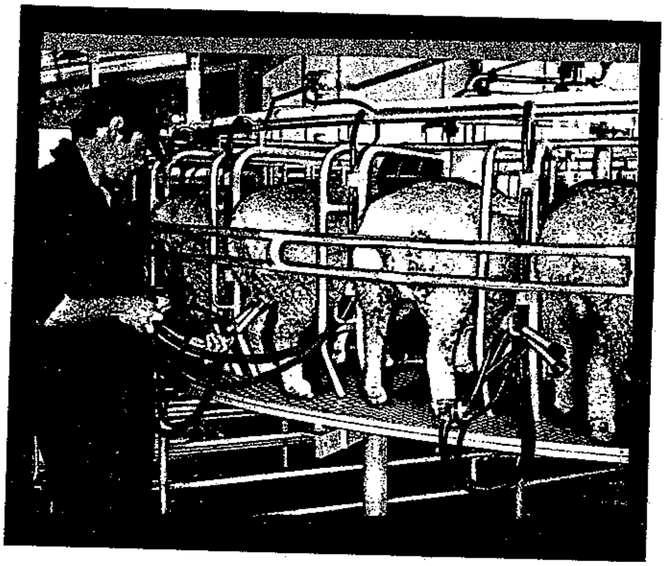
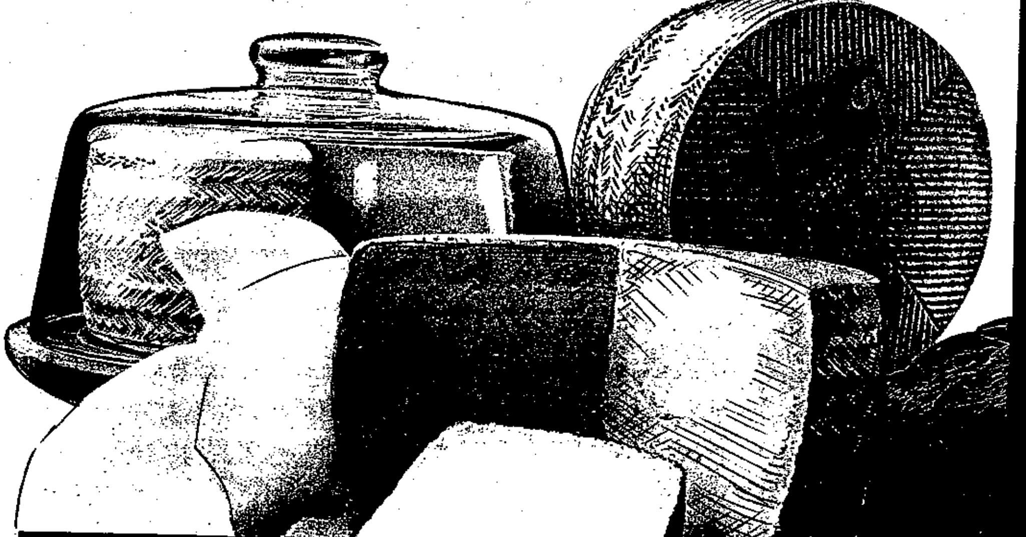
Great Lakes



DAIRY SHEEP

SYMPOSIUM

March 30
1995



Madison, Wisconsin

USA

GREAT LAKES DAIRY SHEEP SYMPOSIUM

March 30, 1995

Holiday Inn Southeast
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:

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Welcome

The purpose of this symposium is twofold: first, is to present technical information on the production, processing and marketing of milk from sheep by some of the U.S. and international experts in the field and second, is to provide a forum where persons involved in sheep dairying can exchange experiences and learn from one another.

Sheep dairying is a new venture in U.S. agriculture. There probably are not enough producers or processors yet for sheep dairying to be considered an agricultural industry, but the future looks promising. The large attendance at this symposium is an indication of the ever-increasing amount of interest in sheep dairying. Sheep dairying in the U.S. owes a great deal, its very existence, to the pioneers in the field. Dr. Bill Boylan of the University of Minnesota was the first scientist in the U.S. to research the possibility of producing commercial milk from sheep. Dr. Boylan, along with his colleague at the University of Minnesota, Dr. Bob Jordan, did much to legitimize sheep dairying as an agricultural enterprise. Roger and Lucie Steinkamp of Hinckley, Minnesota provided the opportunity for sheep dairying to become a reality by providing the first large market for sheep milk with the establishment of their sheep cheese processing plant. They also provided a national forum for sheep dairying when they founded the North American Dairy Sheep Association. Of course, those first producers that milked sheep, often to the amusement of their neighbors and the amazement of more traditional lamb and wool producers, were the real start of commercial sheep dairying in the U.S.

The State of Wisconsin can claim more dairy sheep producers than any other state. In large part, this is due to the positive reception the venture has received from state government, the University of Wisconsin-Madison, Madison Area Technical College and the Wisconsin Sheep Breeders Co-op. Erwin "Bud" Sholts and his staff with the Agricultural Development and Diversification Program of the Wisconsin Department of Agriculture, Trade and Consumer Protection have funded three grants aimed at the development of sheep dairying in Wisconsin. The University of Wisconsin-Madison, College of Agricultural and Life Science (CALS) has supported a sheep dairy research program at its Spooner Agricultural Research Station. A new sheep dairy parlor will be built at the station in 1995. The Babcock Institute for International Dairy Research and Development of CALS (Jane Homan, Acting Director) has provided major funding for this symposium and has funded an additional project with the goal of bringing European sheep dairy technology and germplasm to Wisconsin. Madison Area Technical College's adult sheep program under the direction of Bob Black has among its members sheep dairy producers and an educational program aimed at improving the efficiency of sheep production. The Wisconsin Sheep Breeders Co-op (WSBC) has encouraged sheep dairy producers by providing educational sessions on sheep dairying at recent Wisconsin Sheep Industry Conferences, and this year WSBC is the major sponsor of the Great Lakes Dairy Sheep Symposium.

Welcome to Wisconsin. We are pleased you are in attendance at the Great Lakes Dairy Sheep Symposium. Have a great day.

Dave Thomas
Professor of Sheep Genetics
and Extension Sheep Specialist
University of Wisconsin-Madison

PROGRAM

Great Lakes Dairy Sheep Symposium

Holiday Inn Southeast
Madison, Wisconsin

Thursday, March 30, 1995

8:00 am	**Registration**
8:30 - 9:30 am	**The Economics of Producing Milk from Dairy Sheep** - Janet McNally, Minnesota
9:30 - 10:30 am	**Milking Techniques and Parlour Management** - Olivia Mills, England
10:30 am	**Break**
10:45 - 12:00 pm	**Health Concerns in a Dairy Flock** - Cindy Wolf, Minnesota
12:00 - 1:00 pm	**Lunch:** Speaker - Bill Boylan, Minnesota
1:00 - 2:00 pm	**Genetic Improvement of Dairy Sheep in Europe** - Francis Barillet, France
2:00 - 2:30 pm	**Cheese Making 101** - Jim Path, Wisconsin
2:30 - 3:15 pm	**Developing a Market for Sheep Dairy Products** - Olivia Mills, England
3:15 pm	**Break**
3:30 - 4:15 pm	**Economic Potential for Sheep Dairy Products in the U.S.** - Bill Wendorff, Wisconsin
4:45 pm	**Cheese, Lamb and Wine Tasting**

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THE ECONOMICS OF PRODUCING MILK FROM DAIRY SHEEP

JANET W. MCNALLY

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The past five to seven years have seen a blossoming of a new industry in the U.S. based on the production and marketing of sheep dairy products. Spurred on by low lamb and wool prices, dairy sheep production has caught the interest of many sheep producers. Relatively few people have jumped in, however, and given milking sheep a try. All of these adventurous sheep producers are truly pioneers venturing into an interesting and potentially rewarding vocation. Not all attempts at milking sheep have succeeded, producers citing low milk production (and income) and high labor as the principle problems. It seems appropriate to review the industry's profitability.

In early 1995 a survey was sent to all potential dairy sheep producers asking them to reveal (confidentially) their milk production, milk income, flock size, milking labor requirements, facility investment, and feeding program for 1994. The survey was kept anonymous so as to encourage accurate information. The drawback to the anonymity is that it was not possible to clarify any answers on the survey, as the origin of the information was unknown. Ten producers responded with rather complete information on the productivity, income, and efficiency of their sheep dairy flocks.

From these surveys, I attempted to analyze any trends and construct a "typical" budget. Although the surveys revealed some very useful and important information about the sheep dairy business, they also revealed that no two sheep dairies are even close to similar! Although this variability was expected, I was still surprised at the large variation in production, income, and efficiency.

Some aspects of the 10 farms were remarkably similar, so I will begin with those. Length of lactation (including lamb rearing) ranged from 80 to 150 days with many flocks lactating for 100 to 150 days. Milk price paid to producers who sold milk was fairly similar ranging from 70 to 90 cents per pound with the majority receiving 70 to 80 cents per pound. Nearly all lambs were weaned at 30 to 35 days of age, and most milked in a parlor with a capacity of 12 sheep at a time. Similarities ended at this point.

The variabilities revealed two very important needs in the Dairy Sheep industry. Genetic ability to produce milk is not only dramatically variable but relative to Europe, is very, very low. We are in essence milking Hereford cows and expecting a Holstein income! Secondly the efficiency of the milking parlors is very poor and is in great need of revamping. Producers need to get together and share notes as well as study milking systems in other countries with high priced labor.

Milk production per ewe per lactation ranged from 24 to 300 pounds! Typical milk production was still highly variable with multiple flocks producing 31 to 160 pounds of milk. There was no correlation between the size of flock, ration, or investment in facilities to the amount of milk produced per ewe. Milk income was just as variable, ranging from $32 to $344. Milk income had little connection to milk production. Some low yielding flocks produced higher income per ewe and visa versa. Variability of milk income was due, in part, to the value placed on milk by those enterprises making cheese. "Typical" milk income per ewe was split into two categories. Producers who sold their milk to a processor typically received $32 to $60 per ewe per lactation. Two of the producers who processed their own milk valued milk income at $77 to $172 per ewe per lactation.

