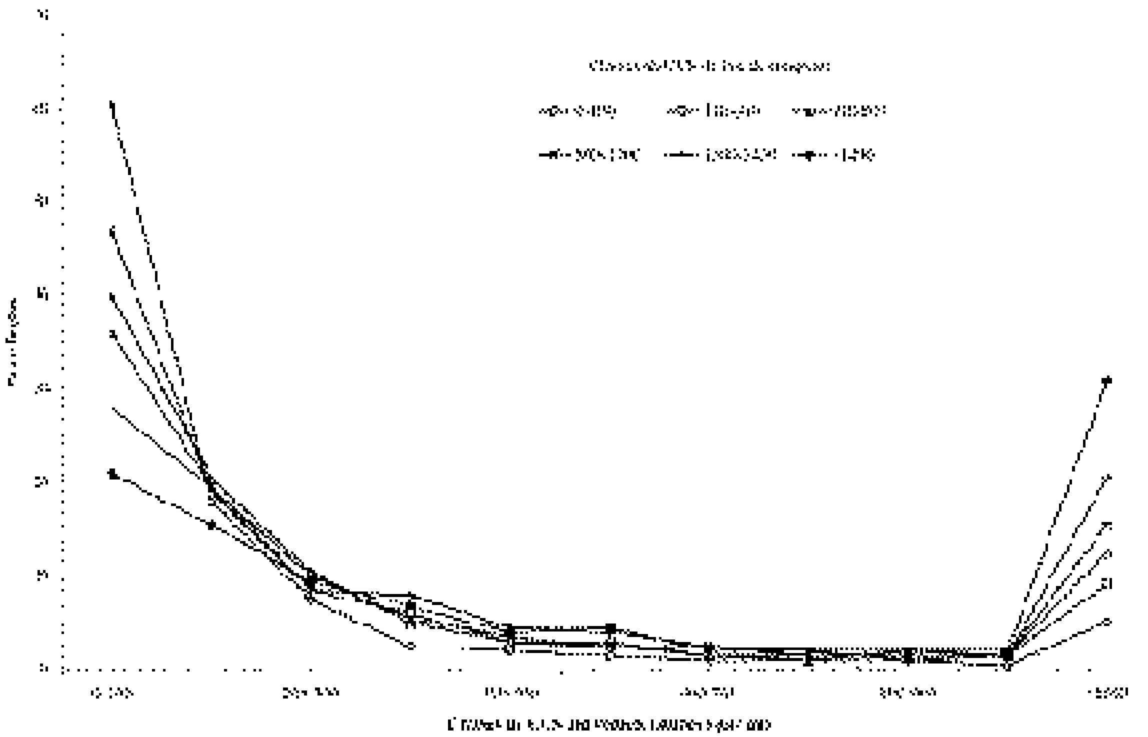

Figure 3 - Distribution of individual SCC in relationship to bulk tank SCC

The distribution of individual SCC for different levels of SCC in the tank depends on the relative ratio of ewes in the extreme categories (less than 500,000 cells/ml and more than 1 million cells/ml (Table 2).

Table 2 - Distribution of individual SCC associated with bulk tank SCC

SCC categories (cells per ml)	Ewes with SCC(%) < 500,000 cells per ml	Ewes with SCC > 1,000,000 cells per ml (%)
< 400,000	90.1	5.1
400,000-600,000	83.5	9.2
600,000-800,000	78.9	12.5
800,000-1,000,000	74.8	15.5
1,000-1,400,000	68.2	20.6
> 1,400,000	56.7	30.9
Correlation with tank SCC	0.79	0.83

Using the thresholds suggested by Bergonier et al., the distribution of individual SCC related to the bulk tank shows that the level of SCC of the bulk tank depends above all on the presence of ewes with high individual SCC.

When considering the whole lactation, prevalence of IMI infections could be deduced from tank SCC as shown in Table 3.

