

Proceedings of the Great Lakes

Dairy Sheep Symposium

March 28, 1996
Madison, Wisconsin USA



Proceedings of the Great Lakes Dairy Sheep Symposium

March 28, 1996

Ramada Capital Conference Center
Madison, Wisconsin USA

Sponsored By:

Wisconsin Sheep Breeders Cooperative
Madison Area Technical College
University of Wisconsin Division of Cooperative Extension
University of Wisconsin-Madison
College of Agricultural and Life Sciences:
Department of Meat and Animal Science
Spooner Agricultural Research Station
The Babcock Institute for International Dairy Research
and Development

Major Financial Support Provided By:

The Babcock Institute for International Dairy Research and
Development of the College of Agricultural and Life Sciences,
University of Wisconsin-Madison

Organizing Committee
Great Lakes Dairy Sheep Symposium

Yves Berger, Spooner, Wisconsin, Chairman
David and Mary Falk, Grantsburg, Wisconsin
Jeff and Sharon Foster, Colfax, Wisconsin
Diane Kaufmann, Chippewa Falls, Wisconsin
Hal Koller, Amery, Wisconsin

with valuable assistance from:

Bob Black, Columbus, Wisconsin

Proceedings edited and compiled by:

David L. Thomas, Madison, Wisconsin
Candice Rowe, Madison, Wisconsin

Cover designed by:

Candice Rowe, Madison, Wisconsin

Additional copies of the 1995 and 1996 Proceedings of the Great Lakes Dairy Sheep Symposium can be ordered from the Wisconsin Sheep Breeders Cooperative, 3696 Country Aire Drive, Cedarburg, WI 53012-9206, USA (phone/FAX: 414-377-1491).

PROGRAM

Great Lakes Dairy Sheep Symposium

Ramada Capital Conference Center
Madison, Wisconsin

Thursday, March 28, 1996

7:30 am	Registration
8:30 - 9:30 am	Early Weaning of Lambs Dean Risa, Minnesota
9:30 - 10:30 am	Nutrition of the Dairy Ewe Antonello Cannas, Italy
10:30 - 11:00 am	Break
11:00 a.m. - Noon	Sheep Dairying in the U.K. and France Yves Berger, Wisconsin
Noon - 1:00 pm	Lunch followed by program: NADSA - What Is It and What Does It Do? Mary Jarvis, Wisconsin
1:00 - 2:00 pm	Sire Reference Schemes Hans Porksen, England David Thomas, Wisconsin
2:00 - 3:00 pm	Producing Farmhouse Cheese on a Sheep Dairy Farm David Major, Vermont
3:00 - 3:30 pm	Break
3:30 - 4:30 pm	How Did the Dairy Goat Industry Break into the Market Laura Jacobs-Welch, Wisconsin
6:30 - 8:00 pm	“Extraordinary Tastes” - Some of Wisconsin’s finest chefs will highlight domestic sheep dairy products and American lamb in a gala promotional event.

TABLE OF CONTENTS

Weaning Lambs at 30 Days of Age Dean Risa, Minnesota	1
Nutrition of the Dairy Ewe Antonello Cannas, Italy	4
Impressions of Dairy Sheep Production in the U.K. and France David Thomas and Yves Berger, Wisconsin	22
Practical Aspects of Sire Referencing Hans Porksen, England	28
Sheep Sire Referencing Schemes - New Opportunities for Pedigree Breeders and Lamb Producers G. Simm and N.R. Wray, Scotland	32
The Why and How of Sire Referencing Derrick R. Guy, England	40
Opportunities for Genetic Improvement of Dairy Sheep in North America David Thomas, Wisconsin	47
NADSA-The North American Dairy Sheep Association What is it and What does it do? Mary Jarvis, Wisconsin	52
The Cottage Industry - Cheesemaking and Marketing David Major, Vermont	54
The U.S. Commercial Dairy Goat Industry: A Brief Historical Account Laura Jacobs-Welch, Wisconsin	58
Growth and Reproduction of 1/4 East Friesian Lambs Yves Berger and David Thomas, Wisconsin	62
Dairy Sheep Basics for Beginners David Thomas, Wisconsin	65

WEANING LAMBS AT 30 DAYS OF AGE

Dean A. Risa

Southwestern Technical College
Pipestone, Minnesota

Challenging! Challenging is the word I would use to describe the process of weaning lambs from the ewes at 30-35 days of age. Challenging, and yet - possible. Because early weaning of lambs is such an important component of profitable sheep dairying, we must carefully plan all segments of the weaning process. My assumption is that all of you have ruled out the possibility of rearing the lambs artificially, and you intend to use the ewe to raise the lamb.

Most importantly, I would boil down the weaning process into two areas: 1) the feeding plan used to develop the rumen of the young lambs which makes it possible to wean the lamb and, 2) the creep area where the feeding is to be accomplished.

Successful early weaning is dependent on the lamb's ability to utilize solid food. Rumen development is therefore the most important physiological factor to consider. Lambs will begin to nibble at hay and grain at a very young age, at least by the time they are a week old. Although they won't consume significant amounts of feed until three weeks of age, the small amounts are very important for establishing rumen function and the habit of eating.

Young lambs need to receive a diet that ferments rapidly and does not lead to an accumulation of indigestible fibrous material within the rumen. Soybean meal and corn are important ingredients upon which to base the creep ration. Soybean meal is highly palatable with high protein content, and corn ferments well in the rumen. Oats on the other hand is high in indigestible hulls and should not be used.

Dr. Jordan from the University of Minnesota and Dr. Hinds from the University of Illinois have done some excellent research on the palatability of different ingredients commonly used in creep rations. The research does much to guide us in selecting feed ingredients on which to base our rations. Lambs to be weaned at 30-35 days of age need to start eating early in life, and to get them to do that we need to offer them what they like to eat. The following chart shows which of the common feeds lambs preferred to eat from birth to 10 weeks of age.

Pounds of Consumption by Two-Week Periods

Feed	0-2 wks.	2-4 wks.	4-6 wks.	6-8 wks.	8-10 wks.
Oat Groats	.00	.05	.88	1.02	1.43
Whole Oat	.12	.29	1.46	1.65	1.25
Grain Corn	.11	.10	2.77	7.83	8.02
Alfalfa Hay	.23	.41	4.43	1.12	1.05
Alfalfa Pellets	.00	.14	1.35	4.06	1.98
Wheat Bran	.27	.55	2.01	3.17	1.08
SBM (Soybean Meal)	.81	1.70	6.94	11.01	10.63
Linseed Meal	.03	.12	.72	1.06	.65
Linseed Pellets	.00	.02	.65	2.62	3.51
Sweet Pellets	.27	.75	3.54	4.08	2.19

High quality legumes also degrade rapidly in the rumen and help to stimulate rumen growth, so they too should be used in the feeding plan. Solid food intake is the best guide to use in early weaning of lambs. Lambs nursing heavy milking ewes are less inclined to eat significant amounts of solid feed, so the amount actually consumed by the young lamb is important.

Lambs need to be eating solid feed as quickly as possible, so they need to have a creep available from the very first day they are placed in the mixing pens with their mothers. The ration does not have to be fancy, however, it needs to contain the ingredients the lambs prefer including soybean meal, molasses and corn.

The best creep ration for your lambs is one they will consume. A ground ration or one made of crumbles is what they prefer. Pellets, whole corn or oats are not desirable because the lambs will not normally consume these feeds in that form at a very young age.

Attention to “details” such as keeping the feed fresh daily and providing a good source of clean, fresh, unfrozen water are very important in helping to insure your success of preparing the lambs for weaning.

An example of a good creep ration lambs will consume readily at a young age is as follows:

1170 lbs Rolled Corn	Ration Analysis:
670 lbs 44 % Soybean Meal	20% Protein
50 lbs Liquid Molasses	72% TDN
40 lbs Limestone	.778% Calcium
20 lbs Iodized or TM Salt	.338% Phosphorous
10 lbs Ammonium Chloride	2:1 Ca to P Ratio
30 grams Lasalocid (Bovatec)	
.3 PPM Selenium	
1,000,000 IU Vitamin A	
200,000 IU Vitamin D	
80,000 IU Vitamin E	

The creep pen is also an important component of early weaning. Feeding the best ration possible will not help to wean early if the lambs aren't in an area consuming the ration you have out in front of them. When setting up the creep feeding system, give consideration to a number of items:

1. Purpose of the creep pen
2. Attitudes of the newborn lamb
3. Attitudes of the ewes
4. Creep pen location
5. Creep pen construction and size

An area needs to be provided accessible to the lambs and inaccessible to the ewes where the lambs will begin to eat the dry grain ration you have provided.

When lambs are born, nature provides them with an instinct to nurse but no real recognition of its mother. Not until it is placed with other ewes and their lambs and has been knocked around by another ewe does it really begin to seek and recognize its own mother and feel a need for her protection. Ewes have a mothering instinct, and she becomes uncomfortable when her lambs aren't by her side or within her sight.

We would like to have our lambs spend nearly all their time in the creep because the creep ration will help them grow and develop their rumen. Therefore much thought must be given to locating the creep in an area where we can accomplish our aims.

Creeps should be placed where a ewe can readily see her lambs, and they can see her. If possible the creep area should be 6 inches to 1 foot higher than the other floor around the pen. Best location is in the center of the shed. After the pen is positioned and there is little or no lamb traffic into it, the producer should consider moving it to a new and perhaps better place. At no time should the lamb feel it is being penned away from the ewe.

Construction of the creep panel entrance is also important. Plenty of openings in the panel and good visibility for the ewes and lambs are important. The pen needs to be designed in a way that will make lambs feel as though they are not being trapped away from their mother.

There are many advantages to a well managed lamb creep feeding system. They are of primary importance for the sheep dairyman. All dairy sheep producers need to evaluate their current system of starting lambs on feed to determine if they are accomplishing their objective of being able to wean at 30 days of age.

Meet the challenge of early weaning!

NUTRITION OF THE DAIRY EWE

Antonello Cannas

Istituto di Zootechnica, University of Sassari, Italy
Department of Animal Science, Cornell University, Ithaca NY

INTRODUCTION

Dairy sheep production is an important economic resource in many Mediterranean countries. During 1990 21 million ewes were milked for a total milk production of 1641 million liters in European Union countries. In recent years, milk production from ewes has become increasingly important in some European countries where in the past this activity was unknown. This is in part the result of the quotas of European Union on cow's milk production.

Proper feeding strategies of the lactating ewe cannot be based simply on what is known for dairy cows. Even though much of the information available for dairy cattle is valid for dairy sheep, it is necessary to be aware of the differences between the two species to avoid using improper feeding strategies for the lactating ewe.

DAIRY SHEEP ARE NOT JUST DAIRY COWS TEN TIMES SMALLER

Recommendations for feeding dairy sheep are often derived from dairy cows, whose nutrition and feeding management have been more extensively studied. Even though both sheep and cattle are ruminants and have many similarities, they tend to have different feeding strategies and they are also different in several physiological functions.

Some of the most important differences between the two species are related to their body size. Dairy sheep are, in general, 10-12 times smaller than dairy cows. Many studies have shown that in both species the total volume of the gastrointestinal (GI) tract varies between 13-18% of the body volume (Parra, 1978, cited by Van Soest, 1994). As adult ruminants increase the size, GI tract volume increases in direct proportion to body weight. This means that the GI tract of a 60 kg sheep is, on average, 10 times smaller than that of a 600 kg cow. However, as the body weight increases, there is a less than proportional increase in energy requirement for maintenance. Maintenance energy requirements are usually proportional to the 0.75 power of body weight ($BW^{0.75}$, often called metabolic weight, MW). This means that maintenance requirements of a 600 kg (MW= 121.2 kg) cow are only 5.6 times higher than those of a 60 kg (MW= 21.6 kg) sheep. If we divide the weight of the GI tract by the maintenance energy requirements it is possible to estimate the digestive capacity (kg of GI tract available per unit of energy requirements). The digestive capacity curve in figure 1 shows that cattle tend to have more kg of GI tract available per unit of energy required for maintenance than sheep, i.e. they can "store" more feedstuff in the GI tract for each Mcal of energy required for maintenance than a sheep.

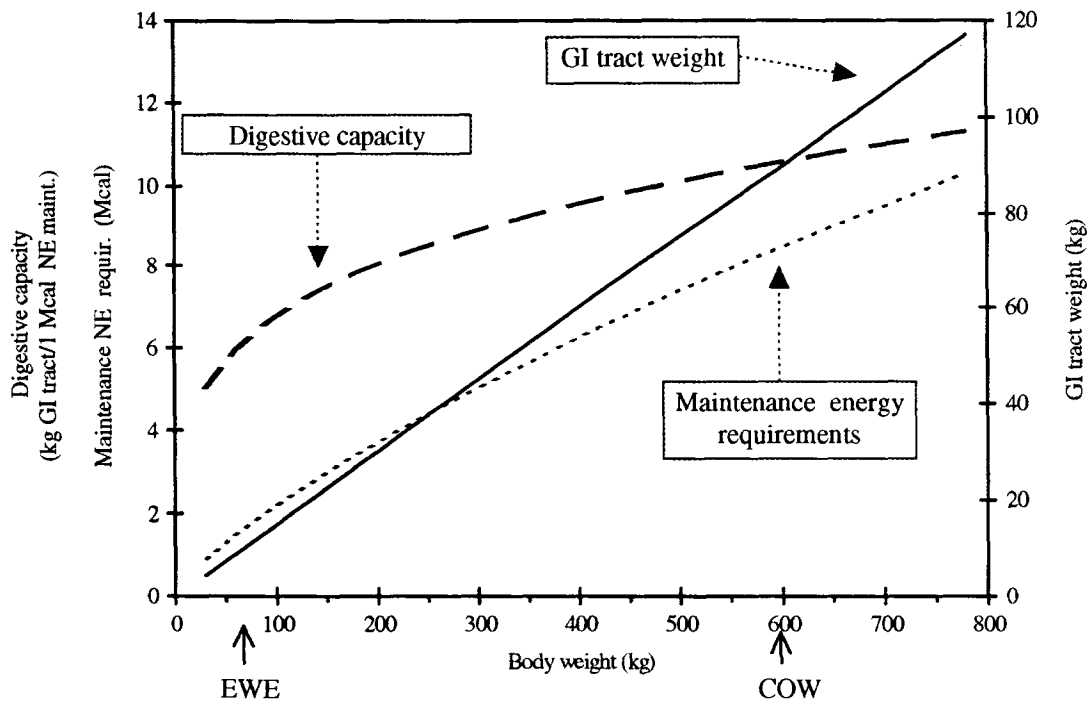


Figure 1- Effect of body weight on gastrointestinal tract (GI) size, maintenance energy requirements (net energy, NE) and digestive capacity.

Fiber can be fermented in the rumen only if it stays there for a sufficient time (several hours). The longer it stays, the more it is digested (up to a limit!). In practice, if sheep and cattle are fed with the same fibrous feedstuff, cows tend to have higher digestibility because they have more room and they can keep the feedstuff in the rumen for a longer time (Table 1). This difference in digestibility is maintained even when in both species the intake is much higher than that typical of dry animals (Blaxter et al., 1966).

Table 1. Apparent digestibilities and retention times for ruminants fed medium quality timothy hay (Uden et al., 1982; Uden and Van Soest, 1982)

Item	Goats	Sheep	Heifer
Body Weight	29	30	555
Intake of dry matter			
g/d	1637	1525	7775
g/kg BW	56	51	14
g/kg BW ^{0.75}	131	119	68
Digestibility (%)			
Dry matter	47	47	54
NDF	44	44	52
Retention time of forage particles			
Rumen (hr)	28	35	47
Whole GI tract (hr)	52	70	79
Ratio: rumen/whole tract	54	50	59

BW = body weight NDF = neutral detergent fiber

There are important practical implications related to these facts. To compensate for their low digestive capacity, sheep have to speed up the passage of feedstuff in the rumen (high passage rate). Therefore, sheep need to eat more feed per day (as % of BW) than cattle to satisfy their requirements. Since the feed stays in the rumen for a shorter period (shorter retention time), each kg of feed is less completely digested. Despite this, due to the higher intake of dry matter, the total amount of nutrients digested per day is usually increased. This explains why high producing dairy sheep may have a level of intake between 5 and 7% of their body weight, while high producing cows usually do not exceed 4%.

Another way sheep face this problem is to select more (Van Soest, 1994). Since sheep have less room for the feed per unit of requirement than cattle and they have to speed up the passage rate, they tend to choose feeds or parts of feeds that are of good quality and high digestibility. Even if the feed stays for a shorter time in the rumen, its digestibility is sufficiently high to allow the animal to meet its energy requirements.

Sheep differ from cattle in chewing activity too. Sheep require between 9 and 16 more time than cows to eat and ruminate 1 kg of dry matter (De Boever et al., 1990). Sheep have to chew more than cattle because they are smaller animals and their chewing activity is less powerful. Sheep also have to grind the particles more finely than cattle to allow them to pass through the rumen and other compartments of the foregut (Van Soest, 1994). This behavior was clearly shown when lactating dairy cows (Holstein) and dairy sheep (Sarda) were fed a pelleted total mixed ration as the only feed (Table 2). While sheep spent more than an hour to ruminate 1 kg of dry matter, cows had very little rumination. Indeed, while sheep were doing well with this diet and were producing a good amount of milk, cows had milk fat depression and showed clear signs of acidosis.

Table 2. Intake and chewing activity of cows and sheep fed with a pelleted total mixed ration as only feed (Rossi, 1994, cited by Van Soest et al., 1994)

		Dairy cows	Dairy sheep
Intake	(kg of DM/day)	8.4	1.2
Eating time	(min/day)	110.7	56.0
Rumination time	(min/day)	<u>19.4</u>	<u>78.5</u>
Total chewing time	(min/day)	130.1	134.5
Eating efficiency	(min/kg of DM)	13.1	46.3
Rumination efficiency	(min/kg of DM)	<u>2.3</u>	<u>64.9</u>
Total chewing efficiency	(min/kg of DM)	15.4	111.2

Since there is a limit in the amount of time a ruminant can spend chewing, intake tends to be limited by the particle size of coarse diets containing long hay more in sheep than in cattle. This fact, and the lower digestive capacity of sheep, explain why grinding often increases intake of forages and why the response is stronger in sheep than in cattle. Greenhalgh and Reid (1973) compared the intake of sheep and cows fed 3 types of diets (high quality (A) and medium quality (B) dehydrated ryegrass and a mix of medium quality ryegrass with barley (C)) presented in either long or ground and pelleted form.

Their results (Table 3) show that grinding and pelleting: a) increase intake more in sheep than in cows; b) increase intake more in young animals than in adult animals; c) increase intake more in medium quality diets than in higher quality diets (B > A > C). Even in ground diets, however, the total digested dry matter intake is higher in high quality diets than in low quality diets.

Table 3 - Effects of grinding and pelleting various diets on intake in sheep and cattle (Greenhalgh and Reid, 1973, modified).

			SHEEP			STEERS		
			6	18	36	6	18	36
			49	72	83	272	464	614
DIET	FORM	INTAKE						
A	Long *	g/kg of BW	21.9	18.1	23.8	20.5	16.5	15.7
	Ground & pelleted**	difference in %	+59	+46	+29	+18	+21	+5
B	Long*	g/kg of BW	17.8	15.2	18.0	19.6	15.9	13.7
	Ground & pelleted**	difference in %	+76	+74	+61	+31	+21	+30
C	Long*	g/kg of BW	22.0	17.5	24.6	20.5	19.7	17.3
	Ground & pelleted**	difference in %	+49	+25	+11	+20	0	0

A= perennial ryegrass, 2nd cut, harvested 7 weeks after the 1st cut (NDF 59%, CP 19%, ADL 3.3%)

B= perennial ryegrass, 2nd cut, harvested 12 weeks after the 1st cut (NDF 64%, CP 16.6%, ADL 4.1%)

C= 60% hay B and 40% milled and pelleted barley

* = long (baled) for cows, coarsely chopped (5 cm screen) for sheep

** = ground (1.44 cm screen) and pelleted through a 16 mm die

Intense rumination activity in sheep can also have important implications when the diet includes grains. Rumination reduces the particle size of grain and increases rumen digestibility of grain and therefore of starch. Sheep tend to chew grains more finely than cattle. This may explain why diets with high digestibility (> 66%) tend to be digested better by sheep than by cattle, while with low digestibility diets cattle are more efficient (Mertens and Ely, 1982).

In conclusion, compared to cows sheep:

- a) have to eat more to satisfy their maintenance requirements. This results in higher passage rate of feed and lower fiber (forage) digestibility
- b) tend to have more selective feeding behavior
- c) are more affected in their intake by particle size and fiber content of the forages
- d) have to spend more time eating and ruminating each kg of feed
- e) tend to have higher digestibility of grains and high energy diets.

REQUIREMENTS OF THE LACTATING SHEEP

Energy requirements

Energy requirements of the lactating dairy sheep are calculated as those of lactating ewes of other breeds. The data for this type of animals come from different organizations. Table 4 reports French (INRA, 1989), Australian (CSIRO, 1990) and

British (AFRC,1993) requirements. Because it was written primarily for meat and wool-production sheep, the NRC (1985) does not specify energy requirements for milk production. For dry ewes sheep NRC (1985) tends to have higher requirements for maintenance than other systems (footnote in table 4). CSIRO (1990) is peculiar because its energy requirements for maintenance grow in proportion to milk yield. The rationale behind this is that when the “sheep machine” is producing milk, in addition to the energy necessary to produce each kg of milk she requires some extra maintenance energy. Indeed, when animals (not only ruminants) produce milk they have higher intakes and they require extra energy to process the extra feed (Ortigues and Doreau, 1995). This leads to higher requirements of maintenance during lactation than during the dry period.

Table 4 - Energy requirements for housed mature sheep (Mcal of ME/d) *

FCM ** (6.5%) (kg/d)	50 kg of live weight				60 kg of live weight				70 kg of live weight			
	AFRC total	INRA total	CSIRO		AFRC total	INRA total	CSIRO		AFRC total	INRA total	CSIRO	
			total	maint.			total	maint.			total	maint.
0	1.53	1.45	1.60	1.60	1.76	1.66	1.83	1.83	1.99	1.87	2.05	2.05
1	3.28	3.19	3.48	1.77	3.51	3.40	3.71	2.00	3.73	3.60	3.94	2.22
2	5.10	4.92	5.36	1.94	5.31	5.13	5.60	2.17	5.53	5.34	5.82	2.40
3	6.98	6.66	7.25	2.11	7.18	6.87	7.48	2.34	7.37	7.07	7.70	2.57
4	8.94	8.39	9.13	2.28	9.10	8.61	9.36	2.51	9.27	8.81	9.59	2.74

* NRC (1985) = maintenance requirements (Mcal of ME/d): 50 kg = 2.00; 60 kg = 2.20; 70 kg = 2.40

** 6.5% FCM (6.5% fat-corrected milk) = actual milk yield x (0.3688 + 0.0971 x % butterfat) (Pulina et al., 1989).

The requirements reported in table 4 include some activity allowance for housed sheep. If the ewes are grazing, an additional allowance should be made for their extra movement. On average, grazing activity increases maintenance requirements by 20% if the ewes are on good quality flat pastures and by 35-40% in more extensive, hilly pastures (CSIRO, 1990). If the ewes have to walk long distances to go to the pasture, a more precise calculation can be done considering the following values (CSIRO, 1990):

Activity	Unity	Live weight			
		50 kg	60 kg	70 kg	80 kg
Walking (horizontal component)	(Mcal per mile)	0.04	0.05	0.06	0.07
Walking (vertical component)	(Mcal per mile)	0.60	0.73	0.85	0.96

Protein requirements

The calculation of protein allowances for lactating ewes represents a difficult and not always successful task. Proteins supplied by the diet are in part fermented in the rumen and in part digested in the intestine. The fraction fermented in the rumen (degradable intake protein, DIP) is used by bacteria (if proper amounts of fermented carbohydrates are present) and allows their growth. Ruminal bacteria then pass to the intestine, where they represent a major source of good protein for the ewe. The requirements of the ewe are then satisfied in part by feed protein that is not fermented in the rumen and is digested in the intestine (undegradable intake protein, UIP) and, in part, by bacterial protein digested in the intestine. The problem is that the amount of protein fermented in the rumen (and as

consequence the amount of UIP) and the ability of bacteria to use that protein is affected by many variables like type and amount of feed eaten (usually related to milk production), feeding frequency and amount of energy fermented in the rumen. In practice, this means that it is difficult to say exactly how much protein will be needed to meet the requirements of a lactating ewe. People feeding cows also face these problems but more information is available for lactating cows than for lactating ewes. Thus, most of the information we use is based on information derived from dry ewes or from dairy cows and they may not reflect actual requirements and feed utilization of dairy ewes. The French (INRA 1989), the Australian (CSIRO, 1990) and the British (AFRC, 1993) systems express protein requirements in terms of metabolizable protein requirements while the NRC (1985) uses crude protein (CP). The use of metabolizable protein may give more precise estimates but requires information often not available. In practical situations, crude protein can be still used as base for balancing the diet of dairy ewes. The sheep NRC (1985) gives practical estimates of protein requirements for maintenance of dry females:

Body weight (kg)	50	60	70	80
Crude protein requirements (g/d)	95	104	113	122

Crude protein requirements for milk production are around 120-125 g of CP per kg of milk with 5% CP. If the milk has a different crude protein composition, CP requirements for its production should be proportionally corrected.