Investment in dairy facilities ranged from $1200 on up. (To protect confidentiality I cannot reveal the upper limit.) Facility investment was only considered for the equipment and building renovation/construction that was unique to the dairy sheep enterprise. "Typical" investment fell into two distinct categories. Lower investments ranged from $1200 to $6000, while the higher investments ranged $8000 to $14,000. There was no connection between facility investment, flock size, parlor efficiency, or milk income. Investment on a per ewe basis ranged from $12 to $3,320 but was typically $50 to $125 per ewe invested.

Efficiency of the parlor possess a significant problem. Since there was no connection between investment in facilities and labor efficiency and little connection between flock size and efficiency, it must be presumed that the variability is due to animal movement through the facility and milking (parlor) procedure. Milking speed ranged from 6 ewes per person per hour to 45 sheep per person per hour. Two people milking greatly reduced efficiency over one person milking. Most farms with one person milking, milked 25 sheep per hour. This slow milking parlor throughput really hampers any possibility of expansion as a way to improve gross farm income to a suitable level. Since one farm was able to milk 45 sheep per person per hour, in a moderate priced facility, it seem that much could be gained by exchanging parlor procedure and layout ideas. The larger dairy flocks dealt with high labor requirements by milking smaller groups of sheep at different intervals throughout the year.

A proposed dairy sheep budget was developed using the average and typical information gleaned from the surveys. This budget is very hypothetical due to the fact that it does not represent any one farm, and for that reason has its limitations. However, the budget should provide a useful starting point for those who are planning a dairy sheep enterprise, and may help more established persons identify weaknesses or strengths.

The budget is based on 120 ewes with 100 of those ewes comprising mature breeding ewes and 20 ewe lamb replacements. All of the usual costs and income of lamb and wool production are not considered here, nor are the farm overhead costs; only the income and cost directly associated with the dairy business. Net income (or loss) needs to be added or subtracted from the net income (or loss) from lamb and wool production. A budget for lamb and wool production will be available at the symposium. Because the sheep dairy business can expect significant growth over the next 10 years, it is safe to assume that most serious dairy sheep producers will be able to market breeding stock. While milk production is so low, sales of breeding stock will prove to be an important income.

Net return from milk sales alone was estimated to be a net loss of $1523 for 120 ewes under a confinement based dairy, while net income from milk sales alone on a pasture based dairy was estimated to be $380 for 120 ewes. Please note that milking labor has already been charged as a cost. Selling breeding stock greatly enhances the income of a dairy farm, pushing net income on the confinement dairy to $3102 and the pasture dairy to $5005.

The biggest challenge revealed in the surveys was the large labor requirement relative to the income received. The ten farms responding represented 77,311 pounds of milk produced in 1994, from 1050 ewes totalling $91,399 gross milk sales. The gross milk sales from these 1050 ewes is no more than the gross sales expected from one 49 cow Holstein dairy. Yet, at current milking parlor efficiency, it would take two people 23 hours a day to milk 1050 ewes vs. only 3 hours per day to milk 49 Holsteins in a stanchion barn (1 person). The total hours milking per year for the 1050 sheep would amount to 2070 hours (@ $10/hr) x 2 people = $41,400. The Holstein cows would require 915 hours per year (@ $10/hr) = $9150 of labor.

The good news is that the U.S. sheep dairy business is at the bottom rung of both production and efficiency and has no where else to go but up! The variability found between farms for milk production, efficiency of labor, and gross income suggests that there exists among us the material for a profitable dairy business. The farm that can put together the right combination of production, efficiency, and price, while controlling costs will indeed produce a rewarding income. New genetics that have entered the U.S. promise to give milk production a big boost, while the sharing of ideas on milking parlor design and procedure will create changes to reduce the labor required for milking sheep.

Sheep Dairy Budget (Income & Expenses Above & Beyond Lamb & Wool Production)			
120 ewes (198 Lambs Produced)		Confinement	Pasture
A	Milk Sales $60/ewe @ 80¢/lb 75 lbs milk/ewe = 9000 lbs	$7,200	$7,200
	Breeding Stock Sales 5 ram lambs @ $450 each 50 ewe lambs @ $125 each	$2,250 $6,250 $8,500	$2,250 $6,250 $8,500
	Minus the market value of breeding stock	-$3,375	-$3,375
B	Net Breeding Related Income	$5,125	$5,125
C	Total Dairy Related Income A + B	$12,325	$12,325
	Facility Change $74/ewe invested = $6,578÷ 15 yrs	$438	$438
	Labor (45 ewes/person/hr x $10/hr) 5.33 hrs x 90 x $10/hr	$4,800	$4,800
	Additional Feed	$2,760	$882
	Supplies	$500	$500
	Utilities (Electric Heat)	$225	$200
	Advertising (Breeding Stock Sales)	$500	$500
D	Total Dairy Related Expenses without advertising	$8,723	$6,820
E	Total Dairy Related Expenses with advertising	$9,223	$7,320
F	Net Return to Milk A - D =	($1,523)	$380
G	Net Return to Milk and Breeding Stock C - E =	$3,102	$5,005

Summary of Dairy Sheep Production Survey

Ten farms responded to the survey representing
77,311 lbs of milk total
1,050 ewes milked
$91,399 total milk sold

	Range	Average	Typical [1]
Number of Ewes	5-250	114	31-160
Pounds of Milk Per Ewe/Lactation	24-300 lbs	74	50-100
Length of Entire Lactation	80-150	116	100-150
$ Milk Produced/Ewe	$32-$344	$75 [2]	7 @ $32-$60 2 @ $77-$172 [3] [2]
Milk Price ¢/lb	58¢ - $5.00	85¢ [2]	70-90¢/lb [4] milk sold
Investment In Dairy Facilities	$1,200 on up [5]	$6,578 [5]	$1,200-$6,000 $8,000-14,000 [5]
Facility Investment Per Ewe Milked	$12-$3,320	$74 [5]	$50-$125
# of Days Facility in Use Annually	70-365	160 days	90-150
Milking Parlor Capacity	8-24	12.7	12
Hours Spent Milking • Per Ewe • Ewes/Person/Hr	.022-.08 hrs/ewe 6-45 sheep/hr	-	.033-.045 13-26 sheep/hr
Age Lambs Weaned [6]	1-45 days old	-	30-35 days old
Ration	1 lb-3.5 lb concentrate/ewe 0-7 lb hay/ewe 0-240 days pasture/ewe	-	3 lb concentrate 4-5 lb hay OR 1-2 lb concentrate ½ lb hay pasture

1 A true mean was difficult to identify as responses were varied greatly.

2 Not including one cheese maker that valued sheep milk at $5/lb earning $120/ewe, and the highest producing flock producing 300 lb/ewe earning $344/ewe as not typical of the group.

3 Both these farms processed milk into cheese.

4 Most cheesemakers valued milk higher, from $1.15 to $5/lb.

5 Excluding one facility that may have included cheese making facilities.

6 Note: the three farms that practiced day 1 weaning had no apparent advantage in total milk yield per ewe over those with 30 day weaning.

MILKING TECHNIQUES AND PARLOUR MANAGEMENT

OLIVIA MILLS

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The milking of sheep has much in common with the milking of cows for which Wisconsin is famous, but there are differences. First, one has to explore who is suitable to milk sheep.

Sheep milking was traditionally a peasant industry, the skills of the shepherd and yields of his sheep were balanced in perfect equilibrium. However, people like Professor Barillet came along to improve the sheep. These improved sheep required a higher standard of management. A higher standard of management needs greater education. Higher education expects more money and less work.

So the techniques of managing a sheep dairy moved from the comfortable symbiosis of the peasant and his sheep to a computerised system where more milk and more money should equate with less work and fewer sheep. This has already happened in parts of Europe, but very careful balance is not kept by some Divine Being; there may be more milk produced than can be marketed at the price needed to keep this educated sheep dairy farmer in the standard to which he has become accustomed.

Improvement in milk yields by even 25 percent can present big problems in marketing. Therefore marketing must go hand in hand with production. So who should milk sheep? In Britain, our experience is that shepherds, on the whole, do not make good milkers of sheep. They have rubbed along with only a bit of extra work to do twice a year and are not prepared for the work involved day by day in milking. Not only does the Dairy Ewe need Dairy Temperament, but the milker needs both dairy discipline and dairy temperament as well. A good training in cow milking or even goat milking makes sheep milking a whole lot easier. There are unlikely to be inherited skills as would be found in the peasant milking areas of the world. Women, on the other hand, do make good and sympathetic milkers. They are able to appreciate the problems of the lactating animal and may even have experienced at first hand the pain of birth, mastitis, etc. so are not likely to leave a ewe to suffer. Also, on small units, the milker may also have to be the marketer: Are there such skills in the family? Have they the time? Are there local markets?

ORGANISATION

The organisation of a sheep dairy depends on demand. If the demand is for fresh milk all the year round then the sheep milker has to plan accordingly. Really only in warm climatic conditions does it pay to milk through the winter unless there are well lighted warm barns, but as the whole climatic range of Europe can be found in the United States, there will be areas where winter milking will be feasible as it is in Israel, parts of Spain and parts of the UK. However, the longer the milking can go on for during the year, the better the cash flow.

The freezing of large quantities of milk to cover the dry period is not really cost effective although possible to do. It is labour intensive and expensive. The only alternative may be to persuade the processor to stagger the ripening of the cheeses, or even freeze curd. Yogurt is more of a problem and may justify freezing milk, as also with drinking milk.

Before starting up, you have to identify your market, be it a processor or a distribution line. You may process all the milk yourself or you may decide to sell the milk to an established product maker. Check if there is one locally or several states away and what is the best method of transport. Fresh milk, bulked up over several days, does now seem to be the best bet, but may not be profitable being transported at less than 1,000 litres at a time. The chosen market for your milk may then make added demands on you for amounts, quality and delivery times.

There are several ways of setting up in sheep dairying:

1. Most people lamb their ewes in early spring, milk while they can and then wait until next spring for the next flush of milk. The poor processor has to cope with frozen milk, no milk, and then a flood.