Table 3 - Prevalence of mammary infection and bulk tank SCC

Annual average SCC of milk tank	< 400,000	400,000-800,000	> 800,000
Number of flocks	14	36	23
Average SCC of the flock	302,000	572,000	1,094,000
% ewes with healthy udders	83.6	71.9	58.7
% ewes with uncertain udder health	10.5	15.6	15.7
% ewes with infected udders	5.9	12.6	25.6

The percentage of infected ewes increases 3.5% for every 100,000 cells per ml increase in bulk tank SCC.

Conclusion

IMI infections in dairy ewes have different characteristics from those observed in dairy cows. However, prevention and elimination of infections require various measures which have already proved their effectiveness in dairy cattle, for example:

- Control and good maintenance of milking machines.
- Good milking routine without overmilking and removal of clusters without impacts.
- Hygiene after milking (disinfection of teats) (if possible).
- Good housing management.

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UPDATES ON SHEEP MILK RESEARCH

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The dairy sheep industry in the U.S. has been a small niche industry for several years. In the 1980's, Dr. Boylan of the University of Minnesota conducted a number of studies in the hopes of helping promote a dairy sheep industry in the U.S. (1). Working with Dr. Morris, they evaluated the potential for producing Feta, Manchego, and Bleu cheese from sheep milk (2). Additional developmental work in the upper Midwest was conducted by Dr. Steinkamp of LaPaysanne, Inc. (3). In 1994, the University of Wisconsin accepted the mission of furthering research in the area of sheep dairying. The UW Experimental station in Spooner was selected as the primary sight for research on dairy sheep production and management. At that time, Dave Thomas requested some assistance from the processing side to aid in the potential development of markets for sheep milk for producers in Wisconsin. Jim Path of the Wisconsin Center for Dairy Research, Dr. Bob Lindsay of the Food Science Dept. and I planned various research activities where we could to assist the dairy sheep industry. Most of the funds to support the research activities came from the specialty cheese program from the Wisconsin Milk Marketing Board (WMMB) and from some USDA funding sources. Some technical assistance came from Scott Erickson of Bass Lake Cheese Factory in Somerset, WI.

Shepherd's Blend Cheese

Early financial support for cheese research came from the WMMB Specialty Cheese program. They were willing to support research in the potential use of sheep milk in blended milk cheeses in which a portion of sheep milk was used to produce the unique flavor that was typical of Spanish sheep cheeses, e.g., Manchego. Obviously, the majority of milk in these specialty cheeses from blended milk was cow milk since they were paying for the research. However, at the same time, we were able to run a full sheep milk control for flavor comparison and that provided the opportunity to gain some experiences in using sheep milk. The final cheese that was developed was a Spanish type cheese, similar to Manchego, that used 80% cow whole milk and 20% sheep whole milk. Initially, the cheese was aged for 4 months to produce a semi-hard cheese with a smooth creamy body and a slight piquant and buttery flavor. At this point, the cheese had about 41% moisture. Later, John Jaeggi, our specialty cheesemaker at the Center for Dairy Research, found that by aging Shepherd's Blend for about 9 months and drying the cheese out, he got a sharper flavor much like dry Manchego. This version of Shepherd's Blend was the favorite at CDR's booth at World Dairy Expo in 1996. The aged version of Shepherd's Blend has about 33% moisture. Shepherd's Blend cheese is currently being sold through the Babcock Hall Dairy store on the Madison campus.

Frozen Sheep Milk for Cheese

In 1994, Dr. Eric Bastian of the University of Minnesota Food Science Dept. reported on a study he conducted on the influence of freezing sheep milk on coagulation of the milk for cheesemaking (4). He found that freezing and thawing sheep milk did not change rennet coagulation properties compared to fresh, unfrozen sheep milk. Eric measured coagulation properties on a formagraph and did not make cheese out of the milk. He froze the sheep milk for 1 month in a blast freezer, so the study was of a short duration. Eric also looked at the activity of five different coagulants on sheep milk. His results are shown in Table 1. The two *Mucor* enzymes did not coagulate sheep milk as rapidly as calf rennet, chymosin, or the *Endothia* enzyme. No explanation was given for the difference in coagulating activity.