Optimal crude protein intake and concentration in the diet can vary substantially depending on the intake of the animals, the type of protein and energy used in the diets and the feeding method. NRC (1985) suggests CP concentration between 13% (90 kg BW) and 14.5% (50 kg BW) for ewes producing with 1.74 kg/d and between 14% (90 kg) BW and 16.2% (50 kg BW) for ewes producing about 2.6 kg/d. These values may be adequate in many situations. However, in many other cases, diets with up to 18.0-18.5% of crude protein can give an extra boost to milk production, especially when protein sources with low rumen degradability are given. This is supported by some experimental results, both in early lactation (Gonzalez et al., 1984) and in late lactation (Pulina et al., 1990; Cannas et al, 1995). Animals with high levels of production need to have diets with more UIP proteins. In these ewes, in fact, microbial protein may not be able to completely satisfy the high protein demand of the ewe. An example of the effects of protein intake and source on milk yield is given in figure 2.

Fiber and non structural carbohydrate requirements

No information seems to be available to define minimum fiber requirements of lactating sheep. Pelleted complete diets with NDF as low as 32% and small particle size were fed ad libitum as the only feed to dairy ewes (Pulina et al., 1995). The level of intake was about 4.75% of body weight and the ewes had similar milk production to the ewes fed with more fibrous diets. It is important to notice that if concentrates are fed separately from fiber sources they may cause acidosis even when the diet contains more fiber. The optimal fiber intake to maximize milk production is not known. When dairy goats were fed diets containing 14% to 26% ADF, they ate the same amount of diet and produced

similar quantities of milk compared to those fed higher fiber diets, while milk fat content was increased in the more fibrous diets (Santini et al., 1991).

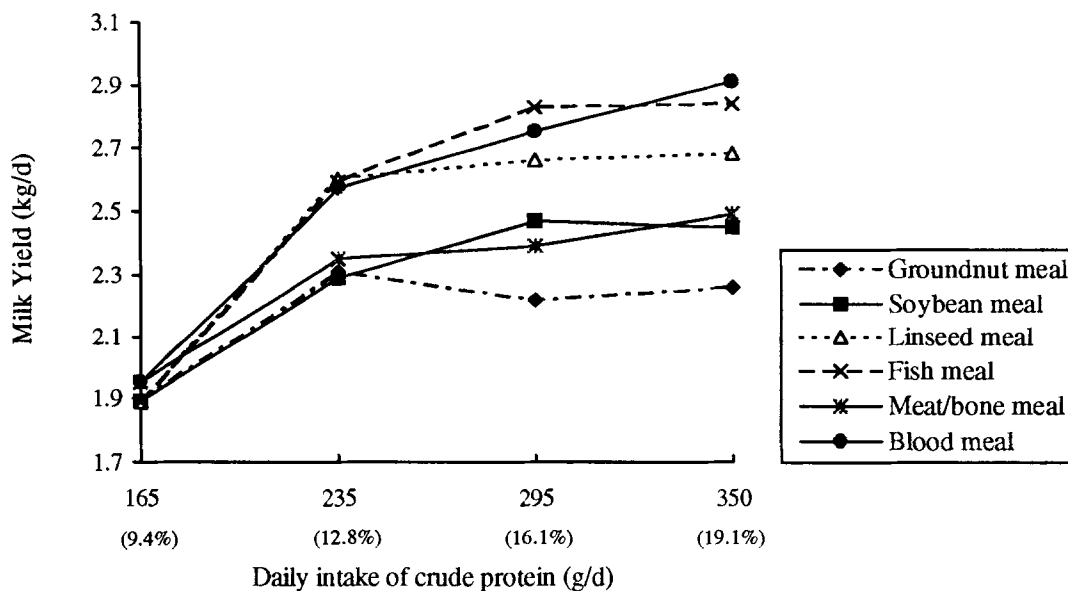


Figure 2 - Effect of different amounts and source of protein in ewes (67 kg BW) in the first month of lactation. The lower protein level corresponds to a basal diet of hay, barley and molasses. Dry matter intake was restricted to 1.8 kg per day for all diets. Numbers in brackets represents CP concentration in the diets (adapted from Gonzalez et al., 1982, and from Robinson, 1987b).

Non structural carbohydrates (NSC) are composed mainly by starch and sugars and are supplied mostly by grains. They tend to decrease when the fiber content of the diet increases. NSC are a very important energy source for the ewes and their rumen bacteria. However, excess NSC may induce severe acidosis and other digestive and metabolic problems (Ørskov, 1986). High roughage diets (60: 40 forage to concentrate ratio) gave much lower milk yield than low roughage diets (20: 80 forage to concentrate ratio, lower NSC content) in Finnsheep ewes in the first weeks of lactation (Brown and Hogue, 1985). However, in dairy goats in the fourth month of lactation milk, yield was only slightly higher when 45:55 forage to concentrate ratio diets were compared with 75:25 ratio diets (Kawas et al., 1991). Diets ranging from 14% to 21% CP were compared at two levels of NSC (as average, 29% vs 40%) (Cannas et al., 1995) in mid-lactation lactating dairy sheep. The ewes fed the diets with the lowest NSC concentration had higher intake (2411 vs 2195 g/d) and produced more milk (1428 vs 1252 g/d). This may have been the result of too much starch in the rumen causing sub-clinical acidosis. Indeed, milk fat, milk lactose and milk pH were slightly lower in the high NSC diets. It is also possible, however, that with the high NSC diet the energy was used more for body fat deposition than for milk production, due to a likely high propionate production, following a mechanism proposed by Ørskov (1986).

The practical implication of these trials is that during early lactation large amounts of grain may help the ewe in negative energy balance to produce more milk, while later on large amounts of grain (and then of NSC) may be detrimental. If the NSC diet content suggested for dairy cows is used for dairy sheep, it should be considered that rumen digestibility of the NSC tends to be higher in sheep (that intensely chew grains) than in cows, while fiber digestibility tends to be lower. This means that for similar NSC content in the diet (i.e. similar forage to concentrate ratios) sheep should have a lower acetate to propionate ratio than cows of comparable levels of production.

PRACTICAL FEEDING OF THE LACTATING EWE

First part of the lactation (first 8-10 weeks)

The first part of the lactation has been studied intensely because of its interest in wool and meat breed. Milk production in this period, in fact, dramatically affects lamb growth and body weight at weaning. In the case of dairy sheep, milk production in early lactation strongly affects the amount of milk produced in mid and late lactation. Both lactation length and total milk production per lactation are usually positively influenced by high milk yield at peak of lactation.

In the first 4-6 weeks of lactation, intake is usually fairly low but the requirements of the ewes are very high. Peak intake usually occurs some weeks after the peak of lactation. This brings the ewe into a negative energy balance. Milk production, then, relies, in part, on utilization of body reserves. The lower the body reserves, the lower the amount of milk that can be produced from fat mobilization (Robinson, 1987a).

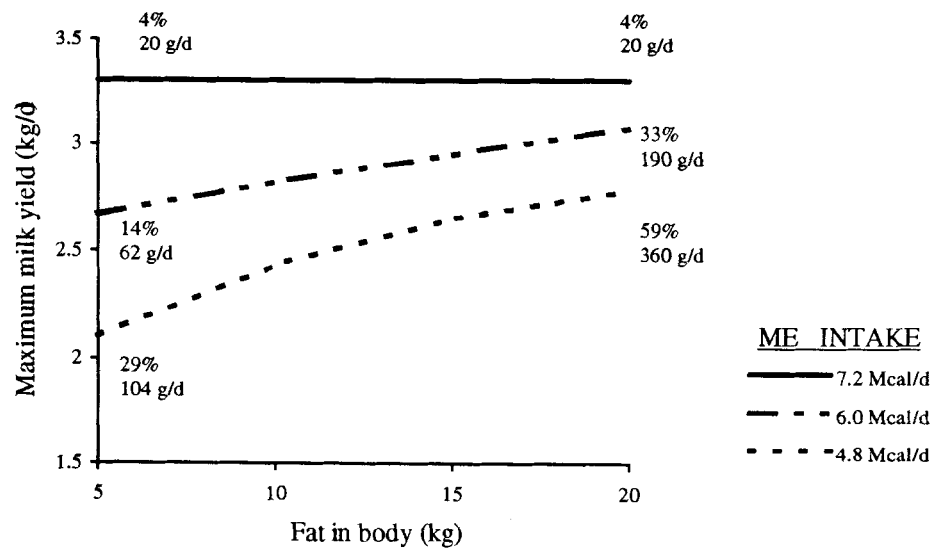


Figure 3 - Effect of body fat reserves and daily intake of metabolizable energy (ME) on maximum milk yield in ewes in the first weeks of lactation. The numbers represent the % of milk obtained from body fat mobilization and body weight losses in grams per day (from Robinson, 1987a, modified).

An important aspect of dairy ewes feeding is to allow the animals to begin the lactation with an appropriate amount of fat reserves (Louca et al., 1974; Robinson, 1987a). Excess body fat in this period, however, may negatively affect intake (Stern et al., 1978). It is critical to provide diets that maximize intake, to avoid excessive negative energy balance and fat mobilization. Figure 3 clearly demonstrates the critical importance of body fat reserves and energy intake in this period. Milk production in ewes consuming high levels of energy is independent of body condition, while milk production of animals consuming low or medium energy rations is strongly affected by it.

Very high intake (almost 7% of body weight) was obtained even in the first weeks of lactation of ewes nursing triplets when pelleted concentrate was fed ad libitum with a fixed amount of hay (Hogue, 1994). This strategy promoted high growth rate of the lambs and even some body weight gain of the mothers (Table 5) but the gain may be costly.

Table 5 - Observed feed intake and body weight gains of triplet-rearing ewes and their lambs (Hogue, 1994).

Feed consumption of the ewes ^a (kg DM/day)			Daily gain (41 days) (grams/day)	Number of animals
Hay ^b	1.3	Ewes	250	14
Pellets ^c	3.1	Lambs ^d	322	42
Total	4.4	3 lambs	966	

^a mean body weight at the beginning of the trial (1-2 weeks postpartum): 64.35 kg ^b limit fed

^c high energy lamb pellets, fed ad libitum ^d lambs had access to pellets in a creep

A fairly easy and practical way to make sure the ewes have enough body fat reserves at the onset of the lactation is to monitor their body condition throughout the pregnancy and to adjust the diet. At lambing, dairy ewes should have a body condition score around 3.5 (Figure 4) (INRA, 1989). Lower values may lead to reduced milk yield caused by insufficient fat reserves, while higher values may cause lower intake and reduced milk yield.

Second part of the lactation

Dairy sheep nutrition in the second part of the lactation (from the 8th-10th weeks until drying) has not been investigated as completely as the early lactation period. It is clear that dairy sheep breeds have not been subjected to the same intense genetic selection that has occurred in dairy cows. This means that the persistency of lactation is often not as good as in cows. In many dairy sheep breeds, after the first months of lactation, the ewes tend to use the nutrients more for body fat deposition than for milk production. This mechanism is even more evident when ewes of meat/wool breeds are used to produce milk. In later lactation dairy sheep (Manchega breed) remarkably increased their milk yield when treated with bovine somatotropin (bST), as shown in table 6 (Fernandez et al., 1995).

Table 6 - Milk yield and composition from ewes administrated sustained-release bST (Fernandez et al., 1995).

	bST- weeks 3 to 8 of lactation			bST weeks 11 to 23 of lactation *		
	0 mg	80 mg/14 d	160 mg/14 d	0 mg	80 mg/14 d	160 mg/14 d
Milk yield, ml/d	997	1198	1337	618	873	947
6% FCM, ml/d	1072	1301	1467	770	1071	1169
Milk fat, %	6.7	6.8	6.9	8.6	8.4	8.4
Milk fat, g/d	66	80	92	50	71	77
Milk protein, %	5.2	5.1	4.9	6.0	5.5	5.2
Milk protein, g/d	51	59	65	36	47	48

* for experimental purposes, from week 18 on the ewes were milked only once per day. This markedly reduced the difference in milk production between the control and the treated animals.

Dairy cows treated with bST behave as genetically superior cows (Peel and Bauman, 1987) and tend to use the nutrients more for milk production than for body fat deposition. It is possible that the high response of bST treated ewes is a sign that there is a lot of “room” for genetic improvement of milk production. Basically this hormone is bringing them to a hormonal status that in the future may be achieved by genetic selection.

The practical experience of Sardinian shepherds tells us that feeding large amounts of grain in the second part of the lactation makes the ewes very fat but does not increase or maintain milk yield. This is probably due to the stimulating effect of the volatile fatty acids produced by grain fermentation (mainly propionate) on body fat deposition, as previously discussed in the section regarding NSC. A better feeding strategy would be based on the maximization of forage intake, the use of by-products with fast-fermented fiber (e.g. soy hulls) and the use of supplements with high levels of protein with low degradability (fish meal, blood meal, roasted soy bean meal). Moreover, the use of protein supplements during the mating season can improve reproductive parameters of lactating ewes (Molle et al., 1995). If grain is fed, slow fermenting starch sources like corn and sorghum grains would be a better choice than the rapidly degradable wheat, barley or oat grains.

FEEDING HOUSED LACTATING EWES

The lactation of dairy ewes can last between 7 and 10 months. This means that for part of the lactation the ewes are fed stored feeds (hay, silage, concentrates).

The quality of the forages fed to lactating ewes is extremely important, especially if hay or silage are a large part of the diet. Even though data for sheep similar to those for cattle (Mertens, 1983) are not available, it is clear that milk yield and forage quality are closely related. High quality forages and small amounts of concentrate supplements allow milk production levels that cannot be obtained with low quality forages, no matter how much concentrate is given.

A major problem of stored forages is how to feed them. Many different feeding strategies are used on commercial dairies. The simplest strategy is to feed loose hay during the entire day and some concentrate supplements at milking. The most complex involves feeding total mixed rations (TMR). Some pros and some cons can be defined for each of the techniques.

Loose hay is often used as the only source of fiber in the diet. Because of the low digestive capacity of sheep, high intake of hay can be achieved only if its quality is high (low fiber content). If hay quality is low (high fiber content), intake will be low and this can lead to low milk yield and a higher probability of acidosis even when moderate levels of concentrate are used. One way to increase the intake of hay is to allow the animals to select. The lower the quality of the hay, the higher should be the amount of hay the ewes are allowed to discard. In table 7 there are some estimates of practical refusals for optimal lactational performance in goats. Even if the numbers do not necessarily apply to the same extent for dairy sheep, it appears that to satisfy the requirements of lactating small ruminants it is necessary either to provide high quality hay or to accept extensive selection and large refusals. It is often more expensive too feed low quality forages with high levels of refusals than to emphasize the production of excellent forages.

Table 7 - Estimates of practical refusals for optimal lactational performance in goats (Van Soest et al., 1994)

Forage	Predicted ^a digestibility (%)	Refusals (%)	Digestibility of ingested forage (%)	Utilization ^b (%)
Alfalfa hay	65	15	69	59
	58	25	66	50
	50	35	60	39
Grass hay	70	20	75	60
	60	35	69	45
	50	50	60	30

^a From composition of the offered forage ^b Digested matter actually ingested as percent of amount offered

In the case of silages, if they are finely chopped the ability of the ewes to select is very limited. With this type of feed, however, intake can be increased by reducing the particle size (Apolant and Chestnutt, 1985), unless other factors limit intake (bad flavors and taste and molds caused by bad fermentations). Finely chopping should not be considered a tool to force sheep to eat poor quality feeds or an excuse to overlook the quality of the forages.

When the forages are given in a total mixed ration, it is not wise to follow the same suggestions given for dairy cows. Sheep are more selective than dairy cows and their intake is more affected by particle size. We do not want to have much selection in a TMR for sheep. If the ration is coarsely chopped, it is likely that the ewes will first eat all the concentrates. This may lead to acidosis even when the average diet does not have too much starch, as sometimes is observed in Italian dairy sheep enterprises (A. Fantini, D.V.M., personal communication). When "cow-like" TMR diets are used for dairy sheep, another problem often observed is low intake and low milk yield. This usually occurs because the particle size that maximizes intake and milk yield in dairy cows is too coarse for lactating ewes. The strategy used by some nutritionists is to allow more grinding of the forages in the mixer wagon. The result in most of the cases is a sharp increase in both intake and milk yield. This observation is supported by some experimental evidence. Brown and Hogue (1985) compared TMR diets with two forage to concentrate ratios

(60:40 and 20:80) in which the forage (alfalfa hay) was ground either through a 32 mm screen or a 8 mm screen. Milk yield increased 25% in the 8 mm diets, without any change in intake. More extreme grinding may be beneficial too. In a trial at Cornell, Dorset and Finn ewes were fed grass hay that was ground through a 12 mm (coarse), 2.4 mm (medium) and 1 mm (fine) screen (Cannas, 1995). The reduction of the particle size increased intake, milk yield and milk protein yield and markedly decreased rumination activity, while milk fat yield was not affected (Table 8). It seems that sheep can produce well even when fed diets that are very finely ground. On farms, it is almost impossible to have diets ground as fine as in that trial. Dairy sheep producers should not be worried about grinding feeds too finely for lactating ewes. Particles that are too coarse are a much more likely problem.

Table 8 - Effect of dietary particle size on feeding behavior and milk production in lactating ewes in the 6th week of lactation (Cannas, 1995)

	DIET			sem
	FINE	MEDIUM	COARSE	
Dry matter intake (g/d)	4005	4132	3767	147
Rumination (min/d)	45 ^a	165 ^a	431 ^b	38
Milk yield (g/d)	2400	2492	1991	192
Milk fat (%)	7.86 ^{ab}	7.03 ^a	9.08 ^b	0.56
Milk fat (g/d)	187.7	185.1	178.6	18.9
Milk protein (%)	4.37	4.13	4.26	0.11
Milk protein (g/d)	105.3 ^a	109.7 ^a	83.8 ^b	8.1

^{abc} Means with different subscript differ (P<0.05)

Diets: 54.9% grass hay, 30.1% cracked barley; 13.0% soybean meal, 2% mineral supplements (CP 16.4%, NDF 41.6%, ADL 3.05%); **Hay ground through:** 1 mm screen (FINE diet); 2.4 mm screen (MEDIUM diet); 12 mm screen (COARSE diet).

FEEDING GRAZING LACTATING EWES

Pasture management and grazing techniques in producing ruminants have been extensively analyzed in many books and reviews and are beyond the scope of this paper. A major problem in feeding grazing lactating ewes is the choice of the amount and of the quality of the supplements. This section will try to give some criteria on supplement management.

Nutritional indicators to choose proper supplements

The main problem we face with grazing animals is that it is very difficult to estimate both their intake and the composition of their diet. For this reason, any decision on quality and quantity of supplements is often the result of a pure guess. A practical and often more effective approach may be based on the utilization of the information available to the dairy sheep breeder to estimate the nutritional status of the ewes and to define the characteristics of the supplements. The indicators that can be used are milk yield and quality, body condition and health status of the animals, and quality and quantity of the pasture.

Milk yield is the most important of these indicators. It is reduced very quickly when pasture quality and availability are reduced and readily goes up if the proper supplement is given. Milk fat is a good index of the fiber composition of the diet. It tends to go up when fiber intake is increased and to go down when a large amount of NSC are supplied. Milk protein is high when there is a proper amount of proteins reaching the intestine, either because there is high production of bacteria in the rumen (large amount of carbohydrate and protein fermented in the rumen) or because large amount of UIP proteins are supplied.

The nutritional status of the ewes can be monitored by body condition scoring. This technique is very useful to check if the ewes are losing too much body fat in the first part of the lactation or if they are overeating and becoming too fat in the second part. The proper body condition score of the ewes in their different physiological stages is given in figure 4 (INRA, 1989). If the flock is large, body condition can be monitored on only some of the ewes (about 20 % of the ewes in medium size flocks and 10-15% in larger ones). Supplements can then be dosed according to the body condition score of the animals.

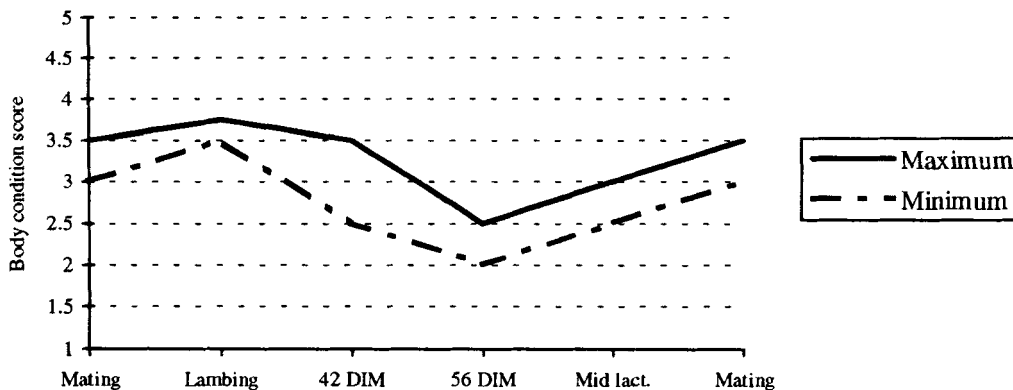


Figure 4 - Target body condition score during the production cycle of dairy ewes (based on INRA, 1989). DIM = days in milk.

The feces are another good indicator of the nutritional status of the ewes. Liquid or loose feces often result from excessive protein in the diet. Ewes grazing on young pastures rich in soluble proteins (first spring growth or regrowth after the harvest) have often this type of feces. The use of readily fermented carbohydrates (molasses, barley, oat) can reduce these problems because bacteria need energy to use a large amount of the fermented proteins (Stephenson et al., 1992). These type of pasture are usually low in fiber. The addition of some hay to the diet may overcome this problem. Excess starch and subsequent acidosis can also produce liquid or loose feces. In this case, however, it is often possible to notice small particles of undigested grains in the feces. Excess NSC in the diets and acidosis are also indicated by the classic typical behavioral signs. Additional fiber in the diets is the proper way to avoid this problem. Pellet-like dry feces are an index of lack of degradable protein in the rumen (low fiber-digesting activity and high fiber content in the feces), low starch or excess of fiber.

In dairy cows urea content in the milk is considered a good indicator of the protein status of the animals (Roseler et al., 1993). In lactating ewes some studies have indicated its usefulness as a predictor of the protein status of the ewes (Egan et Kellaway, 1971, Cannas et al., 1995). Milk urea is highly correlated with the protein content of the diet (Figure 5). It may then possible to use milk urea as an indicator of the protein content of the diet eaten by ewes on pasture. Milk urea is currently tested in Sardinia as a predictor of the nutritional status of the lactating ewes by the local Breeders Association (Associazione Regionale Allevatori). If a sufficiently reliable estimate of the protein content of the diet is known, supplements may be chosen accordingly.