2. The flock can be divided up and lambing staggered. This works quite well. If and when you get in some pure Friesland ewes, then we have found that lambing just at Christmas is the best way to get the highest yields out of them. Crossbred ewes (i.e. Friesland x on to locally available good ewes) can then be lambed at other times to produce milk from June to Christmas. Milking ewes into increasing light hours is easier than milking towards decreasing light hours.

3. The most effective is the lambing of the flock every eight months. This keeps the ewes busy and they do not spend months on holiday being unproductive and it gives a reasonably continuous flow of milk. The downside is marketing the lambs at certain times of the year and understanding the feeding regime so that the ewes do not go "stale."

STAFFING LEVELS

On the whole, sheep milking is a family affair. In fact, in parts of Greece and other such countries, the number milked depends entirely on the number of hands in the family. In Britain, in the Middle Ages, sheep milking declined after the catastrophic losses of manpower during the Black Death c. 1350. Milking by machine without a partner whether whole or part time can produce many problems. One person should be able to manage 200 ewes with extra help at lambing, shearing and for holidays (absolutely essential). However, it is much more pleasant milking with someone to talk to other than the sheep. In costings, many people forget to cost in their own labour and then when they get sick, they can't afford a replacement. If you intend to set up a big, commercial dairy, then the labour cost can be the single biggest item.

WHERE TO START

1. Will you synchronise or leave it to nature? Synchronised bunches of ewes makes lambing and milking easier. Ewes coming into the parlour a few at a time becomes boring and a waste of time and electricity.
2. At lambing do you want to sit up all night?
3. What are you going to do with the lambs?
4. What sort of parlour are you going to have, abreast or rotary?
5. At what hours do you intend to milk the ewes?

Modern technology has an answer to all these problems if you are seriously going in for sheep milking. But a decision must be made before starting out.

Once the system has been worked out on paper/computer, the questions should all be answered. Personally, I think with higher yielding ewes the lambs are best taken off at birth and reared on artificial milk. No Holstein dairy leaves the calves on nowadays and these good sheep are really cows with wool on. Also, it is an excellent way of ridding your flock of O.P.P., a curse if it has been passed on to expensive, imported ewes.

Assuming that a viable number of ewes to milk is 200/400, that can generate quite a lot of lambs. This will require an automatic milk dispenser and free flowing powder. Both, I am sure are available in the U.S. This saves a lot of bottling and lambs all grow at an even pace. The only absolute requirements are getting colostrum in at birth and a high standard of hygiene.

The milking parlour can be the most time consuming part of the operation, so rapid throughput is paramount. The organization of getting the ewes in and out is vital since the time taken in milking itself is negligible by comparison.

I do not think it matters whether you milk at twelve hour intervals or not, provided what you decide on you keep to. A lot may depend on the heat of the day or the temperament of the milker. Ask yourself if you are a Skylark or a Night Owl.

Thus the ewes lamb down, the lambs are taken off, the ewes run happily into the parlour and the colostrum is milked out by machine and fed back to the lambs. If this method does not appeal, then the lambs can suckle for three and a half days and then be taken off and reared artificially before full bonding takes place. By this method, there will be virtually no mastitis in the ewes, no weaning stress, no check of any sort and the valuable milk, which is the main aim of sheep milking, can be sold or manufactured rather than disappearing down the lamb's throats.

If you are determined to leave the lambs on for 30-35 days, then a whole new ball game starts up. At least 60 to 80 litres of milk is lost, maybe more. The ewes are stressed at being weaned from bonded lambs, the teats may have suffered from lamb bites, the udder may be uneven due to unequal suckling, be infected by Pasteurella Haemolitica mastitis and what is worse, the ewe will have developed bad habits due to the natural inclination to start to wean her lambs by kicking them off when they want to suckle. She sometimes finds it difficult to distinguish between her lambs and the cups so she kicks either way. Ewes that have never suckled virtually never kick.

There is, of course, a possible way of rearing lambs on goats. I saw this successfully being done at Pipestone in SW Minnesota, four or more to a goat. Like multisuckler cows, the lambs have to be introduced and the goat must be prepared to take them on.

There is also partial weaning, where the lambs are allowed the residual milk from the ewes after going through the parlour. Although this may sound easy, the problems of parting ewes and lambs twice a day after suckling is labour intensive and artificial feeding of the lambs will prove much cheaper.

With the lambs out of the way, the only techniques left to worry about concern the extraction of the milk in the cleanest and kindest way possible and the maintainance of the total solids in the milk to please the processor.

PARLOUR TRAINING

Recently I have seen a very clever way of parlour training in France. The parlour had no yokes and no food was offered. The old and young ewes were all mixed up and the experienced ewes went up on to the platform followed by the young ewes who felt safe squashed closely to a neighbour on either side. The tighter they are packed in, the less they can move. There were absolutely no problems. If you have a traditional yoked parlour, the young ewes should be brought through before lambing to accustom them to the whole proceedure. Sheep do not forget. If it was a good experience with a reward at the end, they will come in without trouble. If you fight them, they will not forget that either.

CLEANLINESS

There are so many different views on udder washing that I hardly dare to add another. However, based on our own experience, all the views are right at some point in the lactation. Where ewes are kept in barns on clean dry bedding in a climate that has low humidity, they may be clean enough to be milked without anything done to the udders at all provided they are clipped free of wool. I believe that all udders should be handled before the cups are put on to check for mastitis. This can be a very quick movement by an experienced person. If, however, the ewes live out on the pasture, come in through mud, occasionally are a bit wormy or on lush grass, then the udders must be cleaned off. If water is used, it must be very hot as this will kill off any bacteria on the cloth and then the udders can be dried with an impregnated cloth or "Blue towel." Any damp or dirt left on the teats or surrounding udder will get into the milk and although the milk may look clean and white, it is the most perfect breeding ground for every entrepreneur bug you can imagine. And by entrepreneur I really mean they are in the air, in the parlour, on the ewes and on the milker, they are microscopic bacteria or yeasts all longing to get into the warm milk to procreate!

In order to keep hygiene in mind at milking, it is a good idea to wear a white coat. Then see how far you can get through milking without getting it unduly dirty. Hands should be washed at regular intervals throughout milking. The back end of the ewe needs also to be kept clean either by crutching or shearing.

When we set up the British Sheep Dairying Association in 1983, our first Chairman was a Veterinarian, the editor of Sheep Dairy News had spent many years working for the Ministry of Agriculture, and I had had thirty years of milking cows under my belt, so we set up a standard for sheep milk hygiene which even today is many times higher than that set by the EU and we have stuck to it. There have been hiccups, but each has been investigated and learnt from. We have had problems derived from poor quality water used in the dairy, from neglect between cleaning the udder and putting the cups on when the ewe managed to kick fresh dirt on to her teats, from feeding milled food in the parlour, from letting mastitic milk or colostrum into the pipeline by mistake and other small, almost silly problems which led to huge headaches for the processors.

MILKING TECHNIQUE is in fact all part of DAIRY MANAGEMENT

If you have ewes coming in to the parlour at differing stages of the lactation, the milk will be much more standardised, but the milker must always be aware of which are the fresh ewes and which the ones drying off. This entails good rear end marking for easy identification. This can be done by colour marking as well as leg bands, tatoos under the tail or computer chips. The milker must also know what to look for in the way of problems at each stage through milking up to and after drying off. Knowledge is vital where experience is lacking.

The vacuum and pulsation rate of the milking equipment can make a great deal of difference. Low vacuum and high pulsation rate seems to work the best. We milk at 120ppm at about 40kPa vacuum, but many are now going up to 180ppm, the same rate that a lamb suckles. If you have time to pull the foremilk, then do so, but mostly there isn't time. However, when ewes first come in to milking it is a good idea to use a strip cup for the first few milkings or a California Mastitis Test (CMT). Check especially if they have suckled lambs.

Absolute calm and quiet is needed in the parlour, always remember that stress in any form can inhibit milk let down. This can be caused by weaning the ewes, a change of milker or strangers in the parlour, a dog or anything the ewes either are not used to or feel threatened by.

The cups should be applied quickly and deftly with no excess of noise or fumbling. Remember that teat cups are little vacuum cleaners and will quickly pick up any extraneous matter which will go down the milk line. An essential addition to any milk line is a mastitis detector. Not that it detects mastitis, but it does indicate if there is blood in the milk, or if straw or wool is going down the pipeline, etc. and it also clearly shows the milk flow - very important in judging when to take the cups off. Comfort of vision is essential for putting on cups; this entails the platform being at exactly the right height and any rump rail being thin and out of eye line. Bending over to put on cups can end with problem backs.

Taking cups off is a skill in itself. Gentle pressure on the claw should show you if the ewe has any milk left by looking at the sight glass. If there is no increase, turn off the vacuum and let the cup fall into your hand. Some cups have to be pulled off without turning off the vacuum and usually a finger has to be inserted between the teat and the cup to release the vacuum. Long fingernails, can leave a permanent sore on the side of the teat!

There is a great tendency to want to handle the udder with the idea that this will increase the amount of milk given. The ewes enjoy it, they will wait for you to do it each time and even hold back milk waiting for you. If after taking the cups off you observe the udder has filled again - and this is quite common in early lactation, simply put the cups on for a second time. The less you handle the udder during milking, the quicker the ewe will learn to let down her milk there and then. If some milk is left, no matter, you can get it at the next milking.

The next important point in the production of quality milk is how it is handled after leaving the udder. First, it must be carefully strained to remove any sediment, then rapidly cooled which is probably the most important thing (in addition to efficient cleaning of the milking equipment). Milk is likely to come out of the udder in an almost sterile state, so that everything that goes wrong with it happens after you have abstracted it. Do not blame the ewe for dirty milk unless you have failed to detect mastitis in her. It is not her fault if you have failed to clean the milk line or the bulk tank properly.