Sheep Milk Flavors

Dr. Bob Lindsay of the Food Science Department has been working on unique flavor compounds of both goat and sheep milk. In 1991, he reported on some of the branch-chained fatty acids that were unique to mutton and sheep milk (5). More recently, he has been working on a new group of flavor compounds found in sheep milk and sheep milk cheeses (6). These alkyl phenols are responsible for the cowy flavor of cow's milk and the sheepy flavor of sheep's milk. These flavors, at lower levels of intensity, give a slight dairy note to milk, butter and cheeses. They are also involved in what Dr. Lindsay describes as the "bake-through" flavor of butter. Some of these compounds are shown in Table 2. At the current time, Dr. Lindsay and his research group are looking at the use of enzymes to hydrolyze the precursors of these flavor compounds to release these flavor compounds in desirable levels in blended sheep milk cheeses (7).

Food Uses for Goat and Sheep Whey

In the 1980's, there was a significant growth in the dairy goat industry (8). In 1995, there were 6 cheese plants in Wisconsin processing about 11-12 million pounds of goat milk from the upper Midwest. Three of the cheese plants wanted to expand to meet the demand of new markets for their cheeses. However, due to the environmental constraints on landspreading their whey, these plants were hesitant to increase their production at the current sites. In 1995, we initiated a research project on finding potential food uses for goat whey. At the same time, we included sheep whey in the study to provide for a comparison between the two species.

In the first phase of the study, we looked at the seasonal changes in protein composition of whey from commercial manufacture of goat and sheep cheeses (8). We wanted to know what patterns in composition to expect as we looked at potential whey products for the food industry. The average gross composition for each type of whey over the season is shown in Table 3. We then took a closer look at the individual whey proteins in each source of whey to determine potential food use for each source of whey. Each whey protein has slightly different functional properties that may be useful in various food systems. Distribution of individual whey proteins in each source of whey is shown in Table 4. When we looked at the seasonal changes in individual proteins of sheep whey, we observed some minor changes. However, when we took into account other parameters impacting whey composition, we felt that the seasonal variation would not significantly impact processing of whey for specific food uses. Seasonal changes are shown in Table 5.

Results of this first phase of the study showed that goat and sheep wheys have uniquely different whey protein compositions from cow whey. These differences might be useful to provide food-grade whey products for specific uses in the food industry. For example, the high proportions of b-lactoglobulin in sheep whey may offer the potential for whey products with enhanced foaming, gelation, and emulsification.

In the second phase of our study, we separated the whey proteins from the whey in the form of whey protein concentrates (WPCs). Here again, we ran the trials with goat and cow WPC for comparison (9). Table 6 shows the compositional analysis for the WPCs prepared from sheep, goat and cow whey. The distribution of whey proteins in the various WPC's are shown in Table 7. The sheep WPC contained slightly higher levels of minor proteins, such as serum albumin and immunoglobulins than cow or goat WPC and lower levels of b-lactoglobulin. The solubility of the three species of WPC were very soluble at pH 3.0 and 7.0. The foaming properties of sheep WPC were significantly better the goat and cow WPC. Foaming properties are shown in Table 8. Sheep WPC showed the best foaming overrun and stability of all the WPC's. Sheep WPC also produced the firmest gels of the WPC's tested (Table 9). Overall, sheep WPC showed some improved functionality over that of goat and cow WPC. Further studies will have to be conducted in specific food systems to confirm these anticipated functional properties that we observed in sheep whey proteins. The other question would be what is the value of sheep WPC with these improved functional properties.

Potential Use of Sheep Milk for Flavor in Low-Fat Cheeses

Sheep milkfat contains twice as much short chain fatty acids as cow milkfat. With the high level of butyric acid in sheep milkfat, we questioned whether this could help improve the flavor of some blended milk lowfat cheeses. At the current time, we are evaluating the use of 20% sheep whole milk and 80% cow skimmilk as a milk blend to produce a lowfat Muenster cheese (10). Cheese made from this milk blend is being compared against a lowfat Muenster produced from all cow's milk. We are looking at both fat and protein breakdown during aging to determine if sheep milk will contribute improved flavors within aged cheeses.