Concentrate feeding

The most common method to supply concentrates to dairy ewes is to give them during milking (twice per day). If the amounts of grain or starchy feeds given each time is large (400-700 g), the ewes will likely have a surge of propionate production in the rumen. This may lead to reduced fermentation of fiber and stimulation of body fat deposition. In the worst cases, acidosis (grain overload) may occur. Even if the amount of grain fed per animal is not excessive, it is likely that some of the more aggressive animals will eat too much grain. These are the animals at the highest risk.

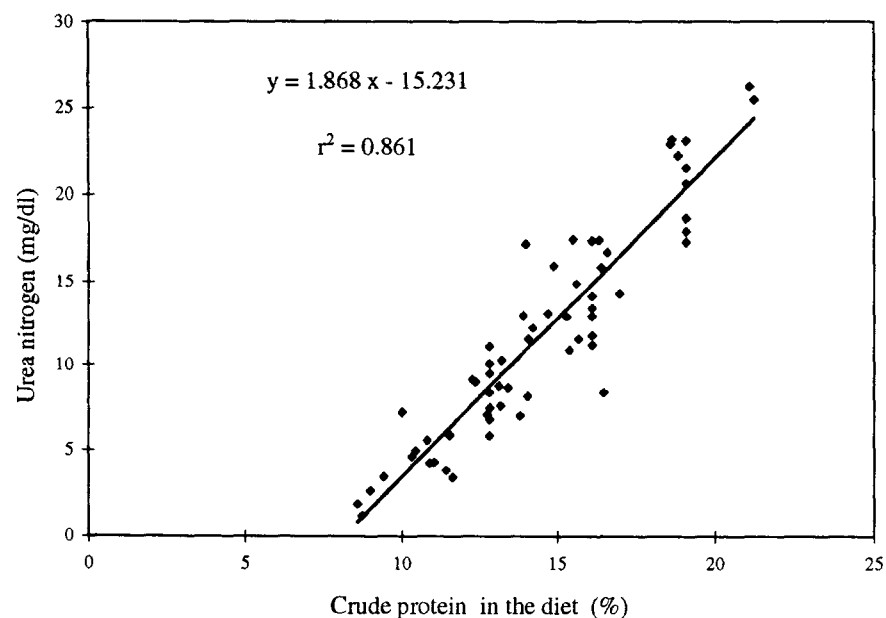


Figure 5 - Relationship between crude protein of the diet and milk or blood urea nitrogen in housed lactating ewes fed diets with several different energy concentrations and sources of proteins (elaborated by the author from data of Cannas et al., 1995, Gonzalez et al., 1982, Gonzalez et al., 1984; Ngongoni et al., 1989). If milk or blood urea nitrogen are used as predictors of CP % in the diet, the following equation should be used : $Y = 0.461 X + 9.033$, where Y= CP in the diet (%) and X= milk or blood urea nitrogen (ml/dl). Blood or milk urea nitrogen = blood or milk urea * 0.4665.

In these cases, if the same daily amount of grain is supplied in several meals, the surges of propionate production are less likely (Ørskov, 1986) and then the risks of low rumen pH, excessive fattening and acidosis are much lower. However, in practical situations supplying the concentrates more frequently than twice per day may be impractical.

In the case of highly fermentable grains like barley, wheat and oat, using whole grains instead of processed ones (cracked, steam-flaked, ground) is definitely beneficial for sheep (Vipond et al., 1985; Ørskov, 1986). Whole grains stimulate rumination and slow down ruminal fermentation. Sheep chew grains more finely than cows and large losses of whole grains in the feces are unlikely. When slowly fermenting starch sources (corn and sorghum grains) are given, some cracking may be beneficial, especially in animals with high intake and passage rate.

The high passage rate of feed in lactating ewes pose limits to the utilization of some by-products with slowly digested fiber and small particle size. Some of them (brewer grains, distillers) may be eaten in large amounts but may be poorly digested (Van Soest et al., 1994).

The utilization of bicarbonate can be beneficial when high grain diets are feed. Rumen pH was increased and maintained above the level inhibitory to fiber digestion when a mix of sodium bicarbonate (64%) and potassium bicarbonate (34%) was added at the rate of 3.5% of the dry matter to the diet of lambs fed large amounts of barley grains, (Mould et al., 1983).

Acidosis and other digestive disorders are frequent in Sardinia (Italy) during the winter, when the ewes are at peak lactation but the pasture is scarce due to the low temperatures. In this period, ewe are usually fed with large quantities of hay and concentrates. Often, however, the intake of hay is low due to its poor quality. In these cases, acidosis is frequently observed even when only 400-600 g/d of concentrates are supplied. With the aim of solving this problem, Rossi et al. (1991), developed a "safe" pelleted feed. This feed is made of a mixture of energy and protein sources plus about 30% finely chopped dehydrated alfalfa or grass. The amount of fiber and its particle size have been calibrated to stimulate high daily intake, sufficient rumination and slower rates of intake than regular pelleted concentrate. Its average energy concentration ranges between 1.55 and 1.70 Mcal of NE_L if no fats are added. This product has been used as the only feed as long as 20 weeks (Rossi et al., 1991) or as pasture supplement without giving any type of digestive or metabolic problem (Cannas et al., 1992; Calamari et al., 1991). When used as a complete feed its intake ranged between 5.5% to 7% of the body weight and always induced much higher milk yield than in the traditional diets. This type of feed is currently produced by three large feed companies with several formulations. In the last two years it has become very popular among Sardinian dairy sheep producers. It has been used mostly in periods when the pasture is scarce or is very young (high in soluble proteins and low in fiber). It has been beneficial in increasing milk production and in reducing many of the diseases related to nutritional stresses (e.g. mastitis and lameness).

CONCLUSIONS

Feeding programs for lactating ewes should consider the peculiar characteristics of sheep. There are substantial differences between sheep and cattle in feeding behavior and digestive capacity. These differences are particularly important when ewes with high levels of production are considered. Since very few studies have been conducted with high-producing ewes, much more research is needed. In particular, more knowledge is needed to define energy and protein requirements of lactating ewes in the second part of lactation and fiber and NSC optimal level throughout the lactation. In order to determine the quality and the quantity of supplements required by grazing lactating ewes, it is important to use the available nutritional indicators and to develop new ones.

REFERENCES

- AFRC (1993) - *Energy and protein requirements of ruminants*. CAB International, Wallingford, UK.
- Apolant, S.M., Chestnutt, D.M.B. (1985) - The effect of mechanical treatment of silage on intake and production of sheep. *Anim. Prod.* **40**:287-296.
- Blaxter, K.L., Wainman, F.W., Davidson, J.L. (1966) - The voluntary intake of food by sheep and cattle in relation to their energy requirements for maintenance. *Anim. Prod.* **8**: 75-83.
- Brown, D.L., Hogue, D.E. (1985) - Effects of roughage level and physical form of diet on Finnsheep lactation. *SID Research Digest, Fall 1985* :11-14.
- Calamari L., Rossi G.C., Cannas A., Cappa V. (1991) - Effect of the addition of fat and of the protein level of a pelleted feed (Unipellet) on metabolic profile of Sarda lactating ewes (in Italian). *Atti IX Congr. Naz. ASPA* : 335-349.
- Cannas, A. (1995) - Effects of the particle size of the diet on feeding behavior and milk production in sheep. M.S. thesis, Cornell Univ., Ithaca, NY.
- Cannas A., Pes, A., Pulina, G. (1995) -Effect of dietary energy and protein concentration on milk urea content in dairy ewes. *J. Dairy Sci.* **78**, suppl. 1: 277
- Cannas A., Rossi G.C., Brandano P., Pulina G. (1992) - Effect of the feeding method of a complete pelleted feed (Unipellet) as supplement of grazing in dairy ewes. *Studi Sassaressi, Ann. Fac. Agr. Univ. Sassari* , **34**:145-149.
- CSIRO (1990) - *Feeding standards for Australian livestock. Ruminants*. CSIRO Publications, Melbourne, Australia.
- De Boever, J.L., Andries, J.I., De Brabander, D.L., Cottyn, B.G., Buysse, F.X. (1990) - Chewing activity of ruminants as a measure of physical structure - A review of factors affecting it. *Anim. Feed Sci. Technol.* **27**: 281-291.
- Egan, A.R. , Kellaway, R.C. (1971) - Evaluation of nitrogen metabolites as indices of nitrogen utilization in sheep given frozen and dry mature herbage. *Br. J. Nutr.* **26**: 335-351.
- Fernandez, N., Rodriguez, M., Peris, C., Barcelo, M., Molina, M.P., Torres, A., Adriaens, F. (1995) - Bovine somatotropin dose titration in lactating dairy ewes. 1. Milk yield and composition. *J. Dairy Sci.* **78**: 1073-1082.
- Gonzalez, J.S., Robinson, J.J., McHattie, I., Fraser, C. (1982) - The effect in ewes of source and level of dietary protein on milk yield, and the relationship between the intestinal supply of non-ammonia nitrogen and the production of milk protein. *Anim. Prod.* **34**: 31-40.
- Gonzalez, J.S., Robinson, J.J., McHattie, I. (1984) - The effect of level of feeding on the response of lactating ewes to dietary supplements of fish meal. *Anim. Prod.* **40**: 39-45.
- Greenhalgh, J.F.D., Reid, G.W. (1973) - The effects of pelleting various diets on intake and digestibility in sheep and cattle. *Anim. Prod.* **16**: 223-233.
- Hogue, D.E. (1994) - Further observations on feeding highly productive sheep. *Proc. Cornell Nutrition Conf., Ithaca, NY* :140-142.
- INRA (1989) - *Ruminant nutrition: recommended allowances and feed tables*. J. Libbey Eurotext, Paris.
- Kawas, J.R., Lopes, J., Danelon, D.L., Lu, C.D. (1991) - Influence of forage-to-concentrate ratios on intake, digestibility, chewing and milk production of dairy goats. *Small Rumin. Res.* **4**: 11-18.
- Louca, A., Mavrogenis, A., Lawlor, M.J. (1974) - Effects of plane of nutrition in late pregnancy on lamb birth weight and milk yield in early lactation of Chios and Awassi sheep. *Anim. Prod.* **17**: 341-349.
- Mertens, D.R. (1983) - Using neutral detergent fiber to formulate dairy rations and estimate of energy content of forages. *Proc. Cornell Nutrition. Conf., Ithaca, NY* :60-68.
- Mertens, D.R., Ely, L.O. (1982) - Relationship of rate and extent of digestion to forage utilization: a dynamic model evaluation. *J. Anim. Sci.* **54**:895-905.
- Molle, G., Branca, A., Ligios, S., Sitzia, M., Casu, S., Landau, S. , Zoref, Z. (1995) - Effect of grazing background and flushing supplementation on reproductive performance in Sarda ewes. *Small Rumin. Res.*, **17**:245-254.
- Mould, F.L., Ørskov, E.R., Gauld, S.A. (1983) - Associative effects of mixed feeds. II. The effect of dietary addition of bicarbonate salts on the voluntary intake and digestibility of diets containing various proportions of hay and barley. *Anim. Feed Sci. Technol.* **10**: 31-47.

- Ngongoni, N.T., Robinson, J.J., Aitken, R.P., Fraser, C.** (1989) - Efficiency of utilization during pregnancy and lactation in the ewe of the protein reaching the abomasum and truly digested in the small intestine. *Anim. Prod.* **49**:249-265.
- NRC** (1985) - *Nutrient requirements of sheep*. 6th Ed., National Academy Press, Washington, D.C.
- Ørskov, E.R.** (1986) - Starch digestion and utilization in ruminants. *J. Anim. Sci.* **63**:1624-1633.
- Ortigue, I., Doreau, M.** (1995) - Responses of the splanchnic tissues of ruminants to changes in intake: absorption of digestion end products, tissue mass, metabolic activity and implications to whole animal energy metabolism. *Ann. Zootech.* **44**: 321-346.
- Peel, C.J., Bauman, D.E.** (1987) - Somatotropin and lactation. *J. Dairy Sci.* **70**: 474-486.
- Pulina, G., Cannas, A., Rattu, S.P.G., Rossi, G.** (1995) - Effect of fibre and protein content of a complete pelleted feed on lactating dairy ewes. *Agr. Med.* **125**: 115-120.
- Pulina, G., Rossi G., Cannas A., Papoff G., Campus R.** (1990) - Effect of the crude protein content of the diet on milk yield and quality of Sarda ewes, (in Italian). *Agricoltura Ricerca* **105**: 65-70.
- Pulina, G., Serra, A., Cannas, A., Rossi, G.** (1989) - Determination and estimation of the energy value of Sarda ewes milk (in Italian). *Atti SISVET* **43**:1867-1870.
- Robinson, J.J.** (1987a) - Energy and protein requirements of the ewe. In: *Recent advances in animal nutrition - 1987* : 187-204. Edited by Heresign, W. and Cole, D.J.A., Butterworths, London.
- Robinson, J.J.** (1987b)- Nutrition of housed sheep. In: *New techniques in sheep production*. 175-188. Edited by Marai, I.F. and Owen, J.B., Butterworths, London.
- Roseler, D.K., Ferguson, J.D., Sniffen, C.J., Herrema, J.** (1993) - Dietary protein degradability effects on plasma and milk urea nitrogen and milk nonprotein nitrogen in Holstein cows. *J. Dairy Sci.* **76**: 525-534.
- Rossi G., Serra A., Pulina G., Cannas A., Brandano P.** (1991) - The utilization of a complete pelleted feed (Unipellet) in feeding dairy ewes. I. Effect of the addition of fat and of the protein level on milk yield and quality of Sarda ewes (in Italian). *Zootecnica e Nutrizione Animale* **17**: 23-34.
- Santini, F.J., Lu, C.D., Potchoiba, M.J., Coleman, S.W.** (1991) - Effects of acid detergent fiber intake on early postpartum milk production and chewing activities in dairy goats fed alfalfa hay. *Small Rumin. Res.* **6**: 63-71.
- Stephenson, R.G.A., Huff, J.L., Krebs, G., Howitt, C.J.** (1992) - Effect of molasses, sodium bentonite and zeolite on urea toxicity. *Aust. J. Agric. Res.* **43**: 301-314.
- Stern, D., Adler, J.H., Tagari, H., Eyal, E.** (1978) - Responses of dairy ewes before and after parturition to different nutritional regimes during pregnancy. II. Energy intake, body-weight changes during lactation and milk production. *Ann. Zootech.* **27**: 335-346.
- Uden, P., Rounsaville, T.R., Wiggins, G.R., Van Soest, P.J.** (1982) - The measurement of the liquid and solid digesta retention in ruminants, equines and rabbits given timothy (*Phleum pratense*) hay. *Br. J. Nutr.* **48**: 329-339.
- Uden, P., Van Soest, P.J.** (1982) - Comparative digestion of timothy (*Phleum pratense*) fibre by ruminants, equines and rabbits. *Br. J. Nutr.* **47**: 267
- Van Soest, P.J.** (1994) - *Nutritional ecology of the ruminant*, 2nd Ed., Cornell Univ. Press, Ithaca, NY.
- Van Soest, P.J., McCammon-Feldman, B., Cannas, A.** (1994) The feeding and nutrition of small ruminants: application of the Cornell discount system to the feeding of dairy goats and sheep. 95-104.
- Vipond, J.E., Hunter, E.A., King, M.E.** (1985) - The utilization of whole and rolled cereals by ewes. *Anim. Prod.* **40**: 297-301.

IMPRESSIONS OF DAIRY SHEEP PRODUCTION IN THE U.K. AND FRANCE

David L. Thomas and Yves M. Berger

University of Wisconsin-Madison
Department of Meat and Animal Science
Spooner Agricultural Research Station

We were fortunate to obtain a grant from the Babcock Institute for International Dairy Research and Development of the University of Wisconsin-Madison to travel in the U.K. and France from June 18 to July 2, 1995 to view their dairy sheep industries. The specific goals of our visits were:

1. Visit dairy sheep producers to learn of technology which could be applied to Wisconsin dairy sheep production.
2. Locate sources of superior dairy sheep genetics for possible purchase and importation to Wisconsin.
3. Study genetic improvement programs for sheep in place in both countries for their potential for implementation in Wisconsin.

Our trip included visits to nine commercial dairy sheep farms (four in the U.K. and five in France), a dairy sheep research farm in France, four sheep A.I. centers (one in U.K. and three in France), a meat sheep research farm in France, the offices of both the Meat and Livestock Commission and the National Sheep Association in the U.K., the Royal Highlands Agricultural Show in Edinburgh, Scotland, and the National Sheep Institute at Rambouillet, France. We were assisted greatly with arrangements by Olivia Mills, Secretary of the British Dairy Sheep Association, Henry Lewis of the U.K. Meat and Livestock Commission and Francis Barillet of the French National Agricultural Research Institute's (INRA) station near Toulouse. We were joined in France by Kristin Tondra, a veterinary medicine student from the University of Minnesota, who served as a very valuable French interpreter for me (Dave Thomas). This allowed Yves the ability to speak with our hosts in his native French without having to break the conversation to interpret for me.

One week in each country was not enough time to learn all there is to know about their dairy sheep industries, and some of the impressions we came away with may not be true of the real situation. However, we had a very intense visit with a packed schedule every day, and we feel that we gained a tremendous understanding of dairy sheep production in these two countries.

The U.K. and France were chosen as the countries for our visit for several reasons. Each of us were familiar with both countries - I had traveled in both countries before, and Yves had worked and traveled previously in the U.K. and, of course, was very familiar with his native France. With Yves' French language skills, communications would not be a problem. We had good personal and professional contacts in both countries that were willing to assist in the planning of our visit. Sheep dairying is a relatively recent farming enterprise in the modern U.K., and the problems U.K. producers dealt with were apt to be similar to the problems facing U.S. dairy sheep producers (e.g. availability of improved genetics, dairy sheep management, milking technology, marketing). France is the largest producer of sheep's milk for commercial processing, and their dairy sheep industry is highly organized and utilizes the latest in technology. The French dairy sheep industry would be an example of where the U.S. industry may be in the future.

General Description

Agricultural production is heavily subsidized in Europe by payments to farmers from the European Community (EC) and from individual countries following guidelines developed by the EC. In the U.K., the annual subsidy payment on a ewe was about \$28.00 but could rise to as much as \$50.00 for ewes run on rough hill country. In France, the annual ewe subsidy was \$30.00 to \$40.00. For most meat sheep producers in both countries, this subsidy means the difference between profit and loss. However, for dairy sheep producers, it is less important because the net income per ewe is higher for dairy ewes compared to meat ewes. In France, the ewe subsidy accounts for less than 10% of gross income of dairy sheep producers. There is general recognition that the EC ewe subsidies (along with other agricultural subsidies) will be phased out in the future. This prospect has increased the interest in dairy sheep production in both countries among current meat sheep producers. Cow milk production in EC countries is now controlled by a quota system, but ewe milk production is not under a quota. Therefore, some dairy cattle producers are looking seriously at dairy sheep production.

There are approximately 100 dairy sheep producers in the U.K. milking 20,000 to 30,000 ewes. The flocks are spread throughout the country. We drove from south of London to southern Scotland to visit four dairy flocks. Producers often do not have neighbors involved in sheep dairying that they can turn to for help and guidance. There is little research conducted on dairy sheep in the U.K. In these respects, the U.K. industry is very similar to ours. The British Dairy Sheep Association does take an active role in bringing results of dairy sheep research from throughout the world to their members through their newsletter, and the association has recently embarked on an embryo transfer program to make superior East Friesians available to their industry. Pure East Friesians and East Friesian crosses were the most common dairy animals.

The French industry is much more localized, organized and technically supported than that in the U.K. The industry is located in three main regions: south-central France around Roquefort, the Pyrenees Mountain region near the border with Spain and the island of Corsica. Within the three regions, there are 745,000 ewes that are milk-recorded (600,000 of these are in the Roquefort area). About 500,000 of these ewes are artificially inseminated each year with semen from rams selected for high breeding values for milk production and maintained in one of four A.I. centers. Flock size in Roquefort varies from approximately 400 to 1,000 ewes. Milk production, selection of A.I. rams, milk marketing and processing, and cheese merchandising are highly controlled by producer organizations with major assistance from scientists and technical support from the government. The Lacaune is the most common dairy breed in the Roquefort area.

Milk vs. Lambs

In both countries, milk is sold to commercial processors for \$.55 to \$.60 per pound. Lactation yields we encountered varied from approximately 350 to 750 pounds for an estimated variation in milk income per ewe across flocks of approximately \$200 to \$450. U.K. and French dairy sheep farmers receive \$85 to \$100 per head for an 85-pound market lamb, so lamb production is an important source of income. Since both the French and U.K. markets discriminate against the poorer conformation of dairy breed lambs, producers try to lessen this effect by breeding poorer milk-producing ewes to meat-breed rams (generally Rogue de l'Ouest, Charollais or Meat Lacaune in France and Suffolk, Texel or Charollais in the U.K.) One U.K. producer we visited was maintaining a Texel-East Friesian crossbred milking flock to maintain high value for all lambs. Of course, lamb income is even more important to U.S. producers than it is to these European producers given the

smaller amount of milk income received from U.S. ewes, but if our industry evolves similar to those of the U.K. and France, we will need to continue to be concerned about the value of the lamb produced from our dairy operations.

Milking Systems and Equipment

Virtually all milking in both countries is by machine in parlors. Hand milking is done in the Pyrenees Mountain region in the mountains in the summer after the ewes are moved from the low-land farms. Of the farms we visited, only one in the U.K. was milking into buckets; all others were using pipelines. All farms in France were milking from a pit with 12 to 24 ewes on each side. Of the four farms in the U.K., two were milking from a pit and two were milking on a platform. One of the producers using a platform would prefer a pit. The two “pit” units observed in the U.K. were only milking ewes on one side but could eventually accommodate ewes on both sides as the flock expanded. Both of these units, however, had the pipeline located on the side of the pit (low line) versus above the pit (high line) so milking ewes on the opposite side was going to result in a major cost for another set of milking units or conversion to a high line. Most farms visited in France had a high line. All of the farms visited in the U.K. were using a “cascading yoke” type of stanchion, and all farms visited in France were using the “indexing” stanchion system where ewes are free to take any stanchion upon entry, and the entire stanchion system is moved back towards the pit once all ewes are stanchioned. In both countries, we saw all the major brands of milking equipment in use - sometimes several brands were mixed on the same farm. All producers seemed pleased with their particular equipment. A double-12 system in France cost approximately \$30,000, and a double-24 system was about twice the cost.

It appears that all major manufactures of sheep dairy equipment represented in Europe produce quality equipment. For ease and cleanliness in milk handling, serious dairy sheep producers are using pipeline milking systems. Pit systems are preferred. Our observations would tend to recommend the indexing over the cascading yoke for stanchioning ewes due to faster movement of ewes in and out of the parlor, and the high line over the low line in order to save cost on number of milking units required in a pit system.

Milking Procedure

The milking time per ewe varied between the countries. Of the three flocks we saw milked in the U.K., each could stanchion 12 ewes at a time and it took one person approximately 18 minutes between batches (1.5 minutes per ewe). These flocks were milking between 180 and 240 ewes, therefore each milking would take 4.5 to 6.0 hours not including set-up and clean-up time. Due to the time required to milk, milking was done only once per day. Producers estimated that milk production only decreased by approximately 20% when moving from twice-per-day to once-per-day milking, probably because of the large udder capacity of the East Friesian. In France, with 24 ewes on each side and two people milking in a pit, a batch of 24 ewes was milked every 5 minutes (12 to 13 seconds per ewe or 300 ewes per hour). Ewes were milked twice per day in France.

The main reason for the differences in milking time were different pre- and post-milking treatments of the udder between countries. On the farms we visited in the U.K., udders were washed very thoroughly and dried prior to milking and sprayed with a teat dip after milking. In France, there was no cleaning of udders prior to milking and no post-milking treatment. French farmers indicated no milk sanitation problems with this lack of udder treatment, and their official reports of somatic cell and bacterial counts that we viewed verified this. A study needs to be conducted under U.S. conditions comparing these two extremes of udder treatments for their effects on milk quality.