THIS WHOLE OPERATION SHOULD BE DONE WITHIN TWO HOURS. If longer is taken man/woman gets tired, gets fed up, gets hungry, gets bad tempered, gets problems. So part of your planning needs to show that your throughput of ewes can be achieved in the time allotted. If not, then a better throughput must be organised. Here such sophistocated equipment as a rotary parlour answers many problems. There is no waiting to refill the parlour as the ewes come in and go out continuously. Or you can extend the length of the parlour itself as the time taken to get them in and out is considerably more than milking them. However, this involves having a lot more units (sets of cups). The sheep dairy I saw recently in France with no yokes, found that after shearing they could get 40 aside on a 20 ewe stand. Therefore, if the ewes can be packed in tight, 40 can be milked with the same number of units on a platform designed for 20 ewes.

WHAT IS QUALITY MILK?

In the UK we normally speak of quality milk as that with a high total solids and take the high hygiene for granted. However, here in the States it appears that quality means hygienic quality. I have travelled to so many countries where hygiene has been totally neglected but the high heat treatment of the milk or low pH of the product has made it safe to eat. In the UK, our problems are more to do with poor cheese yield in say May from Friesland ewes, who, like Holstein cows, produce a lot of extra water in their milk.

HOW TO KEEP UP THE QUALITY OF THE MILK

Basically this is a threefold operation: Hygiene, Feeding and Breeding.

1. **HYGIENE** There are certain countries in the world who do not realise the benefits of clean milk. However, they have learned to counteract any problems by processing the milk immediately after milking when most of the bugs haven't had time to multiply. Nowadays under modern conditions, milk is usually held in a chilled condition, sometimes for two to three days before being processed. On top of that, should the milker not be aware of all the causes that make milk unacceptable to the buyer, he will look elsewhere for his supplies and you could be swimming, like Cleopatra, in a lake of milk. The idea that by pasteurisation ALL milk can be made safe is very misleading. It has been the bane of cow milking where the "hired hand" knowing that pasteurisation will take place, takes much less care with hygiene.

The world has woken up, mainly because of improved technology in detection, to Somatic Cell Counts (SCC). This does not mean the cow dairy people haven't been aware of this problem for many years, but it has only recently been looked at in sheep and goats. At a symposium held recently at Bella in Southern Italy, some of the world's scientists discussed this problem, its cause and effect. Although Professor Barillet's team gave the most comprehensive paper on the subject, all that is needed here is to make a quick summing up and warning.

Somatic Cell Counts in sheep vary through the lactation, naturally increasing towards the end. Where you have ewes milked all year round the dilution factor in the bulk tank may fool you in to thinking you have no problem. However, your processor will start to tell you the yield of cheese is down on milk that appeared to have good total solids. So you are going to have to look for causes. If you only milk once a year and all the ewes go dry together you have to be able to prove that this is normal and not caused by the real problem, sub clinical mastitis. The conclusions at Bella were inconclusive. The actual number of SCCs has not been set, more research is needed. However, 600,000 seems reasonable, half that is better. Cheese yield can be affected at over 200,000.

Drying the ewes off can greatly influence the level of SCC in the next lactation. Where ewes have had high yields, they have been under considerable stress and dry ewe therapy is an excellent tool. If the udder is healthy at lambing, there should be no problems through the lactation. If however, sub clinical infection harbours in the udder during the dry period, it will flair up at lambing time. In fact, if there has been a case of mastitis in a ewe and lumps remain in her udder, it is better she rears lambs and does not come into the parlour again.

Another serious factor in milk quality is any treatment done to the ewe that may go into the milk as a residue. Many quite educated people do not appreciate that milk is blood. Therefore anything that gets into the bloodstream goes, automatically, into the milk. Antibiotics are the curse of the yogurt and cheese makers, the residues kill the cultures used. Fly cover dips still contain unacceptable levels of Organophosphates and the lobby against these is now worldwide. Anthelmintics, vital in the production of clean milk due to the tendency to scouring and dirty udders are still not licenced with a sensible withdrawal time for sheep milk. Planning and knowledge are both vital in these areas.

2. **FEEDING** The total solids level in milk is largely geneticaly controlled and it is extremely difficult to alter the protein level by feeding although the fat level may be influenced to some extent by diet. The less the ewe's diet is altered by changes of feeding policy the better. This problem has been overcome with many high yielding flocks by not putting ewes out to grass as such, but only as part of a controlled feeding programme.

The art in feeding dairy ewes is to maintain a stable rumen condition whilst achieving high energy intake. The high yielding ewe, like the dairy cow, cannot be fed to yield, but must get part of her energy requirement from stored fat to support the milk yield. This approach allows the use of more roughages in place of concentrates which should never exceed more than 50 percent of the total diet.

The ewe's feed is best divided into fibrous and non-fibrous feeds, rather than roughages and concentrates. See Table 1.

Table 1

Non-fibrous feeds	Mix of fibrous & non fibrous feeds	Fibrous feeds
Grain	Good quality hay	Poor/medium quality hay
Potatoes	Alfalfa hay	
Molasses	Dried grass	Corn stover
Fodderbeet	Brewers grains	Straw
Turnips	High quality silage	Treated straw
Sugarbeet pulp	Haylage	Pea haul

Roots are classified here with grain because they are eaten more slowly and are less likely to upset the stability of the rumen than grain feeding. It should always be remembered that ewes prefer whole cereal concentrates if possible as they can "mill their own corn in their mouth." Whole cereals also help to prevent acidosis. We do not necessarily approve of grass silage forfeeding dairy ewes; there is too much danger of Listeriosis. Maize silage seems more acceptable.

Some points on a ewe's digestion which may be relevant in the production of sustainable yields of high quality milk: Generally speaking it is important for fibrous feeds to ferment (digest) as fast as possible while non-fibrous feeds should ferment slowly. The best of the non-fibrous feeds for providing rumen conditions conducive to good fibre digestion are sugarbeet pulp, brewers grains, whole oats, barley or maize and roots. Large quantities of grain, ground or pelleted are indigestible as they create conditions which interfere with the digestion of fibrous foods and may be better if fed at separate times.

Protein supplementation (16-20% CP) is critical in the two weeks prior to lambing and six to eight weeks of early lactation. Food intake in early lactation cannot match the ewe's need for energy to maintain a high level of milk production, so extra protein in the diet encourages the conversion of body fat into energy to maintain production. The highest quality protein of the right sort is vital to kick start the pattern for maximum lactation yield and this is, of course, fishmeal, since it is not broken down in the rumen, but passes to the small intestine for breaking down into the amino acids needed for milk production. As this is expensive it can be replaced later by other partially undegradable protein sources such as Soya bean meal and alfalfa both excellent sources of easily digested protein.

Suggested energy requirements for a dairy ewe are put out in Table 2. As ewes respond badly to changes in diet, palatability is paramount. Appetite may vary with size, but all sizes of sheep need the same maintainance allowance.

Table 2

	Megajoules
Maintainance/day	10
Per litre/milk	7

So it can be seen that a ewe giving 3 litres/day will require 21 + 10 = 31 Mj. This may be supplied by good grass, but the problem with grass is knowing when the feed value is decreasing unless it also contains a high level of clover or alfalfa. So concentrate feeding will have to make up the shortfall. Alternatively, if the ewes get their basic feed in the barn where it can be controlled any extra they obtain outside will boost their yield and prevent this "stale" period so often experienced with barn fed ewes.

Remember that ewes must drink when they want to. Small, individual drinkers often are not a good idea as the ewe may get disturbed by other ewes and not drink her fill. A ewe should take in 8 litres/day, but basically she only drinks to balance the dry matter content in her diet. Any tricks to make her drink more such as providing a salt block or adding molasses to the water may be helpful. If lactating ewes are housed at night, it is a good idea to leave a light on. This encourages them to both eat and drink during the hours of darkness.

Always beware of copper poisoning with bought in concentrates where the wrong trace element supplement may have been put in by mistake. Copper poisoning really can decimate a milking flock.

3. BREEDING This subject I leave entirely to Professor Barillet, but only say that culling on health, yield and total solids in the milk is well worthwhile. Poor yielding sheep eat as much as good ones and if they do not respond to better feeding then they should be in a meat producing flock. The downside, and there always is a down side, is that good records must be kept and these involve more work. However, so many big sheep dairies are computerised these days, modern technology can take care of that now too.

CONCLUSION

Sheep milking should be a pleasurable occupation. If it is not, there is something wrong. Check and re-check your timings and your production methods. Does everything flow nicely? If not, why not and what can be done to improve through put? Happy milkers and happy sheep should bring forth quality milk.

SHEEP DAIRYING IN THE U. S.

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Sheep dairying is in the developmental stage in the U.S. The industry was virtually nonexistent as recently as 4 or 5 years ago. This is in contrast to some European and Middle Eastern countries where sheep milking has existed for generations. Our initial efforts (1984) at the University were directed toward improving milk production of ewes nursing lambs. Our initial interest came about as the need arose to improve the milk production of ewes nursing lambs. The use of prolific breeds, namely the Finnsheep and Romanov, improvements in management, nutrition and health care, have resulted in flocks which produce more lambs now than in the past. However, a concomitant improvement in milk production of the ewe has not been achieved. Our research goal was to improve milk production of the high lamb-producing flocks in order to market lambs directly for slaughter from a forage, pasture-based system. As the research in sheep milk production progressed, industry interests became focused on the opportunities and economic potential of a dairy sheep industry in the U.S.

Sheep Milk Cheese Imports

The U.S. annually imports more than 30,000,000 pounds of cheese made from sheep milk. The cheese has traditionally been imported as a gourmet product and has been priced accordingly. That is, retail prices often range from $5.00 to $15.00 per pound. A gourmet variety that you may recognize is Roquefort. This cheese is made in France and only from the milk of the Lacaune breed and must be aged in the caves at Roquefort. The name and labeling are protected by international agreement. Substantial quantities of sheep milk cheeses are also imported from other countries, including Italy, Spain, Greece, and Bulgaria.

Sheep Milk - A Valuable Commodity

Why is sheep milk valuable? Its relatively high solids content, compared to goat and cow milk, makes it of special interest for the manufacture of milk products. The composition of sheep, cattle and goat milk is shown in Table 1.

Total solids of sheep milk are about 18% vs. 12% to 13% for the other two species. This converts to a yield of about 20 pounds of cheese per 100 pounds of sheep milk vs about 7 to 10 pounds from cow milk. Of course, other properties of the cheese and milk also contribute to the value of sheep milk.