Storage Stability of Frozen Raw Sheep Milk

Samples of raw sheep milk were frozen at two different temperatures, 5°F and -18°F, last July. Samples were thawed at 1, 2, 3, 6, 9, and 12 months and analyzed for total bacteria, coliform bacteria, acid degree value (ADV), and intact protein (11). Preliminary results are shown in Table 10. Results indicate that milk frozen in a standard home freezer at 5°F was not as stable as that frozen in a commercial hardening room at -18°F. After 6 months of storage at 5°F, about one third of the casein was destabilized and precipitated out upon thawing. The raw milk stored at the lower temperature was stable up to the 9th month sampling period. Final analyses after 12 months of storage should give us some feeling for how long we can maintain quality in frozen raw sheep milk. Additional studies may be necessary to determine the cause for the destabilization of casein in frozen milk. Casein precipitation was experienced in frozen concentrated milks that were produced in the 1970's. This destabilization was due to the concentrated milk salts in the frozen 3:1 concentrates.

Future Sheep Milk Studies

Further studies will be required to address milk quality problems experienced in frozen raw sheep milk. Some work may involve the use of a preheat treatment of the milk before freezing to inactivate some of the native milk lipases and proteases. Additional studies may look at the adjustment of salts in sheep milk to stabilize the proteins during frozen storage.

In September 1998, we will be initiating a study on the impact of frozen storage of milk on quality of yogurt. The second phase of this study will address the potential production of a dried sheep milk product that would allow the storage of excess sheep milk solids in a stable form. This dried sheep milk could then be used for fortification of cheese milk or addition to other processed sheep milk products like yogurt or ice cream.

Conclusion

We will continue to support the sheep milk processing industry as best we can with available research funds. Up to the present, much of our research funding has come from the specialty cheese program and has been directed toward blended milk cheeses. We will continue to seek additional funding to attempt to address problems and potentials in full sheep milk products. Our ultimate goal is to assist the dairy sheep industry, as best we can, to develop potential markets for dairy sheep milk products as discussed in our 1995 Great Lakes Dairy Sheep Symposium (12).

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Table 1.
Rennet clotting times (RCT) of sheep milk showing the influence of clotting enzymes.

Clotting enzyme	**RCT (min)**
Calf rennet	10.0
Chymosin	9.5
Mucor miehei	12.5
Mucor pusillus var. Lindt	11.5
Endothia parasitica	10.0

Source: Bastian, 1994.

Table 2.
Concentrations of total volatile phenols in cow's, sheep's and goat's skim milks after sequential mild thermal acidic and enzymic hydrolysis.

	Concentration (ppb)		
Compound	**Cow**	**Sheep**	**Goat**
thiophenol	n.d.	230	n.d.
phenol	860	1890	6600
o-cresol	70	50	60
p-cresol	310	6150	2140
m-cresol	70	3610	610
2-ethylphenol	20	650	n.d.
3,4-isopropylphenol	n.d.	520	n.d.
3,4-dimethylphenol	n.d.	70	n.d.

Source: Lopez, 1993.

Table 3.
Gross composition (%) of goat, sheep, and cow wheys from specialty cheese plants.

Component	Goat Cheddar	Sheep Manchego	Cow Cheddar
Total solids	6.6	7.5	6.7
Fat	0.5	0.8	0.3
Protein	0.8	1.1	0.6
Lactose	4.7	5.2	4.5
Ash	0.6	0.8	0.5

Source: Casper (8), 1998.

Table 4.
Distribution (% of total whey protein) of whey proteins in goat, sheep and cow specialty cheese whey.

Whey Protein	Goat Cheddar	Sheep Manchego	Cow Cheddar
Serum albumin	4.0	4.1	6.5
Immunoglobulins	9.7	7.3	13.0
β-lactoglobulin	58.6	74.0	64.9
α-lactalbumin	27.0	14.8	15.6

Source: Casper (8), 1998.

Table 5.
Seasonal variation in whey protein composition (% of total whey protein) of sheep specialty cheese whey.