Several other things may have contributed to longer milking times in the U.K. The shape of the East Friesians' udders in the U.K. were much more variable than those of the Lacaune ewes in France. The East Friesian flocks tended to have more ewes with large pendulous udders and/or extremely large teats. These types of udders may have a tendency to become dirtier, and they also required extra time in milking (e.g. they required the fitting of a "sagi" hook to support the udder, the teat cups fell off, etc.). Several of the East Friesian ewes had a second milk let down, and the milker would go back and milk such ewes a second time before releasing the batch of ewes. The East Friesian ewes were producing approximately twice as much milk per milking as the Lacaune ewes which will account for some of the difference in milking time. Facilities for moving sheep into and out of the parlor were better developed and more efficient in France than in the U.K.

A major factor determining the profitability of a dairy sheep operation is the number of ewes that can be milked per hour or the parlor time required to produce a pound of milk. Research evaluating the effects of facilities, breed of sheep and udder treatments on milking time is an urgent need of our industry.

Start, End, and Length of Milking Period

As we visited farms, it became apparent that quoted lactation yields can be very misleading because there is tremendous variation between countries and even from flock to flock within countries on stage of lactation when milking begins and length of the milking period.

The general system is somewhat similar among flocks in France. Lacaune ewes appear to be fairly aseasonal, and ewes are artificially inseminated the last two weeks of June and lamb in December. Ewes nurse their lambs for 30 days, and start to be milked in January. Cheese plants in the Roquefort area start operation in mid-December to catch milk from some early lambing ewes and continue to purchase and process milk through the middle of July. In the Pyrenees Mountain region, the cheese plants close in June when the sheep are moved to mountain pastures. Reasons given for cheese plants closing at this time are: 1) tradition, 2) less pasture available in summer, 3) poorer cheese maturation in the summer, and 4) to give shepherds a vacation. When cheese plants close, ewes are still producing milk. A few plants will make some yogurt, and some traditional farmstead cheeses are made from this milk. However, most flocks try to dry ewes off as soon as possible after the plants close because there is little overall demand for the milk at this time and prices are low. Producers will switch from twice-a-day to once-a-day milking, then to once-a-day milking every other day, then to three milkings a week, etc. until the ewes dry off. Most ewes will continue to produce reasonable levels of milk for one month after the cheese plants close, and if managed for milk production can continue for an additional one month into September. Official milk production is recorded from the time the lambs are weaned at 30 days of age until the cheese factory closes and averages 165 days for recorded flocks. During this 165 day period, Lacaune ewes average about 560 pounds of milk. This is their "commercial lactation yield" and not their "biological yield". Comparisons of the lactation yield of Lacaune sheep in France with other breeds in other countries need to consider these differences in management.

Systems vary more in the U.K. In most flocks the East Friesian and East Friesian-cross ewes lamb in the spring. One farm we visited weans lambs at 48 hours of age and raises them on milk replacer. They wean the lambs onto dry diets at approximately 28 days of age. Their total cost in raising each lamb to market weight is approximately \$50.00. Ewes are milked until they dry off after 150 to 210 days. Lactation yields average about 650 pounds. Another flock visited in the U.K. doesn't wean the lambs until the lambs are eight to nine weeks old. Ewes are then milked for approximately 5 months and produce approximately 340 pounds of milk. Another flock weans lambs

at 6 to 8 weeks of age after which the ewes produce about 440 pounds of milk over a 5 month milking period.

These three flocks produce from 340 to 650 pounds of milk per ewe - all with East Friesians, but with considerably different management systems.

Milk Marketing

In the Roquefort area of France, most producers sell their milk to a cheese plant. Each producer has a quota of milk for which he will receive the Roquefort price of \$.66 per pound, the next amount of milk over the quota is paid for at the Feta price of \$.43 per pound and production over the Feta quota is paid for at the milk powder price of \$.19 per pound. Producers averaged approximately \$.55 per pound for their milk. In the Pyrenees Mountain region there has been a dramatic increase in milk production, and the top cheese price has dropped from \$.58 to \$.54 per pound in recent years. Some producers in the Pyrenees Mountain region process all their milk into cheese in small, but very modern, plants on their farms. The cheeses are then cured and marketed by a cooperative under one label. A cheese processing technician, hired by the cooperative, visits each farm four or five times each year to consult on cheese making in order to standardize the product across farms. As indicated earlier, in all regions, some traditional cheeses are made and marketed by the farmers after the commercial cheese plants close.

In the U.K., I did not hear of any large commercial cheese plants processing sheep's milk. Of the four producers we visited, three were processing their own milk and selling the product. The other producer was selling to a small cheesemaker and receiving \$.55 per pound for the milk.

One of the producers was processing all of his milk into cheese. In 1994 he made about 2.5 tons of cheese, and in 1995 he expects to make about 3.0 tons. The cheese is sold through a wholesaler for approximately \$6.00 per pound. This producer showed us his accounting records which showed a net profit from 140 dairy ewes of \$18,200 in 1994. In addition to his dairy ewes, he has approximately 250 ewes for lamb production and 90 beef cows.

Another U.K. producer makes ice cream and yogurt and packages fluid milk on the farm. There appears to be a good demand for fluid sheep's milk among persons allergic to cow's milk. The milk is packaged in plastic pint pouches, frozen and sold frozen. This particular farm sells approximately 1,000 pints of frozen milk per week for \$.92 per pint to a wholesaler or \$1.10 per pint direct to consumers. Milk in excess of their processing capacity is sold to a small cheese plant for \$.55 per pound. This farm has been milking ewes for 8 years. They currently milk 240 ewes but are moving to 400 ewes. A third producer makes cheese, yogurt and ice cream and packages fluid milk. This farm is expanding its processing, storage and sales area.

If the U.K. flocks we visited are indicative of the industry in that country, the dairy sheep industry feels it is important to add value to sheep's milk on the farm in order to make the best returns.

Milk Recording and Genetic Improvement

Of the four flocks we visited in the U.K., only one was recording milk production of individual ewes. As far as we could determine, there was no program in place for the progeny testing of promising young ram lambs. As mentioned earlier, the British Dairy Sheep Association had organized an embryo transfer program where top-producing ewes from a private U.K. flock with milk recording had been superovulated, inseminated with semen from some top foreign East Friesian rams and served as embryo donors. The resulting lambs were on the ground and would be sold to dairy sheep producers.

The French have a highly organized and effective program of genetic improvement which is a model of national genetic improvement among all livestock species. Nine milk recording centers provide technicians to record monthly milk production on over 700,000 ewes. Ram lambs from high-producing ewes are reared at one of four A.I. centers. Half of these ram lambs are culled on the basis of growth, structural soundness and breed type. Fresh semen collected from the remaining ram lambs is used on enough ewes to produce at least 30 daughters over several flocks. The ram lambs wait in the A.I. center until their daughters' first lactation records are obtained. Rams with daughters with poorer production are culled and the proven rams are retained. Proven rams remain in the A.I. center until they are surpassed in breeding value by younger rams. Proven rams average about 4.5 years of age with the oldest about 8 years of age. In each flock, half of the ewes are mated to young rams for progeny testing and the other half are mated to proven rams. During the A.I. season in the Roquefort area, each of the two A.I. centers will collect semen from 200 rams per day and perform 4,000 to 5,000 inseminations per day. During the year, each center will perform approximately 200,000 inseminations with fresh semen on synchronized ewes with a conception rate of 67%. This program results in an annual genetic improvement in milk production of approximately 13 pounds of milk per ewe.

Availability of Improved Genetics

Currently, it is not possible to bring semen, embryos or live sheep to the U.S. from Europe. USDA has proposed to change these rules to allow such genetic material to be imported if it goes into flocks enrolled in the Voluntary Scrapie Flock Certification Program. Only semen and embryos would be allowed to come from countries that have the cattle disease, BSE. Hopefully, these rule changes will be made soon.

Dairy sheep breeding stock in the U.K. is available from private breeders through private genetic companies. If allowed by USDA, East Friesian genetics from the U.K. and other countries in Europe and perhaps other dairy breeds from Europe will be available from these companies.

Lacaune breeding stock in the French genetic improvement program is under the control of two producer organizations. These organizations have dealt with breeding stock exports on a limited basis to a few countries in Europe but have not decided on a policy for export of breeding stock to other countries including North America. While semen and embryos from a few Lacaune sheep from the periphery of this national genetic improvement program may become available to North America in the near future, it may be of questionable genetic value. The ideal situation would be to obtain semen from the elite, proven rams in the A.I. centers where you are assured of top quality genetics that is going to improve each year. Availability of such genetic material in the near future is not known.

Optimism

The dairy sheep producers we visited were very optimistic about the financial future of dairy sheep production. In the U.K., this optimism was based on the production of a high quality and high value product to fill a specialty or gourmet market. In France it was based on a large commercial industry with a track record of profitability. Every farm we visited in France had a son "chomping at the bit" to take over the family farm, because a dairy sheep farmer made a good living. It was uplifting to see young talented people so excited about a career in agriculture. This has not been the case for several years in American agriculture. Perhaps sheep dairying can change that.

PRACTICAL ASPECTS OF SIRE REFERENCING

Hans Porksen

Gallows Hill Farm, Cambo
Morpeth, Northumberland, England

The scheme consists of over 50 Suffolk breeders who mate 30 of their stock ewes to 2 or 3 genetically superior 'Reference Sires'.

The main aim is to identify superior breeding stock with higher growth rates, more muscle and retain fat level at current levels.

Figure 1.
8 Week and 20 Week (Scan) Weight Estimated Breeding Values (EBV) for the Suffolk Sire Reference Scheme.

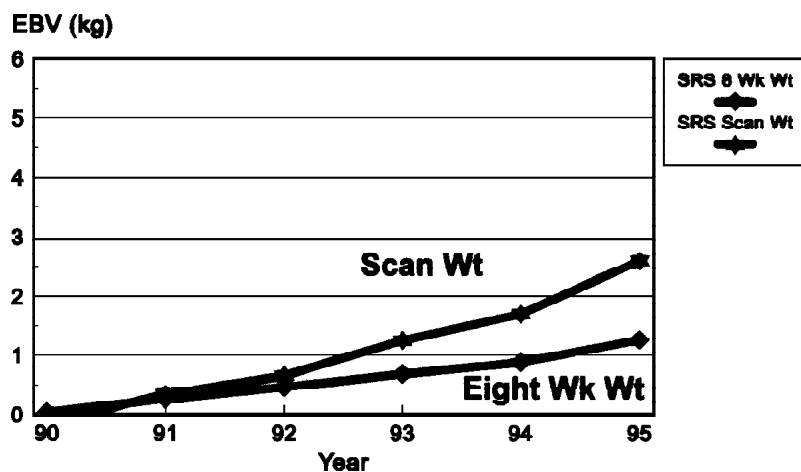


Figure 2.
Muscle and Fat Estimated Breeding Values (EBV) for the Suffolk Sire Reference Scheme.

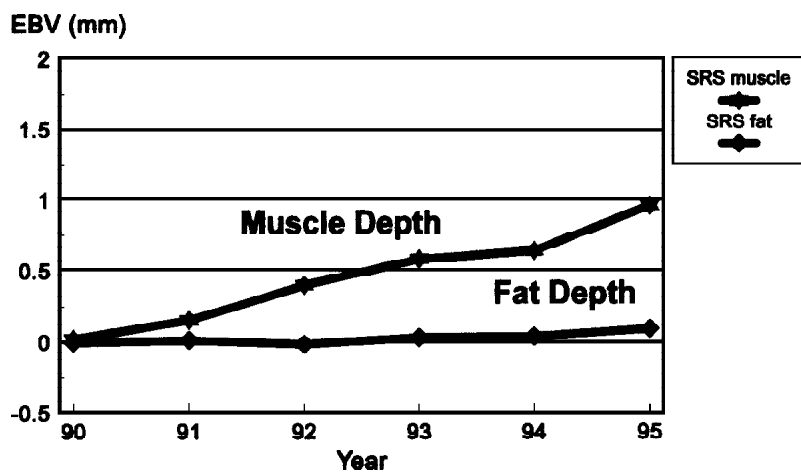
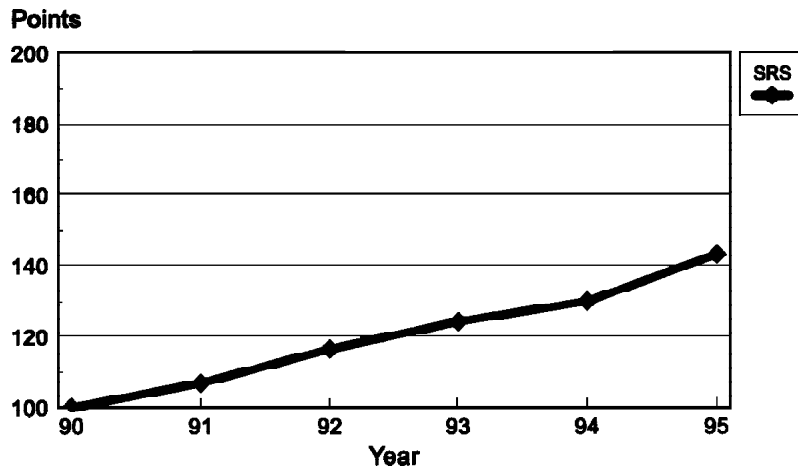


Figure 3.
Index for the Suffolk Sire Reference Scheme.



Why the scheme is successful

1. Breeders make all the decisions after taking advice from the experts.
2. Rules and regulations are kept to a minimum.
3. No element of compulsion regarding which ram is mated to what ewe - the breeder decides.
4. A good selection of genetically superior reference sires are now available.
5. The scheme secretary and members are very involved in promoting the scheme.
6. Artificial Insemination (A.I.) results are improving.
7. Commercial producers are looking for high index sires and are prepared to pay a premium.

How my flock (T79) performs

Figure 4.
Comparison of Flock T79 with the Overall Suffolk Sire Reference Scheme for 8 Week and 20 Week (Scan) Weight Estimated Breeding Values (EBV).

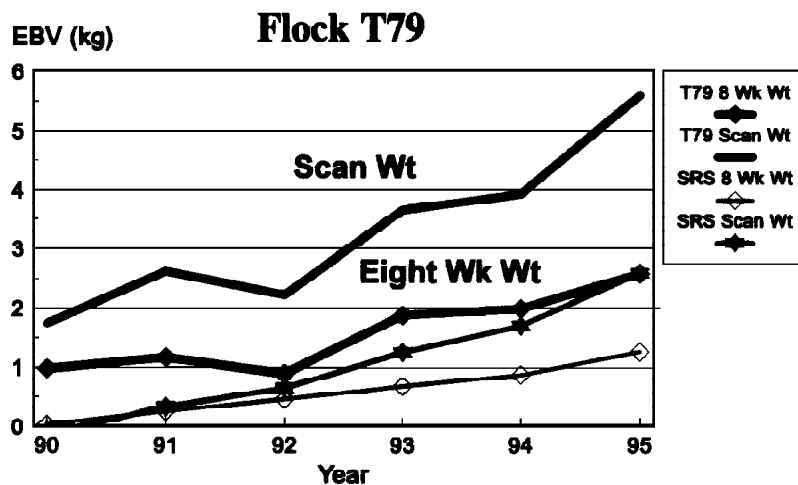


Figure 5.
Comparison of Flock T79 with the Overall Suffolk Sire Reference Scheme for Muscle and Fat Estimated Breeding Values (EBV).

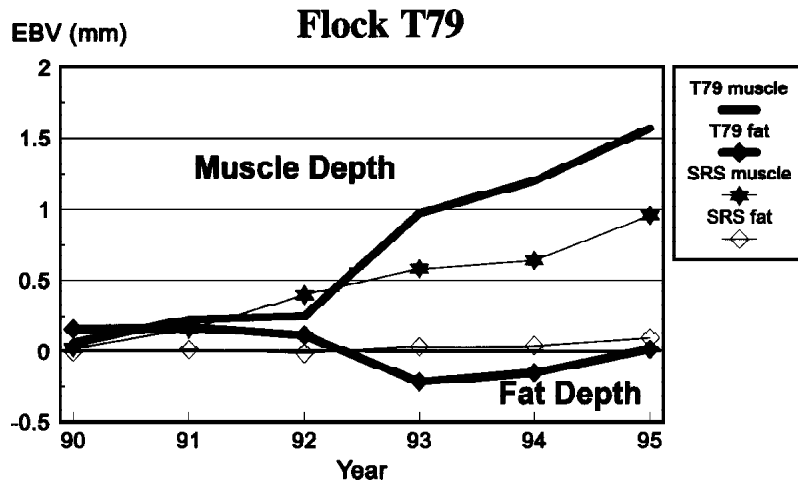


Figure 6.
Comparison of Flock T79 with the Overall Suffolk Sire Reference Scheme for Index.

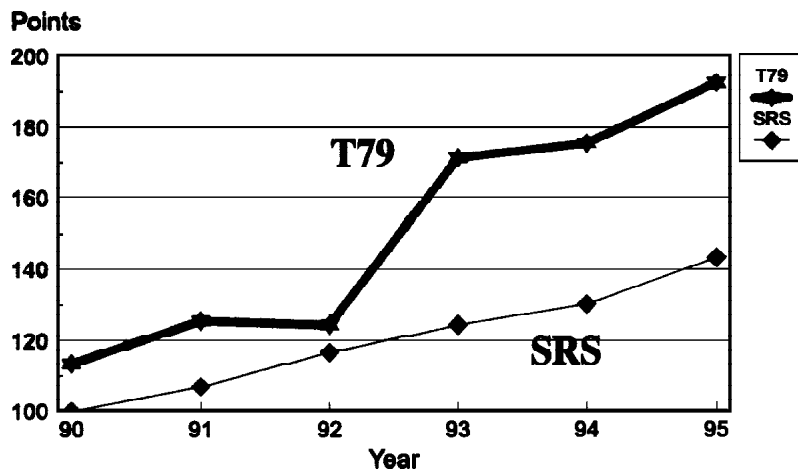


Table 1. T79 Flock Figures 1995.

FLOCK T79	8 week (kg)	20 week (kg)	Muscle (mm)	Fat (mm)	Index
Average for 99 lambs in 1995 crop	2.57	5.40	1.45	-0.01	189

This means in practice that our lambs are on average 2.57 kg heavier at 8 weeks and 5.40 kg heavier at 20 weeks, they have 1.45 mm more muscle and slightly less fat compared to the average of all 4019 lambs in the Suffolk Sire Reference Scheme for the base year 1990 when the Index was set at 100. The current scheme average is 142.

A.I. results -1995/6 season

Of 84 ewes inseminated 75 held to A.I. Both frozen and fresh semen was used.

Average conception	89%
Fresh semen	93.5%
Frozen semen	86%

Reasons for good results

- 'Edinburgh Genetics' instructions are followed exactly.
- Rams used fresh have a selenium injection 10 weeks before mating and are closely inspected and carefully managed.
- Ewes have no contact at all with rams until 5 days before sponge insertion when each ewe is exposed to the ram individually. The effect of this is that all ewes have a silent oestrus the following day, and their ovaries are starting to work before being put 'on hold' by the sponges.

I have no scientifically researched evidence that this will increase conception but believe it to be so. It is a logical follow up from the results of our commercial ewes where last year all but 2 out of 486 ewes lambed within 20 days without the use of sponges and only using this 'ram effect' to achieve synchronization.

- Ewes that don't suit the system are culled.

Selection of Breeding Stock

Sires

Table 2. Sires Used in Flock T79.

RAMS	8 week (kg)	20 week (kg)	Muscle (mm)	Fat (mm)	Index
Savernake Harvest Star	6.33	12.42	4.94	0.42	319
Robinson's Juan Fernandez	3.74	10.10	2.88	-0.08	273
Fordafourie Supersire 94	4.21	8.22	2.89	0.21	241
Hallhill Supersire	4.08	9.31	1.14	0.65	195

In the future only R.R. resistant rams will be used.

Females

All replacements for the flock are above the average flock index.

All stock is inspected carefully to be sound in every way and good examples of the Suffolk breed.

Sheep with obvious faults are slaughtered at 12-14 weeks of age.

Benefits of Being a Member

- Performance level of the flock is improving - both physical and financial.
- Progress is very rapid (it appears slow at the start).
- The future for sound genetically superior stock looks good.

SHEEP SIRE REFERENCING SCHEMES - NEW OPPORTUNITIES FOR PEDIGREE BREEDERS AND LAMB PRODUCERS^a

G. Simm and N.R. Wray
The Scottish Agricultural College
Edinburgh, Scotland

Summary

Sire referencing schemes are cooperative breeding schemes which, through the use of artificial insemination, allow comparisons of sheep across cooperating pedigree flocks. Sire referencing schemes have been established in the Suffolk, Charollais and Texel breeds and are likely to be established in other breeds soon. This note explains how these schemes work and what advantages they offer both pedigree breeders and crossbred lamb producers in selecting rams.

Current Performance Recording Schemes

The aim of any performance recording scheme for pedigree sheep is to assist breeders in identifying genetically superior animals for pure breeding, and to assist customers in selecting rams for crossing. Such schemes are needed because:

- i. The performance of all animals is a function both of their genetic make up (termed 'breeding value') and a host of non-genetic factors such as feed quality and quantity, exposure to disease, physical climate, management and husbandry skills of the owner, etc. (loosely termed 'management' or 'environmental effects'). Recording schemes attempt to disentangle these two types of factors and attempt to identify those animals which are truly genetically superior.
- ii. Selection 'by eye' can be misleading. Large differences in characteristics such as liveweight obviously can be detected by eye, but distinguishing between animals of more similar weight is very difficult. Simple objective measurement of performance takes the guesswork out of selection and extends the range of characteristics which can be improved by selection (for example, fat and muscle depths are difficult to assess by eye or hand, but can be estimated fairly simply by ultrasonic scanning).

In Britain, most pedigree sheep performance recording takes place under the auspices of the Meat and Livestock Commission (MLC). The MLC's Sheepbreeder recording scheme caters for breeds where the objective is to improve either (i) lamb growth and carcass composition, (ii) ewe mature size, (iii) litter size, (iv) maternal ability, or various combinations of these. Recorded flocks are most numerous amongst the terminal sire breeds. In these breeds, recording was initially based on adjusted 8 and 21 week liveweights. However, recently, many flocks in these breeds have started to use ultrasonic scanning to provide estimates of fat and muscle depths at around 20 weeks of age - in 1990 over 350 MLC recorded flocks used ultrasonic scanning. Adjusted measurements of liveweight, fat depth and muscle depth are provided for scanned animals, together with an overall 'lean growth index score' with

^aPublished in 1991 as Technical Note T264 by The Scottish Agricultural College. Reprinted in these proceedings with permission of the authors. Minor modifications have been made to the original publication with permission of the authors.

scores ranging from around 20 points to 220 points within each flock. This index, which was developed at The Scottish Agricultural College (SAC), Edinburgh, aims to identify those animals with relatively high liveweights and muscle depths but relatively low fat depths.

The basis of all variants of the MLC Sheepbreeder Scheme is that records of performance are adjusted for known non-genetic influences, such as birth and rearing rank (single, twin, etc.) and dam age. In addition to presenting measurements adjusted for these effects, rams are rated in bands according to their superiority in the recorded trait within their own flock. Rams in the top 10 per cent in adjusted performance in a given flock are rated as A, those in the next 15 per cent as B and animals of average, or below average, performance as C and D, respectively. This enables breeders and lamb producers to readily identify outstanding animals in all recorded flocks.

Undoubtedly the use of top performance recorded stock can have major benefits on the physical and financial performance of pedigree and crossbred flocks. However, current recording schemes do have limitations. The greatest of these is that, currently, records of performance and ram ratings cannot be compared across flocks or across years. In other words, it is impossible to tell whether an A-rated ram in one flock is better or worse than an A-rated ram in a different flock. Similarly, we cannot tell whether an A-rated ram recorded in 1990 is better or worse than a ram of the same rating recorded in 1991 (whether in the same or in a different flock). One of the biggest influences on the rate of genetic progress that can be achieved, either in pedigree or crossbred flocks, is the number of rams available for selection whose estimated breeding values (EBVs) can be compared directly - it is easier to identify and select animals of outstanding genetic merit from a large group than from a small group. Hence, the inability to compare animals across flocks and years imposes a major constraint on genetic progress in British sheep flocks.