Table 1. Milk Composition (%)

Constituent	Sheep	Cattle	Goat
Fat	6-9 (7.9 avg)	3.6 - 4.8	3.4 - 4.5
Protein	5.5	3.2	3.7
Casein	4.3 - 4.6	2.9	2.9
Albumin, globulin	.9 - 1.1	12.6	12.9
Ash	.9	.8	.8
TOTAL SOLIDS	18.2	12.6	12.9

No Tradition of Sheep Dairying in the U.S.

There is no tradition of milking sheep in the U.S. In contrast to Europe, sheep milk cheese has not been produced here until recent years. The single exception is the Navajo Indians. Years ago they milked ewes in their flocks and consumed the milk and also made cheese. With the onset of World War II, this practice ended.

A major constraint in developing an industry has been the lack of an "infrastructure" for processing milk. Recently (about 5 years ago), commercial sheep milk processors entered the market. Dairy sheep interests now extend from coast to coast.

Milk Production of Some Foreign Breeds

There are sheep breeds existing in the world that are recognized as excelling in milk production. These breeds have evolved and have been improved in areas of the world where sheep milking is an important enterprise. Generally, these breeds exist in the Mediterranean area and the Middle East. A summary of breed performance for milk production is difficult because of the wide variation existing in procedures for measuring production. The diversity includes variation in length of the period over which the milk is measured, management procedures and nutritional regime. Milk production of some major breeds is presented in Table 2.

These figures are summarized from several sources and provide some information about the performance of breeds and the range in milk production. The East Friesian breed stands out as a superior milk producer. Genetic improvements made in recent years in the French Lacaune breed have placed that breed also in the ranks of the high producers.

U.S. Breeds Evaluated

Beginning in 1984 several U.S. sheep breeds were evaluated at the University of Minnesota for milk production potential. Ewes were chosen from available breeds and machine milked twice daily following weaning of their lambs at 30 days of age. Ewes were subsequently milked for an additional 120 days. The performance of these breeds over a two-year period for milk production and milk composition is shown in Table 3.

Table 2. Milk Production in Several Sheep Breeds

Breed	Lactation length (days)	Milk yield (kg)
East Friesian	260	550-650
Awassi	250	150-500
Chios	160-260	180-200
Sarda	170-240	110-250
Garfagnana	180-210	120-150
Massa	180-210	150-160
Serra da Estrela	200-230	100-120
Churro	150	45-75
Manchega	90-150	50-125
Lacaune	100-210	130-200

Experimental Cheese Production

Milk from our dairy sheep experiment was used to make several varieties of cheese. The results are summarized in Table 4.

Variations in product yield (cheese produced/milk weight) were observed in the production of the various cheese varieties. Taste tests were also conducted. Consumers have varied and distinct preferences for different types of cheese. This provides a wide range of possibilities for manufacturers and special niche marketing.

Yogurt, Ice Cream

Sheep milk has a long history of use in the production of yogurt. In the past, it has also provided a convenient method for preserving milk and avoiding spoilage. The increase in popularity of cow milk yogurt in recent years has had a beneficial effect on consumption of sheep milk yogurt. Yogurt made from sheep milk is considered (by connoisseurs) to be the ultimate supreme product. The production of yogurt is of special interest to the producer. The processing time from milk to yogurt is relatively short. In contrast to cheese production, no aging time is required.

Table 3. Least-Squares Means for Several Milk Traits by Breed (1989-1990)

Breed	Milk (liters)	Fat (%)	Protein (%)	Lactose(%)	Total solids (%)
Overall mean	57	6.6	5.8	4.7	17.9
Suffolk	69	6.7	5.9	4.7	18.1
Finnsheep	44	6.1	5.5	4.5	16.7
Targhee	62	6.9	5.9	4.8	18.4
Dorset	61	6.3	5.7	4.5	17.2
Lincoln	53	6.8	5.8	4.7	18.0
Rambouillet	65	6.6	6.1	4.9	18.3
Romanov	44	7.1	5.9	4.8	18.6
Syn. I	45	6.3	5.8	4.7	17.5
Syn. II	60	6.4	5.9	4.6	17.3
Syn. III	57	6.3	5.6	4.7	17.3
Outaouais	54	7.3	6.1	4.6	18.7
Rideau	77	6.6	5.8	4.8	18.0

[1]Syn. I - Finnsheep x Lincoln
Syn. II - Dorset x Rambouillet
Syn. III - Finnsheep x Lincoln x Dorset x Rambouillet

Table 4. Cheese Types Produced and Yield Percentage

Cheese types	Milk wt. (lb)	Cheese wt. (lb)	Yield %
Feta (raw)	777	144	18.4
Feta (past.)	1943	349	18.0
Gouda	1213	205	17.0
Manchego (raw)	1530	242	15.8
Manchego (past.)	1332	227	17.1
Romano	841	121	14.4
Roquefort (blue)	2160	420	19.5
Roquefort (white)	1025	207	20.0
Stirred curd	1464	223	15.2
TOTAL	12285	2138	17.4

Feeding Dairy Ewes

There is a dearth of information in the U.S. relating to feeding dairy ewes to promote high milk production. The justifiable reason is that we don't have a need (or didn't) for the information. We have relied on experiments with ewes nursing lambs. That information may be quite appropriate. At least for the present, it is the best we have.

We conducted two experiments at U. of Minnesota on feeding machine milked ewes. They are briefly summarized below.

Level and Source of Dietary Protein

Three levels of dietary protein were evaluated. Soybean meal (47% crude protein) was the source of protein supplied to a basic haylage and shelled corn diet. Sixty lactating ewes were assigned to the trial conducted over a six-week period. Primary treatment differences were soybean meal supplement fed at the rate of 0.0, 0.5 or 1.0 pound per head per day. Milk production was evaluated in terms of total yield for 6 weeks and average daily yield. These results are summarized in Table 5.

Table 5. Performance of Lactating Ewes for Three Levels of Protein Supplement (Soybean Meal)

Item	Treatment 1	2	3
(Soybean meal, lb/hd/d)	(0)	(0.5)	(1.0)
No. ewes	20	20	20
Total milk yld 43d (liters)	24.7^{b}	22.5^{b}	29.8^{a}
Daily milk yld (ml)	575^{b}	523^{b}	694^{a}
Initial body wt. (kg)	71.2	70.4	73.0
Wt. off test (kg)	67.9	68.9	69.1
Milk composition (%)			
- Fat	5.7	6.1	5.7
- Lactose	4.6	4.6	4.5
- Protein	5.8^{a}	5.7^{a}	5.5^{b}
- Solids not fat	11.4	11.4	11.1

[ab]Means in a row with a different superscript are significantly different ($P < .05$).

Doubling the daily intake of soybean meal in treatment 3 compared to treatment 2 (1.0 vs 0.5 lb/d) resulted in a 32% increase in milk production (29.8 vs 22.5 liters) ($P < .05$). Average daily milk yield followed the same pattern. These results support the suggestion that milk yield is enhanced by increasing the level of dietary protein. There was no apparent explanation for the lack of a positive response in treatment 2 compared to treatment 1 (22.5 vs 24.7 liters). It is speculated that the increased protein level in treatment 2 was not sufficiently greater than treatment 1 to stimulate increased production.

Soybean Hulls and "Protected" Protein

There is a need to study responses in milk production of ewes when fed different sources of energy and protein supplements. Protein and carbohydrate interactions are an important factor in milk yield. Ruminants fed diets high in energy, in an attempt to maximize production, are often affected by adverse changes in pH leading to rumen acidosis and a decrease in production. Soybean hulls may be a valuable alternative to shelled corn as a source of energy. Soybean hulls are a by-product of the soybean processing industry. They are low in lignin, starch free and high in fiber. They are expected to be beneficial in daily rations as a substitute for corn because they may not decrease rumen pH as dramatically as corn and yet enhance fiber digestibility. Some experiments have suggested that energy availability of soybean hulls may be equivalent to corn.

"Protected" or "by pass" sources of protein have been used in an attempt to reduce protein degradation in the ruminant thus enhancing utilization in the gut. Soybean meal that has been treated with heat and calcium lignosulfonate has a reduced rate of degradation of the protein in the rumen which is then available in the gut. Lignosulfonate is a by-product of the wood pulp industry.

The specific objective of this experiment was to assess the source of protein (protected vs. unprotected) and the response to the substitution of soybean hulls for shelled corn in the diet. Forty-eight lactating ewes were assigned to the trial consisting of four treatments in a randomized complete block design. Ewes were fed in pens of six with two replicates for each treatment. Ewes were placed in the trial following weaning of their lambs at 30 days of age and the ewes were subsequently machine milked twice daily for 60 days. Samples of milk were taken on a bi-weekly basis to determine composition. Samples were analyzed for (%) fat, lactose, protein and solids, not fat.

A mixed alfalfa-grass hay was the source of forage. Ewes were fed 3 pounds of hay and 2 pounds of their respective treatment pellets per head per day, on a pen basis. Milk production on the experimental diets was evaluated in terms of total yield for the 60 days. Average weekly production was also determined. The results are shown in Table 6.

The highest average milk yield was found on treatment 4 (hulls: 32.9 liters) followed closely by ewes on treatment 2 (SBM: 32.1 liters). The lowest production was observed for ewes on treatment 3 (protected SBM: 25.1 liters).

The performance of ewes on treatments 2 and 4 provide a direct comparison of soybean hulls vs. shelled corn (32.1 vs. 32.9 liters) as an alternative energy source. In this trial soybean hulls appear to be equivalent to shelled corn and can replace corn on an equal weight basis. Further, it should be noted that some problems with rumen acidosis occurred during the initial 4 to 7 days of the trial, including some ewes "going off feed." This condition was observed in all treatments except treatment 4 which contained the hulls. This finding supports other studies that suggest that soybean hulls may have a special role in ameliorating rumen acidosis. Although the results from experiment 2 showed apparent treatment differences, the statistical significance level was $P=.021$. Confirmation of these findings through additional studies is warranted.