Whey Protein	March	June	August
Serum albumin	3.8	3.6	5.1
Immunoglobulins	7.4	5.5	9.0
β-lactoglobulin	71.9	77.7	72.4
α-lactalbumin	17.0	13.9	13.5

Source: Casper (8), 1998.

Table 6.
Composition (%) of WPC's prepared from sheep, goat and cow wheys.

Component	Goat Cheddar	Sheep Manchego	Cow Cheddar
Protein	66.7	66.6	63.2
Fat	0.3	0.2	0.3
Lactose	26.0	28.0	28.5
Ash	3.6	2.5	4.7
Moisture	2.2	0.8	2.6

Source: Casper (9), 1998.

Table 7.
Distribution (% of total protein) of whey proteins in WPC prepared from goat, sheep and cow whey.

Whey Protein	Goat Cheddar	Sheep Manchego	Cow Cheddar
Serum albumin	0.9	4.0	2.9
Immunoglobulins	4.9	4.5	2.8
β-lactoglobulin	70.9	73.5	77.1
α-lactalbumin	22.9	18.1	17.3

Source: Casper (9), 1998.

Table 8.
Foaming properties of sheep, goat and cow WPC's.

Type of WPC	Foam overrun (%)	Foam stability (%)
Goat Cheddar	1934	85.8
Sheep Manchego	2077	99.4
Cow Cheddar	1634	87.0

Source: Casper (9), 1998.

Table 9.
Firmness of gels made from sheep, goat, and cow WPC.

Type of WPC	Firmness (Newtons at 80% compression)
Goat Cheddar	31.89
Sheep Manchego	37.55
Cow Cheddar	6.30

Source: Casper (9), 1998.

Table 10.
Properties of frozen raw milk stored 5°F and -18°F for various time periods.

Time of Storage (mo)	Coliforms (#/ml)	SPC (#/ml)	ADV	TCA-ppt. protein
Stored at 5°F				
0	44	8200	.285	5.09
1	26	4700	.320	5.06
2	21	2500	.555	5.01
3	0	2200	.460	5.06
6	0	3500	.535	5.02
9	0	340	.550	3.37
Stored at -18°F				
0	44	8200	.285	5.09
1	0	4100	.320	5.05
2	0	3200	.415	4.99
3	0	3700	.380	4.96
6	0	2800	.405	4.89
9	0	2800	.370	4.92

Source: Swenson, 1998.

DREAM VALLEY FARM

Tom, Laurel, Cassie, Missy and David Kieffer
Strum, Wisconsin

Introduction

Dream Valley Farm (DVF) is a diversified small farm providing high-value products and working toward increased ecological balance and sustainability. Farm development began in 1991 when we decided to make a major life change by pursuing a vocation more consistent with our values. We purchased a largely neglected 160 acre property, and the venture began.

Mission

The mission of DVF is to profitably and sustainably produce, market, and sell high-value farm products to buyers in the upper midwest.

History 1991 - 1996

Following our March, 1991 move to the property in northern Trempealeau county, we spent the first several months cleaning up after years of debris, trash, and general neglect. In August, 1991, the first group of purebred registered Rambouillet sheep arrived, and the farm business began, along with the associated learning curve.

In the winter of 1991, Tom began the design work for a new resource efficient house, which had long been a goal. In the spring and summer of 1992, we established the first few paddocks of the farm's controlled grazing system, primarily using temporary, moveable electrified fencing. This approach has proved worthwhile during the first few years while we explored different pasture layouts. A few lambs were born from the initial purchased group, and the excavation and construction of the new house began. Additional projects completed in 1992 were the underground installation of freeze-proof water piping and hydrants, drain tile for the main farm yard, and a dam and drainage culvert for the lower pond. In 1992 also, we purchased additional livestock including Angora goats, and purebred Rambouillet sheep. We discovered that a major portion of the original sheep flock had OPP, which prompted the return of these animals to the original owner. Flock expansion thus took a turn backward.