The reason that records of performance cannot be compared across flocks or years is that differences in average performance between pedigree flocks and between years arise both for non-genetic and genetic reasons and these are difficult to separate. For example, different pedigree flocks have different management and feeding policies, but they also use different rams. Likewise, variations in the weather from one year to the next affect animal performance (directly or indirectly through the quality and quantity of feed available) but so too does the introduction of new breeding stock from one year to the next. The only effective way to disentangle these genetic and non-genetic differences between flocks and years is to use the performance of related animals in different flocks and years as a benchmark. In dairy cattle populations worldwide, because of the widespread use of artificial insemination (A.I.), related animals occur in many different herds and in different years. The availability of these 'genetic links' across herds and years, together with the use of sophisticated methods of estimating breeding values which capitalize on these links, are major reasons for the well documented genetic progress which has been made in dairy cattle, particularly in North America.

The use of A.I. in most British sheep breeds is very low, and so genetic links between most pedigree flocks are weak. Sire referencing schemes (SRS) have been established in the Suffolk, Charollais and Texel breeds to deliberately create genetic links between pedigree flocks and hence enable comparisons of animals across cooperating flocks. (SAC is actively involved in research and development to improve A.I. techniques in sheep. Through its trading division, Edinburgh Genetics, SAC offers an A.I. service to sheep breeders to allow participation in SRS). Before describing how SRS operate, it would be helpful to consider approaches to estimating genetic merit in a bit more detail.

Approaches to Estimating Genetic Merit

Most sheep producers recognize that an animal's performance is a function of its genetic makeup (breeding value) and the way it is managed and fed, or happens to be exposed to disease

etc., as described above. In other words, an animal of low genetic merit for a particular aspect of performance may look better than it really is as a result of good feeding or management and, similarly, an animal of high genetic merit may look worse than it really is as a result of poor feeding and management. The major challenge facing pedigree breeders and lamb producers selecting rams is to disentangle these genetic and non-genetic effects on performance, and to identify those animals with the highest breeding values - that is, those which will leave progeny of the highest genetic merit. Traditionally, attempts to disentangle these effects have been made in two steps:

- i. correcting records of performance for non-genetic effects; and
- ii. estimating breeding values from corrected records of performance on one or more traits from the individual animal and/or its relatives.

Correcting records of performance for non-genetic effects

For some non-genetic effects, it is possible to measure the average effect on performance. For instance, with enough records of 21 week weight, or fat and muscle depths, it is possible to measure the average differences between lambs of different birth and rearing rank, or of lambs from ewes of different ages. Although we recognize that we can only measure the average difference between birth rank or dam age groups, it helps in comparing individual animals if we take account of these average differences. Selection by eye, or on unadjusted performance records, for example for liveweight, would tend to pick out early born single lambs from mature ewes. Although these animals would tend to be larger themselves, they would not necessarily leave progeny with the highest growth rates. Records of performance are often adjusted simply by subtracting or adding the average difference, say, between birth rank or dam age classes, so that lambs are compared as if they were all born on the same day, as twins, out of mature ewes. Another approach, the one currently used in the MLC Sheepbreeder Scheme, is to assume that, on average, lambs of different birth and rearing rank out of dams of different ages are of equal genetic merit. That is, animals are ranked within their own particular birth rank and dam age group (so called 'contemporary environmental groups'). This assumption of equal genetic merit is probably not valid in many cases, but this method of adjusting for non-genetic effects does have other advantages, particularly when flock sizes are small, as they are in most pedigree breeds in Britain, and where there are large differences in performance between flocks.

Although there are non-genetic effects, such as birth rank and dam age, which we can readily identify and attempt to correct for, there are others which we either do not recognize or which we recognize and can do little about. For example, we know that diseases affect animal performance, but it is extremely difficult to predict how an affected animal would have performed if it had not contracted the disease. The best that breeders can do to minimize the influence of these non-genetic effects is to treat animals which they wish to compare in the same way.

Using information from relatives and for several traits

The only way to measure the true breeding value of an animal with certainty is to measure the performance of very large numbers of its progeny. However, we can estimate breeding values with varying degrees of accuracy from the performance of (1) the animal itself, (2) its ancestors, (3) smaller numbers of progeny, (4) other relations, eg. brothers, sisters, etc., or (5) various combinations of 1 to 4 above (eg. the MLC Sheepbreeder Scheme for terminal sire breeds uses information on the individual animal's performance, together with that from full and half brothers and sisters, and other relatives in some cases).

The reason that we are able to estimate an animal's breeding value from the performance of its relatives is that relatives share genes from common ancestors - the closer the relationship, the more genes in common and the greater the resemblance between the relatives - either in appearance or performance.

The accuracy with which breeding values can be estimated from performance of relatives depends, not only on the closeness of the relationship, but also on the number of relatives with records of performance available.

The similarity between relatives depends not just on the closeness of the relationship, but also on the heritability of the characteristic concerned. In fact, one way of defining heritability is as the proportion of the superiority in performance of parents which is passed on to their offspring.

For traits with fairly high heritabilities, such as liveweight and fatness, an animal's own performance is a fairly good indicator of how its offspring will perform (its breeding value). For traits with lower heritabilities, such as number of lambs born, the animal's own performance is a less accurate indicator of its breeding value, and records from a large number of relatives are particularly useful.

In the simplest case, an animal's estimated breeding value (EBV) is its own superiority in performance (eg. advantage in 21 week weight compared to contemporary animals, say, 10 kg for a particular ram) multiplied by the heritability of the trait concerned (about 0.25 for 21 week weight, resulting in an EBV of 10×0.25 which equals + 2.5 kg for the ram concerned). In practice, the performance of relatives is often used to refine EBVs based on individual performance, essentially by adjusting these upwards or downwards, depending on the 'track record' of the relatives. For example, if we had to choose between 2 rams with identical adjusted 21 week weights, one from a family with high average weights and the other from a family with lower weights, we would have more faith in the ram from the fast growing family. Including information from relatives in the EBVs for these 2 rams would increase the EBV for the ram from the fast growing family, and decrease the EBV for the ram from the slower growing family.

In many cases, the economic performance of farm livestock depends on more than one characteristic. It has therefore become common to measure several characteristics of performance and to combine EBVs for individual traits into a single score for overall merit - such as the lean growth index described earlier. Index selection involves 'weighting' EBVs for individual traits according to their relative economic importance and their relationship to other traits of economic importance.

Improved Methods for Estimating Breeding Values

Several decades ago, new procedures, known by the acronym BLUP, were developed in the USA for evaluating the genetic merit of progeny tested dairy bulls. BLUP methods for estimating BV have now been adopted for dairy cattle evaluations in many countries, including the UK, and are being used increasingly in other species.

BLUP stands for Best Linear Unbiased Prediction which sounds complicated, but the important fact is that BLUP is the best method we have for estimating breeding values. That is, BLUP EBVs are closer to true breeding values, or more accurate, than EBVs produced by other methods.

BLUP differs markedly from traditional methods of estimating BV in one very important respect. It estimates the environmental effects and breeding values simultaneously rather than in two steps, which results in better estimation of both environmental effects and breeding values. In addition, it can make full use of records of performance from all related animals, whether in the same or different flocks, to give more accurate estimates of breeding value. As long as there are reasonable num-

bers of related animals in different flocks, or contemporary groups (flocks are ‘linked’ or ‘connected’) and in different years, then BLUP EBVs can be compared across flocks and years. The ability to compare animals across flocks with BLUP evaluations will allow much greater progress, both in pedigree and commercial flocks as rams (in particular) can be selected from a much wider pool than at present with only within-flock evaluations.

Because EBVs can be compared across years, the genetic progress in a breed or in a group of linked flocks can be charted year by year - a valuable check for breeders, and an important marketing tool to demonstrate to customers that the breed or group of flocks is improving.

Running BLUP evaluations requires large computing resources. However, developments in computer hardware and software now make BLUP evaluations feasible in many more animal breeding programs. This, together with improvements in A.I. techniques for sheep to produce links across flocks, provide the basis for Sire Referencing Schemes.

Sire Referencing Schemes

The diagram in Figure 1 illustrates how sire referencing schemes operate. The principle of these schemes is that each cooperating breeder agrees to use semen from several rams from a team of ‘reference sires’ on a proportion of the ewes in his or her own flock. Table 1 gives an example of how the progeny of reference sires can help in selecting ram lambs across flocks. Table 1 shows the 21 week weights of ram lambs in 2 flocks, A and B. The lambs are the progeny of several different rams, but one ram (Sire No. 1) has been used in both flock A and flock B. The performance of lambs in flock A is higher than that in flock B, resulting in a 10 kg higher flock average for flock A.

Table 1. Example Showing How Reference Sires Allow Comparisons Across Flocks.

Ram lamb no.	Sire ID	Adjusted 21 week wt. (kg)	Within-flock EBV for 21 week wt. EBV (kg) Rank		Across-flock BLUP EBV for 21 week wt. EBV (kg) Rank	
Flock A						
1	1 (Ref)	84	+2.25	1	+0.75	4 tie
2	1 (Ref)	79	+1.00	4	-0.50	10 tie
3	1 (Ref)	81	+1.50	3	0.00	8
4	3	76	+0.25	5	-1.25	12
5	3	83	+2.00	2	+0.50	6
6	4	72	-0.75	7	-2.25	14
Flock A average		75				
Flock B						
51	1 (Ref)	60	-1.25	6	-0.25	9
52	1 (Ref)	62	-0.75	5	+0.25	7
53	1 (Ref)	59	-1.50	7	-0.50	10 tie
54	7	69	+1.00	3	+2.00	2
55	7	64	-0.25	4	+0.75	4 tie
56	8	72	+1.75	1	+2.75	1
57	8	67	+0.50	2	+1.50	3
Flock B average		65				

If neither flock had used the reference sire (Sire 1), then we would probably pick ram lamb number 5 in flock A which has the highest adjusted weight (83 kg) and the highest within-flock EBV for 21 week weight (+2.1 kg). However, the use of the reference sire shows that:

- i. in flock A, the progeny of the reference sire are generally better than the progeny of other rams;
- ii. in flock B, the progeny of the reference sire are generally worse than the progeny of other rams.

If the ewes in the 2 flocks are of similar genetic merit, we expect the progeny of the same reference sire to be of similar genetic merit in the two flocks. The fact that the progeny of the reference sire are better than others in flock A indicates that the other sires used in flock A are of lower merit than the reference sire. On the other hand, the fact that the progeny of other sires in flock B are better than those from the reference sire indicates that the non-reference sires and their progeny are of higher genetic merit than the reference sire. This illustrates how the reference sires are used as a benchmark to identify animals of outstanding merit across flocks. The last 2 columns show how this would be reflected in the across-flock BLUP EBVs and the across-flock rankings. These show that the animals with the highest EBVs are lambs 56, 54 and 57, two of which (54 and 57) could have been overlooked if we had used only within-flock EBVs.

As well as making use of the comparative performance of the progeny of reference sires across flocks, BLUP EBVs will be more accurate as a result of more effective separation of genetic and environmental effects on performance, and using information from all relatives. This will result in differences between within-flock and across-flock rankings. At first sight this may cause concern, but even when these differences are less easy to reconcile than in the example shown here, it is important to remember that the across-flock EBVs are most accurate.

Some reference sires are used in successive years to create genetic links which allow EBVs to be compared across years. Other reference sires are replaced by superior rams, identified by their across-flock EBVs. Thus the reference sires have a dual role - creating genetic links across flocks and years and producing more rapid dissemination of genetic improvement. It is difficult to separate the benefits of using BLUP from the benefits of linking flocks but the use of BLUP EBVs probably allows around 20% extra annual genetic progress compared to that possible with traditional methods of estimating breeding value. Additionally, the linking of flocks in the manner described to create a larger pool of animals for selection probably allows around a further 30 to 60 per cent improvement in response to selection.

Sire Referencing Schemes have been used for several years in sheep or beef cattle in New Zealand, Australia, France and the USA. Sire Referencing Schemes were established in the Suffolk and Charollais breeds in the U.K. in 1989/90. The Suffolk Sire Referencing Scheme currently involves around 30 pedigree flocks, with a total of around 2000 ewes. Members of the Suffolk SRS use a minimum of two reference sires on a minimum of 30 ewes in their own flock. Currently about 6 reference sires are offered to members annually. These are replaced periodically by high ranking rams, selected on their across flock EBVs, and subjected to additional screening on functional fitness, breed type and conformation.

The Charollais Sire Referencing Scheme involves around 20 flocks, with a total of around 1700 ewes. Currently two reference sires are available annually for use on a minimum of 10 ewes each in all participating flocks.

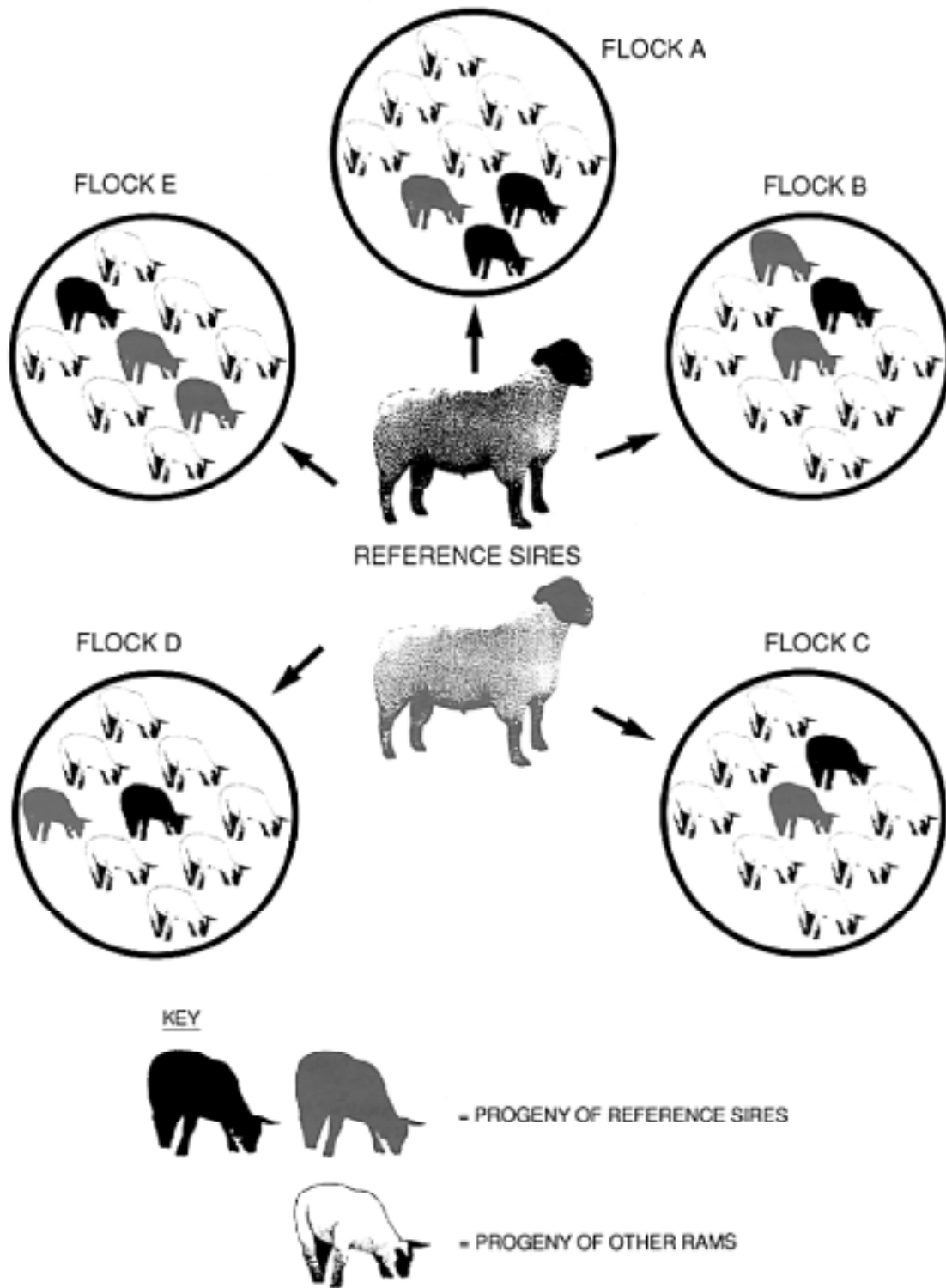
Advantages to Pedigree Breeders and Crossbred Lamb Producers

In brief, Sire Referencing Schemes offer advantages to participating breeders, to non-participating breeders who purchase rams from SRS, and to crossbred lamb producers purchasing rams from SRS because:

- i. EBVs for sheep in SRS are more accurate because they are evaluated using BLUP. (Within-flock EBVs will differ from across flock EBVs as a result of (a) more effective separation of genetic and non-genetic effects, and (b) fuller use of information from relatives. Whenever within-flock and across-flock EBVs are available, breeders and lamb producers should always use across-flock EBVs as these are more accurate).
- ii. BLUP EBVs can be compared across flocks participating in SRS - this vastly increases the pool of animals available for selection, allowing more intense selection of outstanding animals, and hence faster rates of genetic progress.
- iii. BLUP EBVs from SRS can be compared across years. This enables breeders and commercial producers to ensure that the animals they select are better than those used in previous years.

Although participation in Sire Referencing Schemes is on a relatively small scale at the moment, involvement in existing schemes, and the extension of these schemes to other breeds, is highly likely in future. Although the techniques involved are new to sheep breeding in Britain, they have been widely applied and proven in other livestock species, and both pedigree sheep breeders and lamb producers can use the results with confidence.

Figure 1



SCHEMATIC DIAGRAM OF A SIRE REFERENCING SCHEME

THE WHY AND HOW OF SIRE REFERENCING^a

Derrick R. Guy

Senior Genetics Adviser
Meat and Livestock Commission
Milton Keynes, England

Introduction

Breeders are beginning to hear about sire referencing. Some are doing it while others are contemplating it. This note is intended to set the scene and give those considering a sire referencing group a clear idea of the way ahead.

The detail of how and why sire referencing schemes work is given in the last section for those unfamiliar with the concept. Suffice at this stage to say that a team of reference sires (typically 3 or 4) is used across flocks in the same season. Their progeny have a quarter of their genes in common which is used as a benchmark or yardstick against which lambs or stock sires can be compared. The aim is that lambs from reference sires ('reference lambs') should be born at around the same time as lambs from the other stock sires in each flock.

Laparoscopic artificial insemination with frozen semen is normally required. Controlled transfer of rams around flocks may achieve the same ends but requires more care to ensure that flocks do not become genetically isolated from others.

The Meat and Livestock Commission's (MLC) Sheepbreeder Program and scanning records form the basis of the system. Edinburgh Genetics is currently the sole agency for an A.I. service, and the analysis of records across flocks is conducted by MLC in liaison with outside agencies under contract from time to time.

It is important for each group to develop its own procedures and timetables to suit. Table 2 (at the end of the paper) gives guidelines. The timing of the analysis depends upon the selection day, forthcoming sales and availability of resources at MLC.

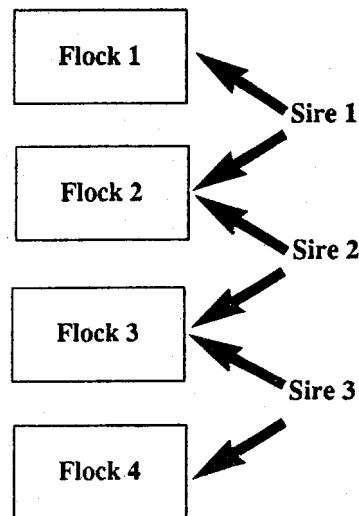
What members have to do

1. A steering group of members is found to be helpful in sorting out technical and procedural details. Obtaining breed society approval is usually a distinct advantage.
2. Decide the basis on which rams join the team of reference sires, how members are to reach a consensus, and how members' own interests are to be protected.
3. Decide on a team of sires to use for this year's breeding. In the first year, and perhaps the second, across flock evaluations will not be available when this decision is to be made. So it becomes more important to ensure members reach a consensus and are confident to use those rams offered. In the first and second years, stud rams in use in member flocks which are supported by good performance figures are good choices.

^aPublished in 1992 as MLC Genetics Newsletter, Series 1, Number 3. Reprinted in these proceedings with permission of the author. Minor modifications have been made to the original publication with permission of the author.

4. The number of reference sires needed depends on how matings are organized. Four is a good minimum. Each member should aim to use at least two from the team if possible. A good rule of thumb is that each member should be able to 'connect' to any other member by the smallest number of reference sires. For example, avoid the situation in Figure 1. In this situation, Sire 3 should also be used in Flock 1. If possible, replacing only half the team each year will help establish good links from year to year.

Figure 1



5. Current advice is to aim for at least 20 reference lambs on the ground in each flock going forward for scanning. In the end, whatever is available is used, but below five and the results may be visibly affected.
6. Decide deadlines (in the following order)
 - i. Date and venue to inspect nominated rams.
 - ii. By which date you need the results (MLC will try to comply but may need to negotiate).
 - iii. When the last scanning visit is to take place.
 - iv. Movement of rams or semen collection in preparation for the next breeding season.
 - v. Frequency of progress meetings.
7. It is imperative that Sheepbreeder records are up to date well in advance of the scanning visit. This means correct pedigrees with lambing and eight-week weights processed and all queries cleared up.
8. Book a scanning visit for the appropriate time. The aim is for average lamb age on the day of scan to be around 147 days. Two visits may be appropriate. Some schemes currently require a second analysis later in the year to pick up late born lambs. We advise scanning both sexes, certainly all male lambs.
9. Contact your local MLC consultant if at all in doubt about filling in the Sheepbreeder records or the scanning visit. They will contact Chief Advisers at MLC Headquarters for clarification if necessary. Remember that errors in recording will affect everyone else as well.
10. Decide a strategy for publicity and marketing, even if it is some way in the future.

What we will do

Sire referencing employs additional resources over routine services, and we are devoting considerable efforts to these initiatives. Liaison is through MLC Consultants with individual members and direct to Milton Keynes where helpful. Members are free to contact MLC staff at any time.

Certain aspects can be complicated, and we try to provide support by way of advice, discussion, presentation or reference documentation, etc. on request. Our offices at Winterhill are available for meetings if this would be helpful.

Results will be delivered to agreed timetables, and provision is made for contingency action to ensure results are available when needed. However, it must be emphasized that recording data that require amending or are submitted late can seriously jeopardize the deadlines. The analysis to rank this season's lambs must wait until data from all members are present and correct.

Some degree of flexibility and understanding is advisable in the early stages of new schemes since some experience is required before optimum mating structures and A.I. conception rates, etc. are known.

The MLC charge to cover resources needed above normal Sheepbreeder and scanning services is £90 per flock on delivery of the final end-of-season report. This fee is currently negotiated over all schemes. Income is reinvested to fund supporting research into optimizing the mating structures and tailoring the data analysis for particular breeds and groups.

What you will get

The analysis of scanning data over the whole group results in the calculation of estimated breeding values (EBVs) for every animal that we know about from the Sheepbreeder records (lambs, sires, dams and ancestors).

The EBV is a direct estimate of the superiority (or inferiority) of the animal's genes. There is an EBV for each trait measured (56-day weight, scan weight, muscle depth and fat depth) in the unit that the trait was measured in.

EBVs for the last three traits (not 56-day weight) are then combined (following the same procedure as the scanning index) to produce a single value on which all animals are ranked. This is called the Scheme Index and has a range from 0 to 200 with an average of 100 points. An example is shown in Table 1.

Table 1. Scheme Index for Two Sires with different EBV's for Individual Traits.

Trait	EBV's	
	Sire 1	Sire 2
21-week weight (kg)	2.41	-0.04
Muscle depth (mm)	0.55	0.72
Fat depth (mm)	-0.12	-0.18
Scheme Index	166	147

This information is presented with the actual measurements originally recorded and pedigree data. Further help to interpret the results is given out at the time, and each member's MLC Consultant will have a copy of their member's results.

Typically members see their own results (latest crop of lambs, and their sires and dams) while everyone gets a copy of the latest ratings for the reference sires. It is for the group to decide whether members' individual results get more widely distributed across the group. All results are confidential to the membership, to the extent that MLC will require a written authority to divulge data between members as well as outside the group.