Table 6. Effects of Soybean Meal (Protected Protein) and Soybean Hulls on Performance of Lactating Ewes by Treatment

	Treatment			
	1	2	3	4
Item	(Corn)	(SBM)	(P. SBM)	(Hulls)
No. ewes	12	12	12	12
Total milk yield 60 d (liters)	29.3	32.1	25.1	32.9
Daily milk yield (ml)	489	535	418	549
Initial body weight (kg)	87.6	82.6	78.5	81.8
Weight off test (kg)	85.8	81.6	78.4	81.4
Milk composition (%)				
- Fat	5.60	6.05	6.02	6.13
- Lactose	4.55	4.44	4.42	4.50
- Protein	6.00	5.97	5.62	5.48
- Solids not fat	11.60	11.45	11.08	10.96

The ewes on treatment 3 (protected SBM) had the lowest level of milk production of any treatment group. Milk production of these ewes was about 27.8% less than ewes which received normal soybean meal (25.1 liter vs. 32.1 liters). There was no obvious explanation for the reduced milk production observed on the diet containing protected soybean meal. It is speculated that the heat and chemical treatments were severe and resulted in a degradation of the protein, resulting in a lower quality.

East Friesian Milk Sheep Germ Plasm

East Friesian germ plasm resources have recently entered the U.S. A small sample of Canadian origin crossbred East Friesian ram lambs were obtained in August, 1993. The ram lambs were from ewes of the new Canadian breed "Rideau" and were sired by an East Friesian ram via artificial insemination. The Rideau breed contains about 14% of East Friesian in its genetic composition. Thus, the imported progeny contains an estimated 57% of the East Friesian breed. The importation was a joint effort by the Universities of Minnesota and Wisconsin and two present dairy sheep producers in Wisconsin, Hal Koller and Diane Kaufmann.

The East Friesian germ plasm available, while not straightbred, offers new opportunities for U.S. sheep producers. Sheep producers will be encouraged by the greater milk production potential and enhanced profitability. Commercial producers should consider the East Friesian.

Crossbred ewes produced by using the available East Friesian germ plasm on U.S. breeds should have improved milk production. It is estimated that on average milk production would be increased 50% in the crossbred ewes compared to the U.S. breed dam (1.0 vs. 1.5 liters per day). Carcass merit, growth rate and body size are impressive on the imported samples.

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The Potential for a Dairy Sheep Industry in the Midwest

R. M. Jordan and W. J. Boylan

Sheep products in the U.S. don't have to be limited to meat and wool. In parts of the world, sheep provide more milk than cattle. It is estimated that about 100 million sheep, 10% of the total number in the world, are milked. To U.S. sheep producers, milking sheep defies the imagination. A trip to France's sheep milking area (Rodez, France) will convince one that sheep milking and production of Roquefort cheese (made only from sheep's milk) are, indeed, thriving industries that deserve exploration by U.S. producers.

Unlike the U.S., one of the most profitable farm livestock enterprises in France is sheep milking. In France, 7 million cows, 1 million of the country's 10 million sheep, and 1 million goats are milked. France isn't the only country that produces sheep's milk. Producers in Spain milk 5 million, and Italy and Greece are big sheep milk producing countries. Many sheep are milked in Middle Eastern countries, but the industry is not as well organized as in Europe. However, only France has the Roquefort caves in which all genuine Roquefort cheese must be aged for three to four months.

There is growing interest in dairy sheep since research was initiated at the University of Minnesota (Boylan, 1984; Jordan and Boylan, 1986). This research initially focused on evaluation of the production performance of various genotypes with the aim of examining methods to improve the milking ability of ewes nursing lambs. The research also included studies on milk composition, lactation curves, and repeatability of milk production records. The potential for creating a dairy sheep industry in the U.S. and the additional source of income for sheep producers and related agribusiness industries was a logical outgrowth of the initial lactation study.

University of Minnesota ewes in automatic-locking stanchions in sheep milking parlor.

A Look At Sheep Milking in France

In the spring of 1985, the French farmer was paid 1.8 francs per kilogram (kg) of cow's milk, 7 francs per kg of sheep's milk, and 5 francs per kg of goat's milk, or, in U.S. dollars, about \$35/cwt for sheep's milk.

Sheep in France are milked for about seven months (December to July) and produce during that period about 128 liters (1 liter = 2.2 lb) per ewe, up from an average production in 1950 of 76 liters. In 1980, France had about 3,000 sheep milk producers, who milked an average of 220 ewes per farm and produced 198 million pounds of sheep's milk.

About 65-70% of all sheep's milk in France is used for production of Roquefort cheese. The milk in excess of Roquefort production is often sold to cheese producers in Italy. While \$35/cwt for sheep's milk may seem high by U.S. cow's milk prices, realize that it takes only about 4 pounds of sheep's milk per pound of Roquefort, in contrast to 8-10 pounds of cow's milk per pound of cheddar cheese.

Sheep income for the French producers is about 65% from milk (\$90-\$100/ ewe) and 35% from the sale of the 30-day-old, 10-12 kg lambs that are sold for 250- 300 francs (\$28-\$33) each to people who specialize in feeding lambs. Thus, gross income approximates \$125-\$150 per ewe annually. A similar procedure could be adopted in the U.S.

The objectives of this research are to present some results of milking sheep and the manufacture of several types of sheep milk cheeses at the University of Minnesota and to examine the economic potential for creating a sheep milking industry that would put U.S. sheep producers in a position to capture a portion of the 25-million-pound U.S. market for sheep cheese.

Table 1. Milk production and milk composition

Category	N	Production, lbs (130 d)	Average daily production, lbs	% Fat	% Protein	% Lactose	% Total solids
Overall average	158	159	1.28	6.3	6.0	4.8	17.8
Purebreds	**	**	**	**	**		**
Suffolk	12	182	1.47	6.8	6.2	4.8	18.5
Targhee	12	155	1.25	6.5	6.1	4.8	18.1
Finn	11	107	.87	5.7	5.7	4.8	16.8
Dorset	11	145	1.16	6.7	6.5	4.8	18.3
Lincoln	12	141	1.13	6.5	6.1	4.8	17.3
Rambouillet	9	154	1.24	7.0	6.2	4.9	18.7
Crossbreds	**	**	**	**	**		**
Finn crosses	24	186	1.49	4.1	5.8	5.0	17.5
Dorset crosses	22	143	1.14	6.1	5.9	4.7	17.6
Lincoln crosses	21	172	1.39	6.3	5.9	4.7	17.5
Rambouillet crosses	24	159	1.28	6.6	5.9	4.8	18.3

** P<.05

Experimental Protocol and Results

In 1985 and 1986, data on 158 purebred Suffolk, Targhee, Finn, Dorset, Lincoln, and Rambouillet ewes and crossbred Finn, Dorset, Lincoln, and Rambouillet ewes were obtained. The ewes were machine milked twice daily, commencing 30 days post-lambing and continuing for 130 days. Total milk production was obtained for all ewes daily, individual ewe milk production was obtained weekly, and milk composition data were obtained biweekly. These data are summarized in table 1.

The average daily milk production of all ewes was 1.3 lb, an amount similar to the 1.3 lb daily produced by the Lacaune breed in France but much lower than the typical daily production of 4.8 lb produced by the East Friesian milk sheep (Mills, 1982). The crossbred ewes produced about 20% more milk (due to heterosis) than the purebred ewes. While the purebred Finn ewe was a poor milk producer, the Finn cross ewes were the best producers (table 1).

Ewes reach their peak in milk production during the first three to four weeks post-lambing, though the percent of fat and total solids increases about 2.5 percentage points from the 5th week until the 23rd week. Our research indicates that ewes that produce high quantities of milk one year tend to repeat with high yields in subsequent years. By culling out the low producing ewes, the average production of the remaining ewes would increase average yields 30 to 40%.

Cheese Manufacture

What's unique about sheep's milk? It has about twice as much fat, 40% more protein, and 30% more total solids than either cow's or goat's milk and produces a high yield of cheese from 100 pounds of milk. Most important, it imparts a distinctive flavor, aroma, and texture to cheeses that entice U.S. customers to pay about $8 per pound for it. Furthermore, the demand isn't thin, as the U.S. imports about 25 million pounds of it (10% of all imported cheeses) annually. At only $5 per pound, that's $115 million! Some of the world's most popular cheeses, such as Roquefort from France, Feta from Greece, Ricotta and Picorino from Italy, and Manchega from Spain, are made from sheep's milk.

Table 2 gives a summary of several varieties of cheeses manufactured from the sheep milk in our experiment. A popular and valuable (higher retail price) variety is Roquefort. In this trial, the yield of Roquefort-type cheese was 21.9%. The Manchego (Spanish type) was also rated high in consumer preference tests, but the yield in our trial was unexpectedly low (16.7%). While the quality of Feta produced was high and well accepted in consumer taste tests, it is a less valuable cheese in price (about 1/3 to 1/2 the retail value of Roquefort). Hence it would not be a recommended variety to produce in this country compared to the price of alternative varieties.

Table 2. Cheese types produced by various batches and yield (%), 1986

Cheese type	Milk wt., lbs	Cheese wt., lbs	Yield, %
Manchego	2,210	369	16.7
Feta	5,763	1,045	18.1
Romano	2,500	505	20.2
*Roquefort	2,215	484	21.9
Total	12,688	2,403	18.9

*Roquefort is a registered tradename and cheese made in USA cannot be called Roquefort.

A second sheep milk product, yogurt, may have equal or greater profit potential than cheese. Limited taste panel tests suggest that yogurt made from sheep's milk is a gourmet product and rates very high in consumer preference tests.

Sheep Milking Production Options

Based on typical ewe and lamb feed intakes and the following feed costs: hay, $60 per ton; corn, $1.96 per bushel; and creep feed, $100 per ton; it costs the sheep producer about $17.35 to raise one lamb that is nursing its dam (conventional production program) to 70 days of age. If the lamb were weaned at 30 days of age, the cost to 70 days of age would be $18.80; and if the lamb were weaned at one day of age, raised on milk replacer for 30 days, and then grain fed to 70 days of age, the cost would be $34 per lamb.

Using these realistic cost values for producing a 70-day-old lamb plus feed costs to produce 60 lb of weight from 70 days to market, a selling price of $70 per 100 lb, and a price of $.50 per pound of milk, a picture of comparative returns per ewe using the three production systems is presented in table 3.