In 1993, we acquired a group of 38 Rambouillet ewes from a reputable producer who was reducing her flock. Incremental paddock development continued, as did house construction. Also during this time, the development of a small base of direct sales customers for fresh frozen lamb, and pelt and wool products began.

1994 saw the purchase of a 50% Arcott Rideau breeding ram intended to produce offspring with higher milk production characteristics. This was the first action toward including sheep dairying in our business plan. A side benefit of this was the improved growth characteristics of these market lambs. Unable to tolerate the old one any longer, we moved into the not quite finished new house in March 1994.

1995 saw the first trials of raising and selling fresh pastured poultry, state licensing of the first DVF meat product, "Dream Valley Bratwurst", and expansion of the direct customer base. Also in 1995, DVF began participating with several other sheep dairy farms and the University of Wisconsin in a project to improve dairy sheep genetics in Wisconsin. This involved having 30 ewes artificially inseminated with semen from 78% East Fresian rams. Lambing rates were quite disappointing. DVF had 30 ewes inseminated in 1996 also. Some of these were with 100% East Fresian semen from New Zealand. Lambing rates were similar.

At the beginning of 1996, DVF again expanded its sheep flock with the purchase of 85 Rambouillet and Columbia ewes bred to 78% East Fresian rams. This was a major step toward the establishment of a sheep dairy as a key component of the farm operation. DVF secured its first outside financing to accomplish this expansion. All development to that time had come out of personal cash flow and reserves.

Marketing

As mentioned, one of our goals is to sell as much product as possible directly to the end consumer. Direct market DVF lamb products are sold by the cut, or in pre-packaged boxes to mostly people from larger cities such as Milwaukee and Madison. Many of these direct buyers are quality and health conscious individuals who desire and appreciate the close contact with the farm that produces their food. Since the processing is done locally at a state inspected facility, we are limited to in-state sales only. Additionally, some are sold on the commercial market as feeders or finished lambs.

DVF pastured poultry is sold fresh and 100% direct. Beginning in 1996, 500 pastured chickens were raised and sold to a very enthusiastic direct clientele, including many local people who had not previously considered trying DVF products. This is an ongoing summer project. We added farm fresh eggs in 1997. Marketing is accomplished through word of mouth and phone calling, in conjunction with mailers and flyers. We continue to receive very favorable feedback. Increasingly, new people call and ask to buy.

The domestic sheep milk market is small and unstable, but with great potential. DVF is a member of the Wisconsin Sheep Dairy Cooperative, which has been working actively to secure local demand among cheesemakers. DVF plans to continue supporting the co-op, while also exploring alternative plans for milk sales. Success of these efforts is essential for the farm’s financial viability.

Recent History

During the past two years, much effort has been put toward developing the farm’s infrastructure to catch up with flock expansion and dairying plans. Some of the accomplishments and ongoing projects include:

- *Completion of 7-wire electrified high tensile perimeter fencing.* We feel this is essential for animal security.
- *Continued progress on 5-wire interior fence* to divide the farm into approximately 30 paddocks, with corridors to the milking parlor and corral. This will simplify our intensive grazing management.
- *Construction of the milking parlor*. This was designed to fit within a section of an existing pole barn. The major work took place during the extremely harsh winter months, which delayed progress, and added significant cost to the project.
- *Construction of the main sorting and handling facility.*
- *Building of several fenceline feeding areas* including the main feedlot which is large enough to easily feed 200 ewes or 300 lambs at one time.

The genetic base of the flock has been slowly converting to East Fresian crosses. The most recent advance in this area has been the acquisition of one 100% East Fresian ram, and several 85% plus East Fresian rams from Canada. In 1997, a purebred Charollais ram was used as a terminal sire with very satisfactory results. Lambs were easily birthed even by 12-month-old ewe lambs, and gained size and depth within 5 days.

Due to our high satisfaction with the East Fresian and Charollais stock, the Rambouillet ewes and lambs will be sold over the next year as we continue to streamline our flock. Our goal at this time is to eventually milk about 160 to 200 high-production crossbred ewes. We also project selling Charollais and East Fresian breeding stock, feeder lambs, and direct market finished lamb.