The summary report at the end of the season can give the results of any rerun plus estimates of sex differences and genetic trends that might be of interest and guidelines for the next season.

And finally

The object of the exercise is to locate those rare animals that have exceptionally good records and which look good from a breeder's point of view. They may then join the team of reference sires or be used within members' flocks or used to some other advantage.

Once going, the scheme provides a focus and framework for further development. For example, incorporating carcass information, a visual classification, recording of defects, or investigation of inbreeding levels. Eventually a tie-in with the other schemes within the breed might be considered. The scheme also provides a sound technical base for group promotions and sales, etc. The possibilities are there for the taking.

The Basics of Sire Referencing

The problem

Readers will already appreciate that an individual flock working independently of all others has severe limitations over what it can achieve. Flock size is often small, making it difficult to get good genetic comparisons between animals. When the time for selection comes around, the choice is often restricted - the animal with all the desirable qualities we are looking for may simply not be there. We may be forced to select an animal that is not quite right in the hope that it will turn out better than expected. Alternatively, we could look outside for new blood. In which case we have the problem of who to go to, the uncertain genetic merit of the supplying flock relative to our own, along with the risk that the (often expensive) addition to the flock will not live, or rather breed, up to our expectations.

An objective recording scheme such as MLC's Sheepbreeder can go a long way to help ensure that relevant traits are objectively recorded, processed to extract the maximum amount of genetic information and presented in a way that helps us make the necessary selection decisions. The rating or rankings of animals remain, however, essentially 'within flock'. There is nothing to tell us whether an animal from another flock is genetically better or worse than anything we have bred ourselves. The only option is to try it and see - by which time the damage, if any, has been done.

The solution

The first step towards a solution is to get together with other 'like-minded' breeders. Coming together with others to agree on common aims and objectives, sharing problems and looking for common solutions is without doubt the most important step an individual breeder can take. The confidence this gives opens up possibilities that are beyond the means of individuals.

A technical possibility is progeny testing. In its day, progeny testing has much to commend it.

- i. It provides the direct comparison of sires from across flocks so difficult to obtain otherwise.

- ii. Sires that are about to be used widely will have ‘proved’ themselves already with progeny on the ground.
- iii. Because the progeny are commercial, information on slaughter traits can be obtained.

The down side is:

- i. Resources limit the number which can be tested so the focus is always on a very small group of candidates.
- ii. There is a limit to how much influence a ‘proven’ ram can have.
- iii. Rather complicated analysis of results is required to ensure fair comparisons of tested rams.
- iv. Considerable delay is experienced in turning over replacements.

Nevertheless it is a rather sure, if slow, method of making genetic progress.

What is needed is a system of progeny testing where the whole operation is scaled up. Where all stock sires over all flocks can be compared with each other. Where the progeny are produced in the members’ own flocks so that they are themselves available for selection. Where all animals can be compared with each other, irrespective of which year or in which flock they were born. In effect, treating the population across the whole group as a single large ‘superflock’. A sire reference scheme is exactly that.

How does sire referencing work?

Sire referencing uses a team of common sires over a group of flocks. The reference sires leave lambs in one flock that are therefore related to lambs being born at around the same time in other flocks (Figure 2). The lambs are half-sibs having a quarter of their genes in common and, to a certain extent, will have similar performance. These can be used as a standard or ‘benchmark’ against which lambs from other homebred sires can be compared.

When lamb performance is analyzed, it allows us to rank all the lambs, sires, dams and even ancestors on the same list without worrying about which year they were born or in which flock.

Each member will know where their stock rank in the list. Those rare outstanding animals that have both good performance and all the other attributes members are looking for, can be identified and located, and by agreement used.

To function properly, the system has had to await the development of three technologies:

- i. A base of good objective recording for economically important traits. For terminal sire breeds, this means Sheepbreeder with scanning.
- ii. The use of artificial insemination to ensure reference lambs are born in the same season in different flocks (this condition may be relaxed in particular cases).
- iii. Analysis programs that make proper adjustment for genetic pedigree and flock environment to enable the benchmarks to operate. These have only very recently been developed from their original use in dairy cattle and very recently beef cattle schemes.

All breeds have had some measure of ‘ram sharing’, whether deliberately or through sales from one member to another. These too can provide ‘genetic links’ across flocks. However, it must be remembered that reference lambs have only a quarter of their genes in common and relationships more remote than this will produce a less effective benchmark (‘weaker link’). Hence our current

launch of sire referencing with the major groups involves laparoscopic A.I. using frozen semen.

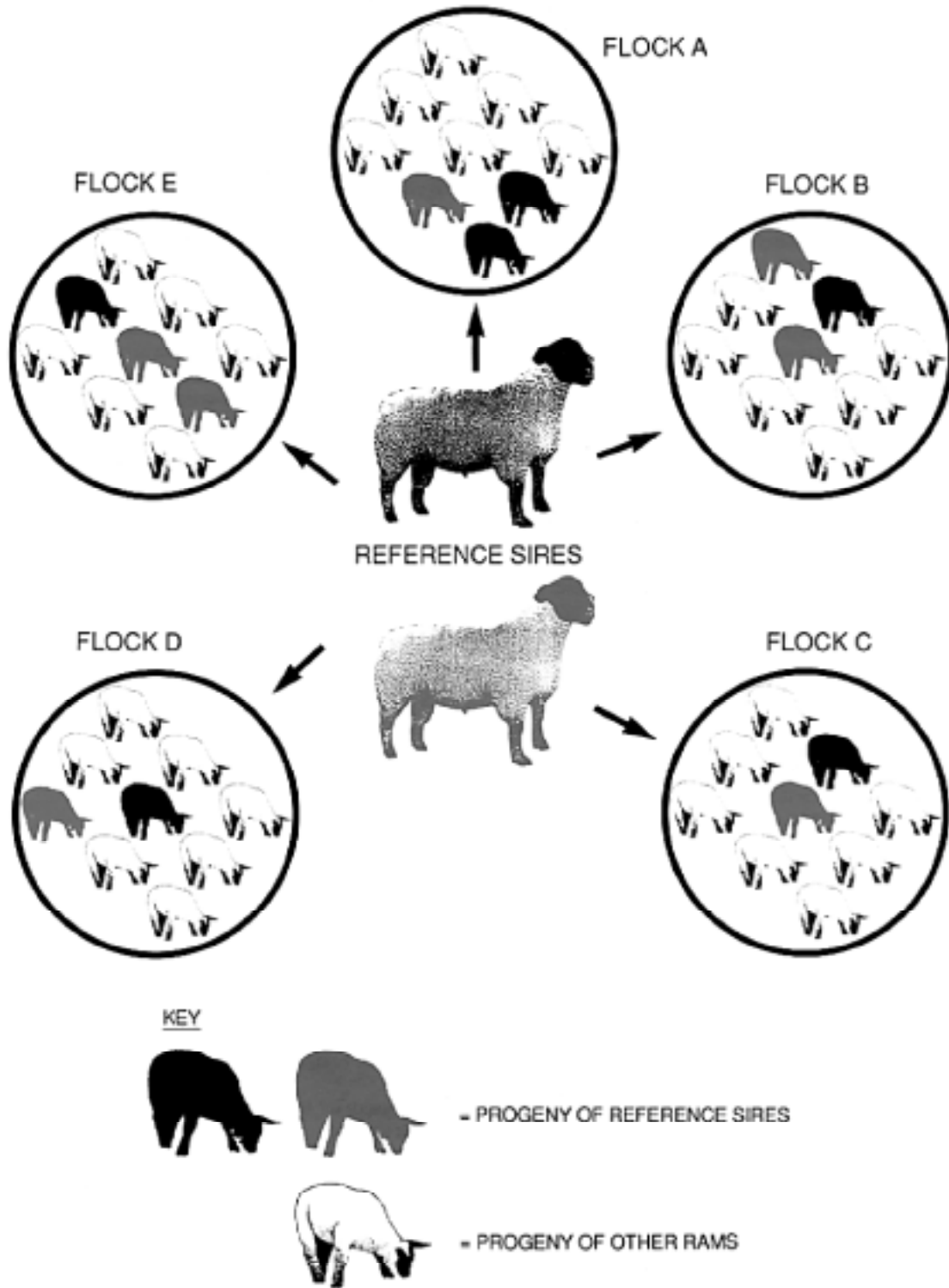
In the medium term, the intention is to make the across flock analysis available as a routine with the Sheepbreeder service. Structured groups that already exist will be in a position to take full advantage of all the benefits available while breeders pursuing a strictly within flock breeding policy will have more precise and accurate genetic evaluation of their animals than currently obtained.

These initiatives are innovative, soundly based technically and open up possibilities never before available to the livestock breeding sector. It is up to breeders to grasp the opportunities. MLC will do all it can to assist.

Table 2. Order of Activities with Possible Months When They Would Take Place.

What happens	When (for a January-lambing flock)
1. At the start and throughout, members need to discuss and agree on breeding objectives for the whole group.	
2. Members record the season's lambing on Sheepbreeder.	January
3. Eight-week weights are submitted and records (pedigrees, sexes, weights, etc.) checked for accuracy.	March
4. Scanning visit on-farm: within-flock results are produced on-farm. Details are sent direct to Milton Keynes by scanner operator.	June
5. Analysis of all records for the sire referencing group is performed within a week of the last scan visit (the deadline for this is negotiable with the group).	June
6. Selection list of lambs, sires and dams (ranked in order of genetic merit) is sent direct to members.	June-July
7. Members shortlist ram lambs as potential stock sires or reference sires.	July
8. Ram lambs, yearlings or stock sires (as appropriate) are nominated to go forward for consideration as reference sires by other members.	July
9. A Ram Selection Day is organized where nominations are inspected, opinions given and voting carried out with successful rams going forward to join the team of reference sires.	July
10. The team of reference sires (with possibly ram lambs from this year) are set to work, either at an A.I. center for semen collection or sires are distributed to farms. Promising ram lambs could be tried out as stock sires in the owner's flock.	August
11. Late lambing flocks and late born lambs within flocks, if required, can be scanned on a later visit, data sent to MLC and all results re-analyzed, incorporating the new data.	October
12. A summary report is prepared on the year's run and delivered to each member.	November
13. Various progress meetings of the members are held throughout the year, at least one over the winter.	December

Figure 2



SCHMATIC DIAGRAM OF A SIRE REFERENCING SCHEME

OPPORTUNITIES FOR GENETIC IMPROVEMENT OF DAIRY SHEEP IN NORTH AMERICA

David L. Thomas

Department of Meat and Animal Science
University of Wisconsin-Madison

Sheep milk, as a commodity for human consumption, has been added to meat and wool in recent years as products that can be produced by sheep in North America. Almost all the milk produced by the developing dairy sheep industry is processed, with most going to cheese and smaller amounts to other products like yogurt and ice cream. With approximately 66 million pounds of cheese made from sheep's milk imported by the U.S. in 1994, there appears ample economic opportunity for this new industry.

Foreign Dairy Breeds

While dairy sheep production has a long tradition in many countries, especially those in the Mediterranean region, North America is without a sheep dairying heritage. Our domestic sheep breeds have not been selected for commercial milk production. Unselected domestic ewes can be expected to produce 100 to 150 pounds of milk over a 90 to 100 day lactation period starting 30 days after parturition. After culling some ewes for low milk production from the first year of milking, average flock production may increase to 125 to 175 pounds of milk.

Experimental studies in the U.S. reveal some differences between breeds for commercial milk production. Among available breeds, Dorset, Polypay, Suffolk and Rideau would be expected to have above average milk yields. However, even the milk yields of these breeds pale in comparison to the yields reported for European and Mideastern breeds selected for milk production over many years. Some of the important world dairy breeds are East Friesian (Germany), Manchega (Spain), Lacaune (France), Sarda (Italy), Chios (Greece), and Awassi and Assaf (Israel). Many flocks of these breeds can average 600 to 1,100 pounds of milk per ewe per lactation. The increased production levels per lactation of these foreign breeds over domestic breeds is due to both a greater production per day and a longer lactation length.

Access to foreign dairy sheep genetics is a priority of U.S. dairy sheep producers. Foreign dairy breeds with the genetic potential for 700 pound milk yields, when crossed with domestic breeds with 150 pound yields, would result in crosses with expected yields of approximately 425 pounds. If sheep milk is worth \$.60/pound, the dairy x domestic crosses would be expected to return \$165.00 more gross returns per ewe than domestic ewes. This represents a dramatic increase in income.

Unfortunately, it is not possible to import dairy sheep germplasm (live animals, embryos, or semen) from Europe or the Mideast into the U.S. due to the animal disease status of countries in these areas. The Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture may issue an import permit for sheep from some of these countries if the imported germplasm goes into an approved quarantine facility for at least five years. Most producers can not afford the construction and maintenance of such a facility. However, there are some anticipated changes in import regulations of sheep which may allow general access to some of the dairy breeds. On May 11, 1995, APHIS published a proposed rule change in the Federal Register (Volume 60, Number 91, Pages 25151-25162) that would allow import of sheep germplasm into the U.S. from

countries in which the major disease of concern was scrapie if the imported germplasm goes into U.S. flocks enrolled in the Voluntary Scrapie Flock Certification Program (VSFCP). Under the proposed regulations, imported animals or animals resulting from imported embryos or semen have to remain in the original flock until the flock obtains scrapie-free certification (after a minimum of five years on the program) or they can move to other flocks enrolled in the program. Offspring of the imported germplasm can move to any other flock at any time. This change in the regulations will open up imports of dairy sheep germplasm from most of the countries of western Europe. Even though the comment period on these proposed changes ended on July 10, 1995, the hoped for changes in the regulations have not been implemented. Dairy sheep producers should press for these changes by calling or writing Dr. Roger Perkins, Staff Veterinarian, Animal and Plant Health Inspection Service, Veterinary Services, National Center for Import and Export, 4700 River Road, Unit 38, Riverdale, MD 20737-1228 (Telephone: 301-734-8170) or by urging members of the U.S. Congress to make USDA/APHIS aware of the importance of these changes to the U.S. dairy sheep industry.

The Canadian government allows the importation of sheep germplasm from many countries of western Europe so there are now dairy sheep genetics in Canada. Live sheep or sheep resulting from embryos or semen imported into Canada from Europe or live sheep, embryos or semen from Canadian flocks which have imported sheep germplasm from Europe within the past five years can be issued an import permit to enter the U.S. if the animals go into flocks enrolled in the VSFCP. Live sheep, embryos and semen from Canadian flocks which have not imported sheep germplasm for the past five years, except from the U.S., New Zealand and Australia, can be issued an import permit to move into any flock in the U.S.

Given the excellent animal disease status of New Zealand and Australia, live sheep, embryos and semen can be imported from these two countries into any flocks in the U.S. Imported live sheep must be quarantined in a USDA/APHIS facility for 30 days before release into the U.S. flock. East Friesian sheep will be available from New Zealand in April, 1996, and Awassi sheep are available in both New Zealand and Australia.

Selection for Dairy Traits

Genetic improvement of U.S. dairy sheep initially will involve crossing of domestic ewes with rams (or semen) from dairy breeds. Progeny of these matings will show large increases in milk production. Scientific studies and producer observations will indicate whether crossing should continue until ewes are a very high percentage of the introduced dairy breeds (virtually indistinguishable from pure individuals of the introduced dairy breeds) or whether there is an optimum mix of domestic and dairy breeding which results in the most efficient production system. At this point, selection will need to take over in order to increase milk yields further.

In order to improve milk production through selection, daily milk yields of individual ewes must be recorded and lactation yields determined or estimated. The following guidelines come from the 1992 publication "International Regulations For Milk Recording in Sheep" from the International Committee for Animal Recording (ICAR). The first test day of the flock takes place 4 to 15 days after the start of milking for that year or season. Subsequent test days should take place at 28 to 34 day intervals until all ewes are dried off. Two choices are given for recording milk:

1. On each test day, milk yield can be recorded at both milkings and added together to determine daily yield.
2. Individual milk yield can be recorded at only one milking, and total flock milk yield is determined at the other milking. The total flock milk at the other milking is prorated to each

individual ewe based upon her proportion of the individually recorded milk. This procedure eliminates the need to individually record ewes twice each day.

Milk yield can be recorded by weight or volume. Since the rest of the sheep dairy world uses metric measurements, it would be desirable to use the weight measures of grams or kilograms or the volume measures of milliliters or liters. The volume to weight conversion for normal sheep milk is: 1 liter = 1.036 kilograms, or 1 liter = 2.28 pounds, or 1 gallon (U.S.) = 8.64 pounds.

Individual milk production per lactation can be estimated using the centering date method using the following formula:

$$\begin{aligned} \text{Estimated milk yield} = & \\ & [\text{production 1st test day} \times \text{no. days between start of milking and 1st test day}] \\ & + [(\text{prod. 1st test day} + \text{prod. 2nd test day})/2 \times \text{no. days between 1st and 2nd test day}] \\ & + [(\text{prod. 2nd test day} + \text{prod. 3rd test day})/2 \times \text{no. days between 2nd and 3rd test day}] \\ & + \dots \\ & + [(\text{prod. next to last test day} + \text{prod. last test day})/2 \times \text{no. days between next to last and last test day}] \\ & + [\text{prod. last test day} \times \text{no. days between last test day and end of milking)]. \end{aligned}$$

It is well known that age of ewe has an effect on milk yield. Therefore, estimated yields should be adjusted for this non-genetic effect so ewes of different ages can be compared fairly. Estimated lactation yields should be multiplied by the appropriate adjustment factor in Table 1 to adjust estimated milk yield to that expected from a 4 to 7 year old ewe.

Table 1. Multiplicative adjustment factors to adjust milk yield to a mature ewe (4 to 7 years of age) equivalent.

Ewe age, years	Adjustment factor
1	1.44
2	1.24
3	1.13
4 to 7	1.00
8 and older	1.04

Example: A 2-year-old ewe has a milk yield of 206 liters. Her age-adjusted milk yield is 255 liters (206 liters x 1.24 = 255 liters).

The age of ewe adjustment factors in Table 1 are based on a limited amount of European data and may be different for U.S. breeds of sheep and under U.S. production conditions. More refined adjustment factors will be developed as U.S. milk production data becomes available. In the interim, use of these adjustment factors is preferable over not using any age of ewe adjustment factors.

Lactation traits have moderate to high heritabilities (Table 2) so reasonable amounts of genetic progress can be expected for these traits. Replacement ewes and rams should be selected from dams with the highest average age-adjusted milk yields. An even better selection criteria would be high EPD's (Expected Progeny Differences) for milk yield. An EPD is an estimate of genetic value of an animal calculated from performance information from all relatives of that individual and is the most

accurate estimate of genetic value possible. An EPD calculation for a prospective ewe or ram replacement would use the milk yields of the individual's dam, maternal grand-dam, paternal grand-dam, full-sisters, half-sisters, and any other female relatives with milk production records. Such EPD calculations require relatively sophisticated statistical techniques and fairly large computing resources. Unfortunately, EPD's currently are not calculated by the National Sheep Improvement Program (NSIP) or any other entity. Hopefully EPD's will be calculated by NSIP in the future as the importance of dairy sheep production grows.

Table 2. Heritabilities of lactation traits.

Trait	Heritability
Milk yield	.30
Fat percentage	.30
Protein percentage	.30
Fat yield	.35
Protein yield	.45

Fat and protein composition of milk determines its manufacturing qualities. Since the vast majority of sheep's milk will be manufactured into cheese with lesser amounts transformed into yogurt and ice cream, milk composition is economically important to sheep milk processors. Fat and protein composition have as high a heritabilities as milk yield so progress from selection is expected in these traits. Most Dairy Herd Improvement (DHI) laboratories in the U.S. that estimate composition of milk from cattle also will analyze sheep milk. Since sheep milk has a significantly higher fat and protein content than cow milk, there is some question as to the accuracy of the analyses of sheep milk samples from laboratory methods calibrated for cow milk, but such laboratory analyses should still accurately rank animals for fat and protein percentage.

At the present time, genetic improvement of milk composition should be secondary to genetic improvement of milk yield. Many countries in Europe which have well-developed dairy sheep industries and national genetic improvement programs are not recording milk composition or only started in recent years. France started recording milk composition in their national program in 1987 and was the first country to do so. Selection for high fat and protein content may become an issue in the future, because both traits are negatively correlated with milk yield. As milk yield improves through genetic selection, the fat and protein content of the milk is expected to decrease making it less desirable for cheese manufacturing.

For rapid genetic improvement, the goal of the dairy sheep industry should be to develop a national or regional breeding programs which include milk recording of ewes, centralized processing of milk production records and estimation of EPD's, planned matings of ewes and rams with superior EPD's, progeny testing of promising young rams, and the rapid spread of superior genetics through the population by the use of artificial insemination with semen from proven rams. This is the U.S. dairy cattle model which has been so successful. The French have developed a system like this with the Lacaune breed in south-central France. Over 150,000 Lacaune ewes are officially milk recorded and 125,000 of these ewes are artificially inseminated with semen from proven rams or promising young rams in the progeny test program. An additional 500,000 Lacaune ewes are on

unofficial milk recording. This French breeding scheme has resulted in a genetic increase in milk production of 12.5 pounds per ewe per year in the entire population. The average milk production per ewe in this population is expected to increase by approximately 100 pounds every 8 years due to selection alone. Increases in milk production due to better feeding and management would be in addition to the gains from selection. This demonstrates the power of a well-designed and focused genetic improvement program.

Wisconsin Efforts

In the falls of 1993, 1994 and 1995, ewes in approximately 10 dairy flocks in Wisconsin were inseminated with semen from 1/2 East Friesian, 1/2 Rideau or 3/4 East Friesian, 1/4 Rideau rams. This insemination program was carried out by the University of Wisconsin-Madison with grant funds from the Agricultural Development and Diversification Program of the Wisconsin Department of Agriculture, Trade and Consumer Protection. A small number of 1/4 East Friesian ewe lambs were milked on Wisconsin dairy farms in 1995. Even though the milk production records have not been analyzed, producers indicated that the 1/4 East Friesian ewe lambs produced about two times the amount of milk of contemporary domestic breed ewe lambs.

A task force of dairy sheep producers was appointed in August, 1995 to develop the Wisconsin Dairy Sheep Improvement Program. The task force has developed a proposed set of bylaws and objectives for this new organization which will be presented to Wisconsin dairy sheep producers for their comments in March, 1996. Anticipated functions of this new organization will be development of standardized milk recording, calculation of estimates of genetic values for dairy traits and organization of a sire reference scheme.

NADSA - THE NORTH AMERICAN DAIRY SHEEP ASSOCIATION WHAT IS IT AND WHAT DOES IT DO?

Mary Jarvis
NADSA Central Region Reporter
Poplar, Wisconsin

The North American Dairy Sheep Association was formed in 1989 as a non-profit corporation, with its purpose being:

- (1) to serve ALL in the industry, including producers, processors, and consumers,
- (2) to promote sheep dairying and products,
- (3) to serve as a resource for information.

The membership is international in scope; we have members in many foreign countries.

Some achievements of NADSA have been:

- 1) Recognition of sheep dairying by the Interstate Milk Shippers Conference, which allowed sheep milk Grade A recognition nationwide. This facilitated the recognition of sheep milk as a dairy product in many states, including Wisconsin. Before this recognition was obtained, sheep dairies had been licensed as food processors rather than dairies, because sheep's milk was not part of the Pasteurized Milk Ordinance. The groundwork that NADSA did to make our product 'accepted' has helped the sheep dairy industry to expand not only in Wisconsin, but also nationwide.
- 2) For many years, NADSA lobbied for the importation of germ plasm into the US from abroad in order that we might be able to bring true dairy breeds to this country. Finally, in 1995, after years of pounding at USDA's gate, a regulatory change was proposed that would allow the importation of genetic material and live animals into flocks that are enrolled in the Scrapie program in this country. NADSA mailed a notice of this proposed change to the membership with a form for members to make comment to USDA- APHIS. Several members did comment.
- 3) In 1995, NADSA and the American Sheep Industry Association, ASI, as well as the Interstate Milk Shippers (IMS) began a collaboration to develop quality assurance standards and programs for sheep's milk production and processing. This effort is currently under peer review, and will be published as a chapter in the ASI Sheep Production Handbook.
- 4) NADSA has established a working relationship with the British Sheep Dairy Association (BSDA) and other foreign contacts. NADSA offers a discounted membership in BSDA through the annual renewal of membership in NADSA. The BSDA publishes a very informative newsletter which NADSA members receive through this BSDA membership. I have been a BSDA member for several years, and as the years have gone by, I recognized more and more names in their membership directory as NADSA members.
- 5) NADSA has held four Dairy Sheep Symposiums; two were in Minnesota, one was at UC-Davis in California, and the fourth was in Montpelier, Idaho. Symposium proceedings are for sale through NADSA. We hope to be able to put on workshops and/or symposiums in 1996 - 1997.
- 6) NADSA offers for sale several different reference materials for persons interested in sheep dairying. We sell Olivia Mills' book, PRACTICAL SHEEP DAIRYING, as well as some other books that

are helpful in setting up a dairy. Please stop by the NADSA booth sometime during the Conference this week to see our selection.