Table 3. Comparative costs and returns per ewe[a]

Feed costs to 70 d.	Feed costs, 70 d. to 110 lb	Total ewe, lamb feed to 110 lb	Total returns/ewe: 110 lb lamb	Milk: lb	Milk: value	Total return	Profit over costs
		Conventional (raise lamb on ewe)					
$17.35	$9.12	$26.47	$77.00	0	0	$77.00	$50.53
		Option 1 (milk ewe for 130 days)					
$18.80	$9.60	$38.40	$77.00	160	$80.00	$157.00	$128.60
		Option 2 (milk ewe for 160 days)					
$34.00	$9.60	$53.60	$77.00	225	$112.50	$189.50	$145.90

[a] Cost to produce 60 lb of gain on a 70-day-old lamb: conventional system, 3.8 lb feed/lb gain; options 1 and 2, 4.0 lb feed/lb gain. Milk yield: option 1, 160 lb; option 2, 65 lb for first 30 days (2.2 lb/day) plus 160 lb for last 130 days. Product value: lamb, $70.00/100 lb; milk, $.50/lb.

Weaning the lamb at 30 days and milking the ewe for 130 days increases the profit over feed costs from $50.53 (for no milking) to $128.60 (for 130 days of milking). Milking for 160 days results in $145.90 profit per ewe over feed costs. Although more labor is required, milking ewes for 130 days provides sheep producers the opportunity to increase their income about $7,800 for each 100 ewes milked. Our data suggest that with very modest milking equipment, about three hours per day would be required to milk 100 ewes. In France, 250-300 ewes are milked per producer-hour.

Future

For a sheep's milk industry to blossom in the U.S., it takes three ingredients: customers for the products, sheep's milk in reasonable quantities, and manufacturers and distributors.

The first ingredient, customers, already exists. The orchestration, or bringing together, of producers and manufacturers is the bottleneck. No one wants to produce sheep's milk if it can't be sold profitably, and no one can manufacture sheep's milk cheese or yogurt if there is no sheep's milk available. A viable cheese production unit would likely need a source of milk from 500-1,000 ewes. Recently, several producers on the east and west coasts have initiated the milking of ewes and the manufacture of sheep cheese.

A unique characteristic of sheep's milk is that it can be frozen, stored or transported in a frozen state, and later thawed without affecting the character of the cheese made from it. This single characteristic enables the accumulation of sheep's milk until an adequate amount is available for cheesemaking.

A cottage-type industry could also be initiated by individual producers who would milk their ewes and produce cheese on the farm. The University of Minnesota developed such a program for dairy cow producers with the development of "Farmstead Cheese" production. On-the-farm cheese production may be the most practical initial route to utilization of sheep's milk. Sheep milk cheese production in the United Kingdom has increased 20 fold in the last 3 years. Most is produced and marketed as a cottage type industry. Can the same growth occur in the USA?

How many ewes would be required to produce the milk for the production of only 20% of the 23 million pounds of imported sheep's milk cheese? If we assume that it takes four pounds of sheep's milk to produce one pound of cheese, then 23 million pounds of cheese x 4 x 20% = 18,400,000 pounds of sheep's milk. If a ewe, after suckling her lamb for 30 days, produced 2 pounds of milk daily for 100 days, or 200 pounds of milk, it would require 92,000 ewes, or 920 flocks of 100 ewes each.

Start-Up Costs

To provide an estimate of what it would cost to initiate a sheep milking enterprise, here are the expenditures the University of Minnesota made in 1985. Since then, the value of the dollar has declined, and inflation has likely caused these costs to rise 60 to 90%.

Start-up costs to equip a 100-ewe milking parlor (University of Minnesota):

Twelve semiautomatic stanchions (Fullwood & Bland Ltd.)	$ 653
Portable vacuum pump (Fullwood & Bland Ltd.)	163
Two single-unit buckets, complete with teat cup, liners, claws, and pulsator	259
Miscellaneous spare parts, hoses, oil	83
Brushes, cleaning products	6
Milking equipment subtotal	$1,164
Stainless steel double sink, 1'10" x 4' (new)	$ 170
Refrigerated bulk tank with compressor, 200-gallon capacity, used	400
Refrigeration labor to connect and start up bulk tank cooling	124
Elevated wooden platform, approximately 5' x 18'2", 2'9" height	325
Several 10-gallon milk cans, used for transfer of milk to campus (on hand)	
Ancillary equipment subtotal	$1,019
Total costs, not including labor for platform	$2,183

As a livestock alternative, milking sheep for the production of sheep cheese or yogurt appears to have tremendous potential.

Sources of Sheep Milking Equipment

Alfa-Laval Agri, Inc.
11100 N. Congress Avenue
Kansas City, MO 64153-1222
Phone: 816-891-7700
Scott Sanford, National Product Manager

Gascoigne Milking Equipment, Ltd.
Edison Road, Hound Mills
Basingstoke, Hampshire
United Kingdom RG21 2YJ
Phone: 44-256-463355
A. H. Miles, Export Manager

Fullwood & Bland Ltd.
Ellesmere, Shropshire
United Kingdom SY12 9DF
Phone: 44-069-1712391
J. R. Roberts, Export Representative

Hastings Welding
1630 Vermillion Street
Hastings, MN 55033
Phone: 612-437-1733
Andre Menard, Manager

The Schlueter Company
216 Center Street
P.O. Box 548
Janesville, WI 53547
Phone: 608-756-1269
Wm. Davenport, Regional Sales Manager

New England Cheesemaking Supply Co.
P.O. Box 85
Ashfield, MA 01330
Phone: 413-628-3808
Robert Carroll, Manager

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Alfa-Laval, 1981. Systems solutions for dairy sheep. Publ. Alfa-Laval AB, Agri-Group, S-14700 Tumba, Sweden, 141 pp.

Boylan, W. J. 1984. Milk production in the ewe. National Wool Grower, Vol 74 (2): 6-8.

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Mills, O. 1982. *Practical sheep dairying*. Publ. Thorsons Publishers Limited, U.K., 224 pp.

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GENETIC IMPROVEMENT OF DAIRY SHEEP IN EUROPE

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SUMMARY

Milk production from dairy sheep is a tradition in Europe, specially in Mediterranean areas. In these regions, most sheep milk is produced by multiple purpose local breeds with low and medium milk yields, which have been raised under traditional husbandry conditions. However, some populations have evolved into dairy types, generally with a simultaneous adaptation of the breeding system to modern husbandry methods. Under these conditions, the question of breeding strategy, crossbreeding or purebreed selection, has been an ongoing debate for the Mediterranean basin. It should be noted that upgrading of the local populations by imported dairy type sheep (especially from Northern European origin) has often given negative results, because the improved breeds appeared in general to be poorly adapted to the Mediterranean conditions. Therefore the breeding strategy involved either the creation of synthetic lines (to limit the percentage of blood from imported breeds), or through dairy selection of local breeds in their native area of production. In practice most often it was wiser to rely on implementing the dairy selection of the local breeds. The conception and optimization of a pyramidal breeding program for a dairy sheep population is described. Such a program requires on-farm official milk recording suitable for sheep, combined with the use of artificial insemination (AI) in the open nucleus flocks, and an accurate genetic evaluation of the animals. An ICAR survey was carried out in 1994 regarding milk recording, use of AI and breeding value evaluation in dairy sheep. Because of difficulties in implementing a breeding program (especially AI) in a lot of traditional Mediterranean areas, only some local breeds show in the 1990s a real genetic trend for milk yield. This situation could modify the future situation for genetic improvement of dairy sheep.

INTRODUCTION

Dairy sheep have traditionally been farmed in Europe, especially in Mediterranean areas. Unlike cattle which are exclusively milked soon after calving, dairy sheep breeding is much more varied and complicated. The system of milking directly after lambing is usually only done in countries or areas where milking ewes is an exception. In Mediterranean countries where there is a population of several million dairy sheep, normal husbandry systems include a suckling period (or a combined suckling plus milking period) of at least one month. Consequently the Mediterranean dairy sheep systems have a dual purpose, often with a comparable income for meat and milk, especially for low and medium milk yield breeds. In almost all cases the production system is characterized by an out-of-season lambing period from October to January followed by a one month suckling period. Milking only begins after weaning and ends in Summer. A wide range of local production systems (climate, feeding, etc...) may be observed, ranging from intensive breeding to semi-extensive systems with grazing even in winter and often transhumance in summer. In this type of situation milk production is related to other sheep production aspects such as meat, wool and even adaptation to local breeding conditions. Thus in the Mediterranean basin, most sheep milk is produced by multiple purpose local breeds with low or medium milk yields, which have been raised under traditional husbandry conditions (*Boyazoglu et Flamant., 1990*). However, some of the populations have evolved into dairy types, generally with a simultaneous adaptation of the breeding system to modern husbandry methods using machine milking, on-farm milk recording, artificial insemination and new feeding practices.

I) BREEDING STRATEGY

A breeding strategy to improve dairy traits may involve either crossbreeding or purebreed selection programs. While purebreed selection is the method generally used for the genetic improvement of dairy sheep in the Mediterranean basin, crossbreeding is also used. However, either farmers are generally not familiar with the various crossbreeding systems, or these different systems are too complicated to manage in dairy production. Thus farmers rely only on the simplest scheme, which involves upgrading of the local populations by dairy type sheep (*Zervas et al., 1975; Mavrogenis., 1992*). Given the wide range of local production conditions and multiple purpose systems, any definition of a breeding strategy needs to take into account not only milk yield merit but also other traits such as body size, sexual precocity, out of season lambing ability, prolificacy, growth rate, wool and adaptation to local breeding conditions (*Barillet.,1990*).