The Charollais crosses should finish on pasture at about 115 pounds, lean and meaty. This fits our management goals. East Fresian mom's easily raise twins and triplets to acceptable weaning weights in 30 days.

Dairy Facility and Milking Routine

The sheep dairy parlor is a double-sixteen, crowd type, pit parlor with a low-line pipeline. Thirty-two animals are in the parlor at one time with 16 units in place. There are no headgates in this system. Ewes are crowded in the pipe structure with three tiers of spacing for head placement. Feeding troughs are constructed of PVC pipe. Commercial galvanized water pipe with bolt together clamps, gates, straps, pulleys, and ropes are used to create the handling system. The pit was designed to be a comfortable height for the shorter people in the family. An overhang on the sheep floor decreases back strain for those milking. Hoses with spray nozzles are placed on the middle of each wall to allow for easy cleanup. The concrete is brushed to reduce slipping, and sealed with commercial grade sealant to aid in cleaning.

The pipeline, clean-in-place system, bulk tank, vacuum pump, and accessories were purchased used from area dairy farmers who had ceased milking. Milking units and pulsation are new. Installation and modifications on the system were provided by a local implement and dairy systems company. They provided excellent support and assistance during the start-up process.

The building is all steel inside and out, with enough insulation to allow for year-round use. An in-floor hydronic heating system allows for maintenance of above-freezing temperatures. The concrete floor was poured with steel rebar and mesh welded together and grounded to prevent potential stray voltage problems. Lighting is sealed fluorescent fixtures installed under a utility sponsored rebate program. We designed and built the building conversion, parlor, and handling systems. Considerable study was involved before we began the process.

For milking, the sheep are brought in from pasture and crowded into the holding area alongside the barn. They are counted into the parlor through the two south drop doors, attracted by a small amount of corn. Sixteen or 17 ewes are placed on each side. The larger number works well to help control new, more anxious ones. Unless conditions are extremely muddy, udders are not washed before milking. Teats are dipped with a commercial product afterward. Sheep then exit through the north drop doors. The main grain ration is fed in the lot after milking is completed, and ewes are then moved back out to fresh pasture. Free choice mineral, salt-kelp, and water are available at all times. Milk is stored a maximum of four days in the 35 degree bulk tank.

The first ewes lambed in February. This amounted to about one-third of the flock. We began milking once a day in early April with the lambs on during the night. Our goal is to start milking ewes once a day about 10 days post lambing, especially if the ewe has only a single. Ewes are then milked once a day until their lambs are a minimum of 30 pounds and adjusted to grain and pasture.

The second wave of lambing began in late April. Due to the insecure milk market, all of the late lambing ewes and lambs are not being weaned until at least 30 days. We have a chest freezer that stores just below zero. Additional milk is being warehoused for sale later in the year. Our preference is to sell fresh. We are anticipating this market to increase this summer with the addition of at least one new cheese plant as a buyer.

Generally, we are very pleased with the layout of our parlor, corrals, corridors, and handling, and parlor systems. They allow for easy handling of large numbers of sheep and their lambs. Neither the humans nor sheep become highly stressed. Once both species have a routine established, things go quite smoothly.

The Financial Picture

The farm has been an increasing drain on family financial resources since its inception. The major goal for 1997 was to begin the sheep dairy operation. Due to obstacles of health, construction delays, and seasonal water well problems, DVF could not sell milk in 1997. This created another serious financial setback. The 1998 milk sales are not as stable as 1997, so the financial situation remains tenuous at best. Off-farm income remains essential to allow the farm to continue to operate. A major requirement for 1998 and beyond is for this to turn around. The family can no longer support this negative cash flow.