- 7) NADSA does produce a newsletter; often not as often as we would like. Since it is all a volunteer effort, sometimes peoples' busy schedules don't synchronize with getting the material submitted. Our current newsletter production editor is Carolyn Coffman, and Tanya Gendreau takes care of mailing it out. The Editor is Ron Sundberg, from California. We try to have regional reports from each region of the country, as well as informative articles and updates on what's happening.

I was asked to talk to you about what NADSA can do for you.

I have already given a synopsis of its several accomplishments since 1989. I think that the rest is all up to you, the members. It has been wonderful to be involved in this organization from near the very beginning. We've seen people come and go, some have stayed through it all. This core membership has become a network of support and encouragement for me personally, and I'm sure most of you feel the same way. It wasn't that long ago that people said "You mean GOATS, don't you?" when I said I milked sheep. Today, this has changed, we've become respectable! NADSA is responsible for that, in part.

Several of the members have access to the Internet and e-mail which makes for a quick exchange of information and ideas, with the potential for a network discussion group to be formed. We have been publishing peoples' email addresses in the NADSA newsletter. Rusty and I recently established a web site; these locations will also be published, and potentially, linked. I don't think that the possibilities lurking in cyberspace have begun to be tapped at all.

Carolyn Coffman, Tanya Gendreau or I will be at the NADSA booth during the WSBC conference. We hope you will stop by to buy a book, become a member, or just chat us up! We look forward to talking to you!

THE COTTAGE INDUSTRY - CHEESEMAKING AND MARKETING

David Major
Major Farm
Westminster West, Vermont

It is my intention to describe my family's farm and business, which we call "Major Farm," and then to follow that description with a few principles and bits of advice that we have found helpful in producing and marketing our primary product, Vermont Shepherd Cheese. In the end, I will show a few slides of our operation and take questions. If you have any specific questions during the course of my talk, please feel free to interrupt.

Major Farm is a hill farm in southeastern Vermont. While we have enough hay land to make all of our own hay, much of the farm is good for pasture only. This winter, for the second time this century, an avalanche rolled down from the top of the ridge and across several of our pastures - so you can see, it's steep.

The number of productive ewes on Major Farm varies considerably throughout the year. At the moment, we have 200 mature ewes and 130 hoggets, plus lambs. We use about 200 acres of open land.

I grew up on Major Farm, where we have always kept sheep. My wife, Cynthia, grew up in New York, where her family has a dairy. They are the ones who suggested we milk the sheep. So we did, starting in 1988, the summer we got married. One of our wedding guests stayed and milked during our honeymoon. 1996 will be the ninth year we have milked the sheep.

The economics and management of our business is fairly complex. The sale of our cheese gives us sixty to seventy percent of our gross farm income. The sale of lambs, sheep, wool, and hay make up much of the rest. Many years, we also receive income from a couple of Vermont's ski areas, which pay us to graze our sheep on their steepest slopes. Cynthia and I both work full time on the business with a couple of employees during the summer.

Over the years we have thought long and hard about how to make the most of our pastures. That goal determines how we manage the farm. Our calendar begins with the approach of the grazing season. I will sketch out the important events of the year, then I will describe in greater detail our lambing, weaning, cheesemaking, and the like.

We milk and make cheese only when the sheep are on pasture, because the cheese has more character in this season. Thus we lamb our first group of approximately eighty ewes in mid-March. The lambs nurse for 30 days before weaning, then we start milking and cheesemaking just as the grass takes off in the second half of April.

Additional groups of ewes lamb later in the spring, with the last group lambing in early June. The last group of ewes to lamb is made up of the oldest, most experienced ewes; they lamb on pasture. We spread the lambing out all spring because our facilities and available labor are not sizable enough to deal with all of the ewes, all of the lambs, and all of the milk at once. What is more, this system allows us to milk the full length of the grazing season.

Milking continues until October or November and ends for various ewes as they are put with the

rams. For the duration of their pregnancy, the ewes live outside on the snow - until the last few weeks when we shear them and bring them into the barn. Then, in mid-March, the lambing and growing season begins all over again.

After weaning, our lambs lead a much more relaxed life than that of their moms. We wean the lambs week by week throughout the spring as they reach thirty days of age, and we wean them on to pasture. All of the ram lambs are sold off during the course of the summer as hothouse or feeder lambs. Most of the females we keep. We graze them rotationally throughout their first summer, moving them every other day. Like all our sheep, they spend the winter outside. Their second summer, they spend on a mountain where they graze down ski slopes. In the fall of their second year, we select which ones we would like to keep and breed them; thus they do not lamb until they are a full two years old.

You can tell from this sketch of our farm activities that we make and market our cheese seasonally. April through October we make cheese three times per week; on Mondays, Wednesdays, and Fridays. My wife, Cynthia, and I work together making cheese. Cheesemaking mornings are about the only time we have to be together in relative peace.

We make only one type of cheese, an aged traditional style mountain cheese. We call it Vermont Shepherd, and it ages for four to eight months. This means that our cheese marketing year is four months or more out of sync with our cheesemaking. We sell our cheese from August through mid spring, then have no cheese to sell for several months until the first of the next year's cheese is ready to sell again in August. Making, curing, marketing, and shipping the cheese is a lot of work and takes up most of Cindy's time.

Having described for you our farm in brief, now I would like to describe in greater detail our procedures for milking, making cheese, and cheese marketing. However, I should mention another project of ours before I do so. Recently, we purchased the farm just down the valley from Major Farm. With the help of the Vermont Land Trust and the Vermont Department of Agriculture, we are using this farm to teach Vermonters about sheep dairying and farmhouse cheese production. In a few years we hope to have a network of farms in Vermont milking sheep and producing cheese independently, but curing and marketing the cheese together. We call this project "The Sheep Dairy Center at Patch Farm." This spring we are beginning to pasture and milk a large group of ewes there, just as we do on Major Farm.

Our milking set-up is a fairly simple one. Usually only one person does the milking. The procedure first involves getting the sheep from pasture. Then we set up the equipment, milk the ewes, put the ewes on to a new pasture, and wash up. We give the ewes new pasture every twelve hours, that is, after every milking.

We use an old surge bucket for milking. It allows us to milk two ewes at a time. While we are milking them, we wash the next two, then move the teat cups over. Our parlor is a fourteen unit, one sided parlor. The sheep are held in place with a cascade yoking system. With this system, we milk about sixty sheep in an hour.

The cascade yoking system that we use is a European design. We have a business making and selling the headgates to people milking sheep and goats. Ask me for a brochure if you are interested

Our sheep move easily in and out of the parlor on their own. I think the reason is that the sheep walk straight up a ramp into the parlor, they are walking toward light, they can see where they are going, and the headgate is simple for them to operate. I have seen parlors where the animals have to

be crowded to push them into the parlor. I know this adds to the labor of milking; we are lucky to avoid this.

We measure how much milk each ewe is producing regularly every Tuesday morning. Until this year we have milked the cross of domestic sheep that my family has always had. Their lifetime per lactation average stands at just over 160 pounds, with the best ones producing around 500 pounds per lactation. That is a tremendous improvement over the 60 pound average we had the first summer we milked. We are about to see further improvement since we now have some Swiss East Friesland/Major sheep crosses that are old enough to be milked.

We have our production records on computer. We do our accounting on computer as well.

A single milking of sixty to 110 ewes will fill one to two 40 quart stainless steel milk cans. We store these cans in a can cooler until we are ready to make cheese.

The cheesemaking itself is relatively simple and a relaxed sort of work, though it leaves no room for error. The cheesemaking work compliments the farm work well, I think. I take the milk, which is fresh, not frozen, to the cheese house immediately after milking on cheesemaking mornings, and I start the heating process. The milk pretty much takes care of itself until the last couple of hours of the morning, when Cindy and I both work, cutting the curds and forming the cheeses. In the afternoon one person needs to spend an additional couple of hours cleaning and turning the newly made cheeses.

Each wheel of our cheese averages about ten pounds, and we make between three and twelve every batch, about twenty per week. For the year we are making close to three tons of cheese. Last year we made one pound of cheese for every 4.6 pounds of milk.

Cindy puts considerable time into curing the cheeses - her babies, she calls them, to the jealous annoyance of our kids. The cheese requires more attention than waxed or vacuum packed cheese, because it is a natural rind cheese and needs turning and wiping regularly. Most weeks Cindy spends upwards of ten hours in the curing room.

After the three years it took us to make a decent cheese, the marketing of the cheese has been a pleasure. As a kid, Cindy's dad programmed her to stop in the markets between her home and school and move her family's milk cartons to the front of the dairy case. So you see, she has marketing in her genes.

In 1993, we took an award for best farmhouse cheese in a national contest. That award and similar awards we received in 1994 and 1995 have helped introduce our cheese to cheese buyers. At the moment, demand well exceeds our supply. We wholesale the cheese for nine dollars a pound plus shipping, and send it out UPS. Stores and restaurants in Boston, New York, Washington, Ann Arbor, Chicago, Los Angeles, and Seattle all buy our cheese. We have about thirty accounts in all.

Thus far our efforts at promotion have been fairly modest; the cheese has been selling itself, and has wound up on the pages of Gourmet Magazine, Food and Wine, and the New York Times through no special effort of our own. One thing we do try to do is establish friendly relations with the buyers. Cindy volunteers to work at cheese shops for a day or two at a time and do in store cheese promotions. In the very beginning, we found it a valuable experience to market the cheese at a farmers' market. So far, we have not found mail order to be worth the time and money; it is best handled by a couple of the stores we sell to.

I should note that few people who buy our cheese know it is made from sheep's milk, any more

than they know that Roquefort is made from sheep's milk. They buy it because it is good. I think there is a tiny market out there for sheep's milk products. But the market for high quality whole-some cheese is far greater.

There are a few principles and bits of advice that we have found helpful building our farm and cheese business. If we have any secrets, it is these.

Secret number one is low inputs. We make the most of what we have - plenty of grass, stones, labor and baling twine. The original reason for keeping down inputs was economic necessity; the farm could not pay for quantities of purchased feed, cement foundations, or factory made lamb jugs. A second reason for keeping down inputs has become obvious more recently. It builds character - we are using the grass and labor resources of the farm, not generic inputs. Character is important, because it is what sells specialty cheese.

Secret number two follows logically. This one we learned on a two week trip to France, after making bland cheese for three years. There we made cheese on different farms, all of them small, family run affairs in the southwest of France, where the valleys are narrow and deep and the mountains snowcapped. The recipes the farmers were using were all the same, but the cheese was different, because of the different vegetation growing at different elevations, because of the variety of sheep being milked, because grandfather Pujalet insists on stirring the heating milk with his bare hands. So the secret is this: Every valley, every farm, has a special character of its own. If you are careful, you can capture that specialness in the products coming from the farm. This is a fairly abstract and hocus pocus-y idea for us Americans, but it has some practical consequences. First off, let the native grasses grow. Second, let the sheep eat those grasses. Third, keep sheep that are best adapted to the place. Fourth, milk in season. Fifth, treat the milk with care, it has a lot of precious stuff in it; do not agitate the milk, do not freeze the milk or overly heat it, and do not change the temperature of the milk too fast. Sixth, make the cheese by hand. And seventh, cure the cheese in the natural environment.

I want to say a few more words about freezing milk. We froze our milk for the first few years of our dairying. When we told the French farmer hosts that, all conversation ceased; they could not get over the shame of it. So we quit, and our cheese improved vastly. I know you can make good cheese from frozen sheep's milk, but I do not believe you can make top quality cheese - milk is too fragile.

I think the main point is that we stress quality even more than efficiency, character even more than consistency. In marketing, we rely on the quality of the cheese to sell it, rather than fancy packaging or advertising. We are trying to keep the business one with a high margin and a low volume.

In this country, we are short on farmhouse cheesemaking expertise. Nevertheless, we have found the American Cheese Society to be a wonderful resource. It's phone number is 415-661-3644. Also, you have a fine cheesemakers' association in the state of Wisconsin. It can be reached at 608-255-2027.

THE U. S. COMMERCIAL DAIRY GOAT INDUSTRY: A BRIEF HISTORICAL ACCOUNT

Laura Jacobs-Welch

Administrator
American Dairy Goat Products Association
Darien, Wisconsin

The dairy goat has been an important source for food and fiber for mankind for thousands of years and was an important part of the necessities which the earliest settlers brought to these shores.

In the 1970's, a back-to-the-earth movement was catching on in America. A return to more simple, sustainable agricultural techniques were also finding new interest. The dairy goat was a perfect animal to fit into these new lifestyles. Due to her adaptability, she quickly fit into the many different terrains of the U.S. Breeders of this highly intelligent animal were finding challenges in breeding for increased milk production, housing and fencing, and providing feed sources for the somewhat picky eater (despite an undeserved reputation to the opposite). Since the 1980's, with the evolution of the American palate towards more healthful and natural food sources, the popularity of dairy goat products has grown each year.

Originally considered a medicinal alternative to cow milk, goat milk was often sold to those with cow milk intolerance and was valued for its therapeutic value rather than its excellent flavor and texture. One of the largest processors of goat milk in the U.S. found their first market in drugstores across the country during the 1930's. That company was Jackson-Mitchell, and they have pioneered in the industry by providing pasteurized and ultra-pasteurized goat milk products, as well as developing a facility for powdering milk. Until recently, however, with nationwide distribution of this product and many others, the consumer's source for goat milk was at the farm, in health food stores, or in ethnic markets.

Over the last ten years, however, the demand for fresh, natural, and wholesome foods has encouraged the growth of a variety of wonderful goat milk products which are available in almost every metropolitan area of the United States. While goat milk, ice cream, and yogurt are sold in various parts of the United States, the best known goat milk product is soft goat cheese or chevre. The development of nouvelle and regional cuisines across the country increased the demand for the soft, lactic goat cheeses that Americans call 'chevre', the French word meaning 'goat'.

During the last decade there has been an enormous increase in consumer interest for domestic goat cheeses. The number of domestic goat cheese producers has increased dramatically and there are currently over 50 such producers in the United States. Not only has domestic production increased, today's world-class American made goat cheeses are replacing foreign goat cheese in many domestic specialty shops.

Sure, the goat is not a cow, and we now look for the differences our goats exhibit. Differences from feeding to animal health differences to even the justified difference in flavors. Dr. Bob Lindsay educated judges at last year's product competition in Madison to respect and look for the goatly flavor in each particular product. The sharp, clean, tangy taste evident in the fluid and solid product is something to be celebrated.

You see, it has happened! The goat and her products are beginning to take on a new persona.

One of desired, individual characteristics, and a number of important factors continue to play a role in the continued success of the dairy goat and her products.

I. 1970 - A change in philosophy

Big is not always better, in fact sometimes, better is better! Sustainable agriculture and smaller farms began making a come back, in addition to the popularity of farmers' markets. The American consumer was getting tired of being fed pablum. They wanted taste and quality, individuality and personality in their food sources. As the home and the hearth were taking on new importance, however, many Americans in large urban cities found themselves in two-career families. With less time for cooking, but more money, they frequented restaurants that offered unique menus, and they began to find everything from shitake mushrooms to homebaked bread, a better chocolate chip cookie, and a face behind a name, which now became increasingly important. A chef who could introduce a new goat milk product and also tell his clients who made it had a hit.

II. 1980 - Determination and dedication

A group of devoted, adoring fans of the dairy goat grew up out the smaller hobby farmer into the commercial farmer of today. Names like Mary Keehn, Cypress Grove Chevre; Judy Schad, Capri-ole; Letty and Bob Kilmoyer, Westfield Farms; Jennifer Bice and Steven Schack, Redwood Hills Farms were some of the original farmers who believed enough in their product to think they could actually make a living off the goats. And people like Laura Chenel, with a French native background, or Paula Lambert, who remembered those wonderful handmade cheeses from Italy, brought hard work and new recognition to the industry. There was no million dollar association to back them up with nationwide, generic, marketing efforts. They donated much product over the years to in-store demonstrations and to chef-producer tastings all over the country. They went out and found and developed markets for their product. The resulting press began to bring notoriety to this new kid on the block. And these small and mid-size processors were joined by large processors, like Fleur de Lait Foods and Jackson-Mitchell in popularizing the products of the dairy goat in America. Soon, a distributor and a retailer caught wind of this new adventure and began requesting the product for their shelves. Still no national marketing campaigns!

Another market presented itself to the small and mid-size processor in the form of the Farmer's Market, popping up in all major urban locations. Smaller farmers, especially, just getting into the commercial business, found they could supplement their income by selling their product at the local Farmer's Market, and maybe even introduce themselves to a new market, as chefs shopped for the freshest produce for their weekend clients. Soon, "JOE PUBLIC" was beginning to try and take home the goat cheese. Another phenomenon, the main streaming of goat cheese was beginning to occur.

III. 1990 - The return of the Specialty Cheese

In the 90's, one of the most important occurrences was the reemergence of the Specialty Cheese as a popular menu item. Now, attention was being paid to those unique aged cheeses, especially as they won competitions all over the nation, from California to Green Bay and on to the East Coast. Names like Hubbardston Blue, Wabash Cannonball, and Humboldt Fog now signified a new class of cheese. Those wonderful aged and ripened cheeses that were remembered from Europe were taking on a personality all their own. The American Cheese Society celebrated these specialty cheeses produced by the farmer from milk made by his/her animals on the farm. And specialty cheeses began showing up in cheese courses offered by premier restaurants around the U.S., and in return were

featured in numerous articles by the top industry publications supporting the food industry, as well as home and hearth.

Did many of you catch the Martha Stewart Living magazine published in September 1995? I'm sure quite a few of you know of Martha Stewart? If you aren't familiar with her, she is the current guru on everything from home furnishings to remodeling to entertaining. She has a program on the cable network, and she has a favorable past experience with goats. She covered goat milk products in beautiful, colorful detail to the immense benefit of the whole dairy goat industry. The pendulum is swinging back to another direction now, and the dairy goat industry is flourishing just in time to meet it. In America, farmstead products are being celebrated: front basket weaving to jam making to cheesemaking. Lost art forms are revived daily. The American Dairy Goat has come of age in a time ready to support it's individuality.

And still no National Marketing Campaign!

Prior to 1991, the organized group for goat owners was the American Dairy Goat Association, a breed registry association primarily involved with the purebred goat. However, there were a number of directors as well as members who exhibited a limited willingness to support financially a producers' organization.

In November 1991, the American Dairy Goat Products Association was born - "to provide a network for those who produce, process, market, and promote the products of the American dairy goat industry, and to encourage the growth of this industry through information, promotion, research and regulatory action." We put together press kits made up of colored note cards and posters and a goat milk brochure extolling the benefits of our product. The brochure is now in its 2nd printing, with more than 100,000 having been sold by the end of 1995. The association also owns a display which it makes available to members who want to sponsor dairy goat conferences and want to promote the dairy goat industry. As of 1996, we still have no national checkoff program, and yet we still continue to make progress and are the only organization in the United States supporting the commercial industry. And most of that continuing progress can only be attributed to the belief of its volunteer members that this product is worth something to the consumer. This strong belief has carried us through a myriad of image problems based on a stereotype of the tin-can eating, smelly, obnoxious goat that our grandparents and parents remembered. We are cultivating a new goat, however, an extremely useful animal that is very versatile, intelligent, and productive. Some of our greatest industry challenges are still to be met as we educate our producers to become the best that they can be. We might find ourselves facing a critical nationwide milk shortage as our processors find their markets expanding. Due to the seasonality of our milk supply, processors have been dealing with fluctuations in their supply which can be detrimental to their businesses. More research must be done to increase successes of out-of-season breedings and to promote the breeding programs of those interested in raising animals with consistent, extended lactations.

We must also develop meat markets for the many dairy "kids" born on the dairy farms. As at the current time they have been effectively a wasted resource. Some producer/processors have begun to market their kids in much the same way as they did their cheese; by getting in touch with the chef, offering a farm fresh product that offers less fat and less saturated fat than in a 3 oz. portion of beef, pork and lamb and less calories than all those but chicken. In addition, this same portion offers more protein and iron than all of them.* It has only been in the southwest where a market has actually been developed, and this to serve the large Hispanic market.

Another goal, and one which we have already become involved with, is in distinguishing the differences in the makeup between goat and cow milk as far as legislators are concerned. For example, we now know that elevated levels of somatic cells present in cow milk that indicate udder health don't necessarily mean that in goats. New methods of testing are being looked at for determining udder health in goats by Dr. Lynn Hinckley at Cornell University as well as new calibrations for goat's milk in current equipment. With work from members, again volunteer, who sit on the Interstate Milk Shippers Board, we are beginning to make our presence felt as an industry to be counted.

We are very optimistic in the dairy goat industry and have overcome serious stigmas and amazing odds to become nationally recognized as an alternative dairy source. With our enthusiasm and the current tide of excitement, we intend to accomplish much more in the next five years. Indeed, why shouldn't the industry succeed?

For more information about the commercial dairy goat industry, contact the ADGPA office at: W7702 Cty Rd X, Darien, WI 53114 and by phone (414) 728-1633 or fax (414) 728-1658.

*From Use of Goat Milk and Goat Meat as Therapeutic Aids in Cardiovascular Diseases. Dr. John R. Addrizzo, MD, Staten Island Medical Center, NY

Sources:

1- USDA Handbook #8 1989

2-Nutritive Value of Foods. Home and Garden Bulletin Number 72, USDA, Washington, DC, US Government Printing Office, 1981.

3 oz. roasted	Calories	Fat	Saturated Fat	Protein	Iron
Goat- 1	122	2.58	.79	23	3.2
Beef- 2	245	16	6.8	23	2.9
Pork - 2	310	35	8.7	21	2.7
Lamb - 2	235	16	7.4	22	1.4
Chicken - 2	120	3.5	1.1	21	1.5

GROWTH AND REPRODUCTION OF 1/4 EAST FRIESIAN LAMBS

Yves M. Berger and David L. Thomas

University of Wisconsin-Madison
Spooner Agricultural Research Station
Department of Meat and Animal Science

The East Friesian breed of sheep is considered one of the highest producing dairy sheep breeds in the world. The main goal of this project is to determine if East Friesian genes will improve commercial milk production of U.S. ewes. Since many U.S. sheep dairies are milking purebred or crossbred Dorset ewes, the East Friesian will be compared to the Dorset at the Spooner Station. Lamb production will continue to be an important source of income to sheep dairies for the foreseeable future. Therefore, this report presents the first comparative results of the growth and reproduction of crossbred sheep with East Friesian or Dorset breeding.

In August 1993, the University of Wisconsin-Madison purchased two 1/2 East Friesian ram lambs from a Canadian producer in British Columbia. The rams were born in March 1993 and were the progeny of Arcott Rideau ewes artificially inseminated with pure East Friesian semen imported from Switzerland. In October-November 1993, (Dorset x (Romanov x Targhee)) and (Dorset x (Finn x Targhee)) crossbred ewes were exposed to either two pure Dorset rams or to the two 1/2 East Friesian rams in single sire pens. The ewes lambed in March-April 1994.

Postweaning, twenty-eight 1/4 East Friesian and twenty 3/4 Dorset ram lambs were placed in two adjacent pens and growth and feed efficiency were measured. The lambs were chosen on the basis of weight and age in order to have two groups of approximately the same average weight and the same average age at the start of the trial.