We have succeeded in developing and selling a convincing business plan to a banker and a friend. The resulting loans have allowed for the major investments of recent years. Performance during the coming months will indicate whether DVF has long term viability. The approximate costs for the major items related to the dairy operation are:

- Barn conversion for parlor construction $ 20,000
- Parlor, milkhouse, systems, equipment $ 11,000
- Corral, handling and feeding area $ 4,500
- Flock improvement $ 15,000
- Fencing $ 10,000

Goals and Plans

Our goals for 1998 and 1999 are:

- Dream Valley Farm income will cover expenses, including loan payments and ongoing related expenses. Income will come from:
  - Milk sales
  - Breeding stock (Charollais, Rambouillet, East-Fresian)
  - Goat sales
  - Wool, pelt, fiber products
  - Feeder lambs
  - Direct market lamb, processed lamb, and poultry sales

- A reliable market for fluid milk will be established.
- 90% of the Rambouillet stock will be sold to make room for high-percentage East Fresian ewes.
- By 1999 milking season, a stable flock size of 180 to 200 ewes of a minimum of 40% East Fresian breeding will be reached.
- Milking flock will be production and component tested monthly.
- Corridor and paddock fencing will be completed.
- Begin experimentation with farmstead sheep milk products, begin market research, planning, seek start-up funds.
- Market lamb quality and direct sales will be substantially increased.

Conclusion

Since 1991, we have come a long way toward realizing our dream of a small but profitable family farm operation. The journey has been far more difficult than anticipated. The cash drain has also been greater. We continue to aspire to a vision that Dream Valley Farm is only a short distance from beginning to be financially sustainable. We have found ourselves over the past few years doing a great deal of idea exploration, self questioning, and modifying of our plans. We plan very conservatively with income expectations, and increase our best guess at expenses. (Murphy's Law reigns supreme.) There are days we seriously question the sacrifices we've made by giving up well-paying off-farm jobs for all the hard work with low financial return.

The youth of this industry creates frustration and insecurity. But no new industry became viable without sweat and hard work. We only hope that what we do makes a difference to someone and that our real dream of helping re-establish the small family farm as a sustainable way of life can be realized. We appreciate and are very grateful for the people who are in this with us, who know the day-to-day frustrations, but also share the dream. We are especially grateful for our three children, Cassie, Missy, and David. Without their contribution, this process would probably not be possible.

BUTLER'S FARM

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When we made the decision to move to Wisconsin to start our sheep dairy, we aroused looks of bewilderment from our friends. You're going to do what? You're going to move where? Why? These were the three basic questions we had to answer time and again. At times, even we ask these questions of ourselves.

The answer is, really, a simple one - quality of life. For ourselves as well as our son. We have no delusions of grandeur. We don't strive to someday be a large corporation with many employees shipping product throughout the world. What we do want to be is an efficient, family-run business with enough accounts that will enable us to remain on our farm. A farm, into which, we have poured sweat, labor, and love. Our life and our hopes lie in the hills surrounding our home.

Since 1993 we have been busy planning, renovating, building, planting, producing, manufacturing, marketing, distributing, failing, succeeding, and above all, learning. What we have after five years of toil is a small Grade A sheep dairy plant producing organic cheese and yogurt for a steadily growing clientele. What you will see at Butler Farms covers everything from seed to shelf.

We came to Wisconsin with one plan in mind. That plan was to produce and sell sheep milk products. So that is where we started. Before pouring a lot of time, money, and effort into genetics and infrastructure, we wanted to test the hypothesis that there was in fact a market for sheep milk products in the upper mid-west. We started at the grassroots and have proceeded from there.

The first stop was farmer's markets. We feel that once you get people to put sheep milk products in their mouths, you will build a following. While at these markets, we find out where people shop and proceed to those retail outlets as soon as the markets are done. Off comes the farmer hat and on goes the marketing hat. We have been fortunate to find that most retailers were more than willing to give us a try. We would then keep in personal contact with these outlets weekly, take their orders, put on the distributor hat, and deliver the product.

We have attended markets and shows to expose our products and make connections within the food industry. This has paid off. We currently have two distributors carrying our products. With our distribution needs now being fulfilled by professionals, we have been able to turn more focus back to the farm and marketing our products. The past two years we have used two 3/4 East Friesian rams. We hope this will improve our milk production and thereby allow us to fill our growing orders.

It has been a long road, and we still have a very long way to go.