In addition to the lambs discussed above, in February 1994 some lambs were born from the mating of the 1/2 East Friesian and Dorset rams to Romanov x Targhee and Finn x Targhee ewes. These February-born ewe lambs were mated from September 19 to October 24, and the March-born ewe lambs out of 1/2 Dorset ewes were mated from October 26 to December 1. Ewe lambs were mated to either 1/2 East Friesian or 3/4 East Friesian rams.

Table 1 presents the lambing performance of the 1/2 Dorset ewes mated to Dorset or 1/2 East Friesian rams, the survival rate of the lambs as well as their birth weights and their adjusted weights at 60 days. Ewes mated to 1/2 East Friesian rams gave birth to more lambs than ewes mated to Dorset rams (2.38 and 2.10, respectively). The survival rate of 1/4 East Friesian lambs was very high (98.4%) and greater than the survival rate of 3/4 Dorset lambs (93.3%) even though more lambs were born per ewe from ewes mated to 1/2 East Friesian rams.

Among ewes raising 1/4 East Friesian lambs, only three lambs from three different sets of triplets were raised on milk replacer. Therefore, two ewes raised single lambs, 14 ewes raised twin lambs and 12 ewes raised triplet lambs. Among ewes raising 3/4 Dorset lambs, only 1 lamb from a set of triplets was raised on milk replacer. Therefore, 13 ewes raised single lambs, 20 ewes raised twin lambs, 16 ewes raised triplet lambs and 1 ewe raised her set of quadruplets.

The mean birth weights adjusted for sex and type of birth were not significantly different between the two types of lambs, although birth weights of 1/4 East Friesian lambs were consistently higher. Only birth weights of twin lambs were significantly different between the two breed groups.

The mean weight of lambs at 60 days adjusted for age of ewe, type of birth, type of rearing, and sex of lamb, was 10 pounds higher for the 1/4 East Friesian lambs than for the 3/4 Dorset lambs. By combining the fertility, litter size, survival rate, and adjusted weight at 60 days, ewes mated to 1/2 East Friesian rams weaned more pounds of lambs than ewes mated to Dorset rams (147.2 lbs. and 100.1 lbs., respectively).

East Friesian lambs had greater postweaning gains than Dorset lambs (.95 lbs and .76 lbs./day respectively) with an similar feed efficiency of approximately 4.6 lbs of feed per pound of gain (Table 2). The fastest growing East Friesian had a total ADG of 1.19 lb/d.

Performance of ewe lambs lambing at approximately 12 months of age is presented in Table 3. Dorset-sired ewe lambs were lighter at mating, had lower fertility, and had lower litter size than 1/4 East Friesian ewe lambs. Adjusted 60 day lamb weights were greater for lambs produced by the 1/4 East Friesian ewes than for lambs from the 3/4 Dorset ewes, but weights were similar for lambs from the 1/4 East Friesian and 1/2 Dorset ewes. Relative to crossbred Dorset ewe lambs, crossbred East Friesian ewe lambs appear to have a higher reproductive rate and produce lambs of similar or greater growth rate.

In conclusion, 1/4 East Friesian lambs had a very high rate of survival to weaning with no evidence of any particular health problems thereafter, grew faster from birth to 60 days of age than Dorset-sired lambs, grew faster from weaning to 120 lbs. than Dorset-sired lambs, had the same feed efficiency as Dorset-sired lambs, and had greater lamb production at 12 months of age than Dorset-sired ewe lambs.

Table 1. Performance of Ewes Mated to Dorset or 1/2 East Friesian Rams and Prewaning Growth of Lambs

Trait	Breed of Service Sire	
	Dorset	1/2 East Friesian
No. ewes exposed	52	26
Fertility, %	96	100
Litter size, no.	2.10	2.38
Lamb survival to weaning, %	93.3	98.4
Lamb birth weight, lb (overall)	9.4	10.0
Singles	10.8 ^b (13) ^a	11.0 ^b (2)
Twins	9.4 ^c (40)	10.6 ^b (24)
Triplets	7.9 ^b (48)	8.5 ^b (36)
Quads	6.1 (4)	
Adjusted 60 day wt., lb	53.1 ^c	62.8 ^b
Wt. of lamb weaned/ewe present at breeding, lb	100.1	147.2

^a(Numbers of lambs born of each birth type).

^b^cp < .01

Table 2. Postweaning Growth of 3/4 Dorset and 1/4 East Friesian Ram Lambs (48 Day Trial)

Trait	Breed of Sire	
	Dorset	1/2 East Friesian
No. ram lambs	20	28
Starting age, d		
	80.4±1.18 ^a	78.8±1.03 ^a
Starting weight, lb	74.2±3.11 ^a	78.3±2.7 ^a
Ending weight, lb	110.9±4.02 ^b	123.8±3.49 ^a
ADG, lb/d	.76±.04 ^b	.95±.04 ^a
Feed efficiency, feed/gain		
	4.57	4.55

^a_bP < .01

Table 3. Reproduction of Ewe Lambs sired by Dorset or 1/2 East Friesian (EF) Rams

Trait	Breed of sire:		Breed of dam ^c :	
	Dorset	1/2 EF	Dorset	1/2 EF
	1/2R,1/2T	1/2R,1/2T	1/2D,1/4R,1/4T	1/2D,1/4R,1/4T
	1/2F,1/2T	1/2F,1/2T	1/2D,1/4F,1/4T	1/2D,1/4F,1/4T
No. ewes exposed	16	16	31	32
Age start of breeding, d	208±1.3 ^a	212±1.3 ^a	212±1.0 ^a	211±1.0 ^a
Wt. start of breeding, lb	115.4±4.0 ^b	126.3±4.0 ^a	119.7±2.1 ^b	129.3±2.1 ^a
Age at lambing, d	371±4 ^a	380±4 ^a	366±3 ^b	363±3 ^b
Fertility, %	81.3	87.5	87.0	96.9
Litter size, no.	1.71 ^{ab}	2.29 ^a	1.42 ^b	1.81 ^{ab}
Lamb survival, %	100	97.0	92.3	92.7
Adj. 60-d lamb wt., lb	67.4±2.7 ^{ab}	63.9±2.7 ^{ab}	58.6±2.1 ^b	67.7±1.7 ^a

^a_bP < .01

^cBreed of dam: R=Romanov, F=Finn, T=Targhee, D=Dorset.

DAIRY SHEEP BASICS FOR BEGINNERS

David L. Thomas

Department of Meat and Animal Science
University of Wisconsin-Madison

History

Sheep have been raised for their milk for thousands of years. Today the commercial dairy sheep industry is concentrated in the European and Mideastern countries on or near the Mediterranean Sea. France alone has almost one million ewes in dairy production. Most of the world's sheep milk is processed into cheese. Roquefort, the blue cheese of south central France, is one of the better known of the sheep milk cheeses. The U.S. annually imports more than 60 million pounds of cheese made from sheep milk.

It is estimated that approximately 100 farms in the U.S. are now milking ewes. Sheep dairy farms are spread throughout the country with the largest concentration located in northwestern Wisconsin. Some very large sheep dairy farms are located in New York and California. While the potential market for sheep milk and sheep milk products appears very promising, the present markets for sheep milk are few. Before venturing into a dairy sheep enterprise, be sure you have identified a stable market.

Characteristics of Dairy Sheep

Sheep that are commercially milked are of the same genus and species (*Ovis aries*) as sheep that are raised for meat and wool. However, a few specialized dairy breeds have been developed over time that are exceptional milk producers, e.g. East Friesian of Germany, Lacaune of France, Sarda of Italy, Chios of Greece, British Milksheep of the U.K., and Awassi and Assaf of Israel. These breeds will produce 400 to 1,100 pounds of milk per lactation. Due to very strict animal health regulations on the importation of live sheep, embryos and semen, these breeds are not readily available to U.S. producers. There are a few East Friesian sheep and their crosses available that were imported into Canada and then into the U.S. It is anticipated that there will be improved access to specialized foreign dairy sheep genetics in the future.

Domestic breeds which appear to be the best adapted to dairy production are the Dorset, Polypay and Rideau Arcott. Individual ewes of many other breeds also are good milk producers. However, the milk production of domestic ewes (100 to 200 pounds per lactation) is far below that of the specialized dairy breeds.

There are very large differences between breeds of sheep for all production characteristics so ewes that are milked can also be very variable depending upon the animals selected. Following are some realistic ranges for various characteristics and production traits:

Ewe Traits:

- Mature body weight (ewes) - 150 to 170 pounds
- Attainment of mature size - 2 to 3 years
- Productive life span - 6 to 8 years
- Wool production - 6 to 10 pounds per year

Reproduction:

Seasonal breeders - will mate from September through December
Length between estrous periods - 17 days
Gestation length - 147 days (~ 5 months)
Lambing months - February through May
Puberty - 7 to 10 months
First lambing - 1 or 2 years
Number of lambs per birth - 1 to 3

Lamb Growth:

Birth weight - 7 to 10 pounds
Survival of lambs to weaning - 85 to 95%
Weaning age - 30 days (30 to 60 days younger than for non-dairy flocks)
Weaning weight - 20 to 35 pounds
Daily gain (postweaning) - .6 to .9 pounds per day
Lamb market weight and age - 100 to 125 pounds at 5 to 8 months

Lactation Traits:

Lactation length - 90 to 150 days for domestic ewes, 120 to 240 days for specialized dairy breeds
Milk production per lactation (mature ewes) - 100 to 200 pounds for domestic ewes, 400 to 1,100 for specialized dairy breeds, 250 to 650 pounds for crosses between domestic and specialized dairy breeds
Fat content of milk - 6 to 8%
Protein content of milk - 5 to 7%

Sheep Housing

Most dairy sheep producers should have a barn or shed that can accommodate all their ewes. Fifteen to 20 sq. ft. of barn space per ewe is necessary to provide adequate space for ewes and lambs. The barn should have a porous floor (dirt, gravel, etc.) to allow moisture to move away from the sheep. The barn also should have good ventilation but be draft-free to prevent chilling of newborn lambs. Such a barn is a necessity for flocks which lamb in the winter.

Ewes and lambs can be maintained in barns and dirt lots year round and fed stored feeds, but use of pasture will decrease feed costs. One acre of improved and fertilized pasture should support at least 5 ewes for the grazing season. Pastures can be fenced with traditional woven wire or with 5 strands of high tensile electric fencing. Greater efficiency of pasture use will be achieved if large pastures are temporarily subdivided into smaller paddocks with portable electric fencing.

Sheep are often grazed with cattle, but ewes in lactation should be grazed separately so they do not have to compete with cattle for available forage. In areas where predatory animals are a concern, guard dogs, donkeys and llamas that have been bonded to sheep often are commingled with sheep as a deterrent to predators. Sheep should not be commingled with horses or pigs.

Feeding

Adequate amounts of clean water are essential for maximum production. Lactating ewes have the highest water requirement of any class of sheep at approximately 3 gallons per head per day.

Ewes can be feed a variety of feedstuffs. The most common feeds for sheep are pasture, hay (legume, grass or legume/grass mix), haylage, corn silage, grain (corn, oats or barley), soybean meal,

loose salt with trace minerals added, and loose mineral supplements. The ewe's requirements are the greatest during the last month of gestation and during lactation. Table 1 presents some sample rations for a ewe throughout the year.

Total feed requirements for a ewe for a year will be dependent upon her lactation length. A ewe milking for 180 days would require approximately 1600 pounds of alfalfa hay, 325 pounds of corn and 45 pounds of soybean meal per year if these were the selected feedstuffs.

Table 1. Alfalfa Hay and Corn Rations for 155 Pound Ewes

Stage of Production	Pounds of feed per ewe per day		
	Alfalfa hay	Corn	Soybean meal
Dry and non-pregnant	4.0		
Flushing (2 weeks before start of breeding season and continues for 4 weeks)	4.0	1.00	
Early pregnancy (first 4 months)	4.0		
Late pregnancy (last month)	4.0	1.00	
Early lactation (first 60 to 70 days)	5.0	1.75	.50
Mid lactation (~60 days)	5.0	1.50	.25
Late lactation	4.0	1.00	

A mineral mix prepared for sheep is offered free choice at all times. The alfalfa hay can be eliminated for ewes on high quality pasture.

Some feeds can impart undesirable flavors to the milk (e.g. fish meal) and should not be fed in large quantities during lactation. Copper can be toxic to sheep. Only mineral supplements and prepared feeds that have been specially formulated for sheep should be fed, because many feeds for other livestock species contain added copper. Specially formulated mineral mixes for sheep also contain added selenium which is required by sheep but deficient in much of the Great Lakes' region.

Weaning age for lambs in non-dairy flocks is 60 to 90 days. However, in dairy flocks, lambs are weaned at approximately 30 days of age in order to put ewes into the milking parlor while they are still producing adequate amounts of milk. Nursing lambs must be offered at all times a high concentrate (75+% total digestible nutrients), high protein (16%) ration in an area where they can escape from their mothers. This extra feed will improve their weights at weaning and adapt them to solid feed. Once they are weaned, they should continue on this ration, with some alfalfa hay provided also, until reaching approximately 75 pounds. From 75 pounds to market weight, they can be fed a ration with a lower protein content (14%). Each lamb will require 350 to 400 pounds of feed from birth to market weight. Feed costs can be reduced if lambs are raised on pasture, but their daily gains generally will be less. Pasture raised lambs also are more susceptible to predators and to infestation with internal parasites.

Health Care and Sanitation

For the most part, health considerations for dairy sheep are the same as for sheep raised for meat and wool. Lambs should be vaccinated with a combination vaccine that gives protection against enterotoxemia and tetanus. Ewes should be given the same vaccine prior to lambing to provide

passive immunity to the newborn lambs to these two diseases. If abortion disease is common in your area, ewes should be vaccinated against *Campylobacter fetus* and *Chlamydia psittaci*. Lambs and ewes should be routinely treated for internal parasites, especially while on pasture.

Care must be taken to make sure that lactating ewes are not administered any drugs or compounds which may taint the milk. Lactating ewes should be monitored for mastitis and treated at the first signs of the disease. Routine use of the California Mastitis Test (CMT) will identify an incidence of subclinical mastitis for early treatment.

A complete flock health program should be developed in consultation with your local veterinarian.

A ewe and her lambs will produce about 7 pounds of manure per day. Combined with bedding material, this will result in production of 10 to 12 pounds of waste material per ewe per day while ewes are housed indoors. Provisions must be made for proper disposal of this material. Local and state regulations must be checked to determine the allowable amount of waste material that can be spread on your land.

A disposal method for carcasses of dead sheep also must be in place. This is an especially crucial problem because many rendering companies which collect dead stock at the farm will no longer pick-up sheep carcasses. Other disposal options to investigate include burying or land fills.

Milking Facilities and Equipment

Milking facilities and equipment will be one of the greatest expenditures of the dairy sheep operation. Before any facilities are built or equipment is purchased, visit as many dairy sheep farms as possible and visit with several dairy sheep equipment firms to determine what will work best on your farm. A milking parlor and milk room will be required. Producers should contact their State Department of Agriculture for regulations regarding requirements for such facilities.

Producers who will be milking less than 50 ewes should consider constructing a milking platform for the ewes to stand on while being milked. Most states will require the platform to be made of non-porous material, generally metal. The platform should be 32 to 36 inches off the floor with a ramp at either end for the ewes to enter and exit. One side of the platform will have a set of stanchions for securing the ewes and a manger for feeding grain. Adequate space must be available in front of the platform for a person to fill the manger with feed. The ewes are stanchioned side by side and milked from the rear. When stanchioned, the rear legs of the sheep should come within 3 to 5 inches of the edge of the platform. The width of the platform will depend upon the size of the ewes to be milked, but a width of 35 to 45 inches from the stanchion to the rear of the platform will accommodate most ewes. Commercially manufactured stanchions come in groups of 6, so one platform should be constructed to accommodate 6 or 12 ewes at one time. If desired, two platforms can be constructed and set parallel to each other, back to back, with 40 to 45 inches between platforms for the milker(s) and milking equipment. Two platforms allow ewes on one platform to be milked while ewes on the other platform are released and replaced, thus eliminating the need to stop milking to wait for ewes to enter the platform.

Producers with 100 or more ewes should consider constructing a "pit" parlor where the ewes enter at ground level and the milker stands in a pit. Sheep tend to move into the parlor faster in a pit system than in a platform system, and sheep are easier to train to the pit than the platform system. The pit and the area on which the sheep stand are constructed of concrete. The dimensions are the same for the pit and platform systems with one possible exception. With a pit system, there is a choice of two possible stanchion systems - the stationary stanchion used in the platform system or a

movable stanchion. Movable stanchions are mounted on wheels and moved forward to allow a greater area between the stanchion and the pit than is present on a platform. This greater area allows the ewes faster entrance to the stanchions. Once all ewes are stanchioned, the entire stanchion system is moved back until the ewes' rear legs are near the edge of the pit. This movable stanchion can accommodate ewes of different sizes. To install a movable stanchion, there must be at least 90 inches of area in front of the pit plus some additional area for feeding of the sheep.

Minimum milking equipment in the parlor will include a vacuum pump and line, one set of milking claws, and a milking bucket. Milking time is reduced with more milking claws and buckets. Use of buckets requires carrying of milk from the parlor to the milk room. Labor is reduced, but capital and maintenance costs increased, if a pipeline is installed which transports the milk from the sheep to the milk room. In the milk room, the milk is deposited into a bulk tank for cooling.

After the milk is cooled, it can be transported to the processing plant. However, more often than not, it is moved from the bulk tank to plastic buckets or other large containers and frozen. Therefore, adequate freezer space is necessary for the storage of several days of production. While fresh milk may result in a product of slightly higher quality, frozen milk has been shown to produce very acceptable products. The ability to freeze milk on the farm and deliver large quantities to a processing plant at infrequent intervals has allowed the establishment of dairy sheep farms great distances from the processing plant.

Economics

In a dairy sheep operation, milk is one of three major products - the other two being meat and wool. Lamb and wool will be a major source of income from a dairy sheep operation, and their production must receive adequate attention in order to maximize returns.

Milk can be sold to a processor for conversion to cheese (yogurt and ice cream also are made from sheep milk) or the milk can be processed by the producer and marketed as a value added product. Before venturing into the processing of sheep milk, producers must make sure they have the necessary processing and marketing skills and a ready market for the final product. It probably is a good idea to first concentrate on the production of milk from sheep for sale to a processor. Processing your own milk can be a future effort if it appears to be economically feasible.

Table 2 presents a sample dairy sheep budget.

Table 2. Sample Dairy Sheep Budget.

Assumptions:

100 ewes of domestic x dairy breed cross

1.7 lambs raised per ewe, 1.5 lambs marketed per ewe, .2 lambs per ewe retained for replacements

Ewes graze pastures for 5 months each year

Lambs do not go to pasture

Item	Total	Your estimate
Receipts:		
Milk - 250 lb. x 100 head x \$.55	\$13,750	
Lambs - 150 head x 115 lb. x \$.70	\$12,075	
Cull ewes and rams - 15 head x 150 lb. x \$.20	\$450	
Wool - (100 ewes x 8 lb. x \$.40) + (170 lambs x 3 lb. x \$.20)	\$422	
Total receipts	\$26,697	
Feed costs:		
Ewe feed - (90,000 lb. hay x \$.04) + (32,500 lb. corn x \$.06) + (4,500 lb. soybean meal x \$.12)	\$6,090	
Ewe pasture - 500 ewe months x \$1.50	\$750	
Lamb feed - 375 lb. x 170 head x \$.09	\$5,738	
Misc. feed (mineral, lamb milk replacer, etc.)	\$400	
Total feed costs	\$12,798	
Other variable costs:		
Health program	\$700	
Marketing	\$500	
Supplies	\$900	
Misc. variable costs (e.g. utilities, equipment maintenance)	\$900	
Total other variable costs	\$3,000	
Fixed costs:		
Buildings, remodeling, fencing - \$11,000/10 years	\$1,100	
Ewes - (100 head x \$125)/5 years	\$2,500	
Rams - (3 head x \$300)/2 years	\$450	
Milking equipment - \$8,000/7 years	\$1,143	
Total fixed costs	\$5,193	
Total costs	\$20,991	
Net returns to labor and management	\$5,706 or \$57.06 per ewe	

SOURCES OF ADDITIONAL INFORMATION

People and Associations:

North American Dairy Sheep Association
Route 3, Box 10
Hinckley, MN 55037
(612-384-6612)

American Sheep Industry Association
6911 South Yosemite Street
Englewood, CO 80112-1414
(303-771-3500) (FAX: 303-771-8200)

Dairy Sheep Producers
Throughout the U.S.

Sheep Extension Specialist
State Land Grant Universities

Publications - General Sheep Production:

Sheep Production Handbook. American Sheep Industry Association, 6911 S. Yosemite St., Englewood, CO 80112-1414

Ricketts, G.E., Scoggins, R.D., Thomas, D.L., Thompson, L.H. and Carr, T.R. 1993. Management guidelines for efficient sheep production. North Central Regional Extension Publication 240. Available from Cooperative Extension Service offices in Illinois, Indiana, Iowa, Kansas, Michigan, Missouri, Nebraska, South Dakota, Minnesota and Wisconsin.

Sheep Housing and Equipment Handbook, MWPS-3, Fourth Edition, 1994. Midwest Plan Service, Agricultural and Biosystems Engineering Department, 122 Davidson Hall, Iowa State University, Ames, IA 50011-3080 or Extension Agricultural Engineer, your Land Grant University.

Publications - Dairy Sheep:

Mills, Olivia. 1989. Practical Sheep Dairying. Thorsons Publishers Limited, Wellingborough, Northamptonshire NN8 2RQ, England.

Alfa-Laval. 1981. Systems Solutions for Dairy Sheep. Alfa-Laval AB, Agri-Group, S-14700 Tumba, Sweden.

U.S. Feed Grains Council. Profitable Milk Production from Sheep. 1400 K Street N.W., Suite 1200, Washington D.C. 20005.

Jordan, R.M. and Boylan, W.J. 1988. The potential for a dairy sheep industry in the midwest. AG-FO-3430, Minnesota Extension Service, University of Minnesota.

Greaser, G.L., Ishler, V.A., Harper, J.K. and Engle, C.C. Milking Sheep Production. Agricultural Alternatives. Pennsylvania State University, College of Agricultural Sciences, Cooperative Extension.

Various Dairy Sheep Symposium Proceedings. North American Dairy Sheep Association, Route 3, Box 10, Hinckley, MN 55037 (612-384-6612).

Proceedings of the Annual Great Lakes Dairy Sheep Symposiums. Wisconsin Sheep Breeders Cooperative, Richard Roembke, Treasurer/Secretary, 3696 Country Aire Dr., Cedarburg, WI 53012-9206 (phone/FAX: 414-377-1491)

Dairy Equipment Manufactures/Sales Representatives:

Westfalia
Attn: Jim Parker
1862 Brummel Dr.
Elk Grove Village, IL 60007

J. R. Roberts, Export Representative
Fullwood and Bland, Ltd.
Ellesmere, Shropshire
United Kingdom SY12 9DF

Bob Borchert
Schlueter Co.
3075 Streb Way
Cottage Grove, WI 53527

Alfa-Laval, Inc.
Attn: Mr. Mark Hart
11100 N. Congress Ave.
Kansas City, MO 64153

Alfa-Laval Agri, Inc.
c/o Randy Rheingans, Area Representative
713 Woodhaven Ct., NE
Rochester, MN 55906

Alfa-Laval Agri International AB
Sheep Dairy Equipment Division
S-147 00 Tumba
Sweden

La Paysanne, Inc.
Roger Steinkamp,
Gascoigne Equipment Dealer
Route 3, Box 10
Hinckley, MN 55037

Gascoigne Milking Equipment Ltd.
Attn: Mr. L. J. Harland
Edson Road Houndmills
Basingstoke, Hampshire RG21 2YJ
England

The Coburn Company, Inc.
P.O. Box 147
Whitewater, WI 53190

Major Farm
David Major
RFD 3, Box 265
Putney, VT 05346
802/387-4473