Theoretically it would be necessary to have precise knowledge of the differences in average genetic levels between the breeds for all the aforementioned traits and the specific abilities of each candidate breed for the local breeding system under consideration. This would be a necessary first step, in order to be able to choose the best breeding strategy (crossbreeding or purebreed) for each local situation. But in practice, there are many different local dairy sheep breeds, with each breed generally being located in a regional area of production with its own specific management conditions. This means that there is significant confusion between the average genetic merit of the considered breed and its breeding system, so that the comparison of the milk yield levels between breeds (using only published results) is often less informative than expected. Naturally the same difficulty exists for the other traits described above. Taking only the average milk yield level, it would be necessary to respect some obvious and simple regulations if any comparison of the recorded results is to be reliable, namely :

- the application of ICAR (International Committee For Animal Recording) regulations which recommend to record and calculate milk yield at the milking only, if ewes are being milked after a suckling period (*ICAR., 1992*). Given that we will consider the milking period only, the range of the relationships between total lactation, milk yield and daily milk during milking only are shown in table 1 for different production levels. It should be noted that it is easy to reverse the ranking of two breeds if the published results correspond to milk yield at milking period for one breed and to an estimated total lactation for the other breed.
- remembering that the average production of several thousand ewes is always more representative than the results of a hundred ewes (particularly if these ewes correspond to a biased sampling of elite females).

Because these obvious and simple regulations are not always applied, dairy sheep literature sometimes offers «optimistic information» on the differences in milk yield (and composition) for average genetic levels between breeds. Considering these various problems, it is realistic to organize fair comparisons between breeds in the same environment when deciding whether to keep the local breed or to import an improved breed.

Table 1
Milk Yield at milking period only and total lactation for different levels of production

MILKING PERIOD (ONLY)		TOTAL LACTATION (range of estimated production in liters)		
MILK YIELD (liters)	Range of daily Milk Yield (liters)	Length of the suckling period (days)		
		0 (colostral phase)	30	45
100	0.6 to 1.0	100	120 - 150	130 - 160
150	0.8 to 1.2	150	180 - 220	190 - 230
200	0.9 to 1.4	200	240 - 280	260 - 300
250	1.1 to 1.6	250	300 - 350	320 - 370

Moreover, it is important in order to have a good idea of the expected genetic gain over 10 years in case of direct selection for milk yield of the native population. The genetic coefficient of variation for milk yield (at milking period only) is between 10 and 13% (*Barillet et Boichard., 1987*). Thus the genetic standard deviation increases from about 10 liters for an average level of one hundred liter to 30 liters for a population with an average milk yield of 250 liters. So the predicted genetic gain in 10 years may reach about 15-25 liters in a population with a one hundred liters production level, and 40-65 liters in a population with a 250 liters production level (table 2). It should be noted that these figures represent an efficient breeding program.

Table 2
Expected asymptotic gain for milk yield in 10 years according to the milk yield level of the breed (in the case of miking after a one month suckling period)

MILKING PERIOD (ONLY)		EXPECTED GENETIC GAIN IN 10 YEARS (range in liters)
MILK YIELD (liters)	GENETIC STANDARD DEVIATION	
100	10 to 13 liters	15 to 25
150	15 to 19	20 to 40
200	20 to 26	30 to 55
250	25 to 32	40 to 65

In the nineteen sixties and seventies different comparisons between breeds were carried out in Western Mediterranean countries (France, Greece, Italy, Spain) and also in Israel (*Goot., 1966; Flamant et Ricordeau., 1969; Ricordeau et Flamant., 1969 a et b; Zervas et al., 1975; Kalaissakis et al., 1977; Boyazoglu et al., 1979; Katsaounnis et Zygoyiannis., 1986; Mavrogenis., 1988*). Attempts to improve local livestock production were based on the importation of improved breeds (generally the East Friesian breed in all countries, and Chios or Awassi breeds in Eastern Mediterranean areas). It should be noted that Chios and Awassi are respectively semi-fat-tailed and fat-tailed breeds, which is not a suitable characteristic for the meat market in Western Mediterranean countries. This is one of the reasons why the East Friesian breed was generally chosen for the comparisons carried out in Western European countries. The main results of these comparisons were as follows :

- in most situations and breeds, average genetic level differences ranged between 1 and 3 genetic standard deviations for milk yield, *i.e* about 30 to 75 litres.
- drastic genotype environment interactions for milk yield (or other traits) appeared frequently. Specifically genotypes with more than 50 % of Friesian genes appeared to be poorly adapted to the Mediterranean conditions.

Consequently upgrading of native sheep populations through reliance on improved breeds appeared in most cases to be too difficult to manage. In these conditions the breeding strategy involved either the creation of synthetic lines through crossbreeding of local and imported productive breeds (FSL in France, Frisarta in Greece, Assaf in Israel) to avoid having more than 50 % of the genes coming from the imported breed, or through dairy selection of local breeds in their native area of production (*Flamant et Barillet., 1982)*. The balance between cost/time and specific situations must therefore be taken into account for any final decision. In practice the genetic and economic comparisons carried out in the nineteen seventies in Western Europe concluded most often that it was wiser to rely on implementing the dairy selection of the local breeds in their specific area and conditions of production.

Moreover some authors tried to classify Mediterranean breeds according to their supposed average genetic level for milk yield (*Boyazoglu, 1989; Casu et Boyazoglu, 1990*). However such classifications are not reliable enough, especially for the supposed medium milk yield breeds for the reasons explained above. The only conclusion that can be reached is that in the Mediterranean basin some breeds have a good to high milk yield level, e.g. Awassi, Chios, Comisana, Lacaune or Sarda breeds. Moreover it is important to know whether or not efficient breeding programs are being carried out before one can predict the future situation of dairy sheep breeds.

Thus in the Western Mediterranean basin, efforts in research and extension have concentrated on the design and implementation of breeding programs using local breeds in their specific area of production.

II) CONCEPTION OF BREEDING PROGRAMS FOR DAIRY SHEEP

Whatever the proposed program, it should be kept in mind that an efficient breeding program must ensure genetic gain and also its diffusion to the entire population (recorded and unrecorded flocks). In other words, our purpose is to conceive of an efficient breeding program for a dairy sheep population (300,000 to 3 millions ewes) and not for a few solitary breeders.

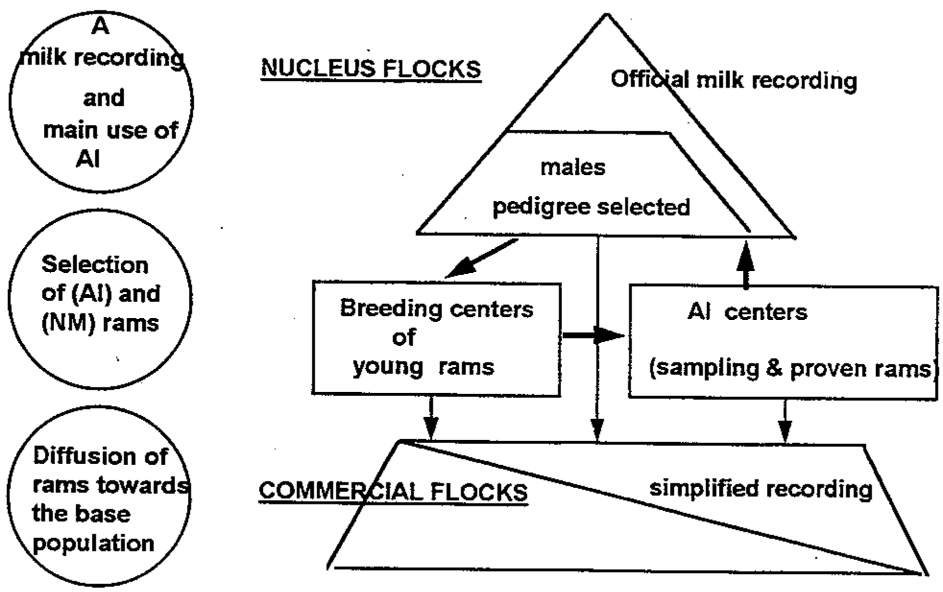
1) Pyramidal management of the population:

Whatever the dairy species, the most efficient breeding programs need to progeny-test AI (artificial insemination) males born from assortative matings. Consequently, such a program requires on-farm milk recording, artificial insemination (eventually embryo transfer) and an accurate genetic evaluation (breeding value) of the animals. However, in practice, some biological and economical constraints means that these selection tools have to be adapted to sheep conditions (*Barillet et Elsen., 1979; Flamant et Barillet., 1982*).

From use on a large scale (several thousand per day over a short period of 2-3 months a year), AI for sheep must be carried out with fresh semen and induced oestrus. The diffusion potential of an AI ram is multiplied by 10 to 20 compared to a natural mating ram, but remains very limited compared to AI bulls (*Barillet et al., 1984*). The official A4 milk recording (monthly recording of the two daily milkings) is the most popular method used in dairy cattle recording. For dairy sheep, its cost relative to the income per animal is 2 to 3 times as much as for dairy cattle (*Flamant et Poutous., 1970; Barillet et al., 1987*). Under these conditions, the development of a dairy sheep breeding program is suitable only in the framework of a pyramidal management of the population, both for AI and NM rams, which is far removed from the dairy cattle situation based on only a few AI bulls : indeed with such a pyramidal organization the breeding tools required by the breeding program (pedigree recording, official milk recording, AI, progeny test, assortative mating...) can be concentrated in a selected nucleus *(Elsen et Mocquot., 1974).*

In pyramidal management of the population (figure 1), the breeders are divided into two groups, on the one hand the selection breeders of the nucleus flocks, on the other hand the breeders for the commercial flocks of the base population *(Barillet., 1985; Barillet et al., 1986).*

Figure 1 : Pyramidal management of the population



Official milk recording is used only in the nucleus. AI is primarily reserved for the nucleus flocks but may be used elsewhere. The breeding centers play a crucial role in such a scheme (*Barillet et Elsen., 1979*). These specific centers, managed by the breeders associations, have to raise the young males born from assortative matings in the nucleus, from their weaning (at 1 month old) to 8 months of age. Thereafter, theses males either join the AI centers for a subsequent progeny-test, or are sold to commercial flocks for natural mating. Note that the gene flow from the nucleus to the base population is based partly on AI, and partly on these naturally mating rams, born in the nucleus, raised in breeding centers, and used in the base population. In spite of its good stability, the nucleus remains open. This means that each year some of the best breeders in the base population may join the nucleus.

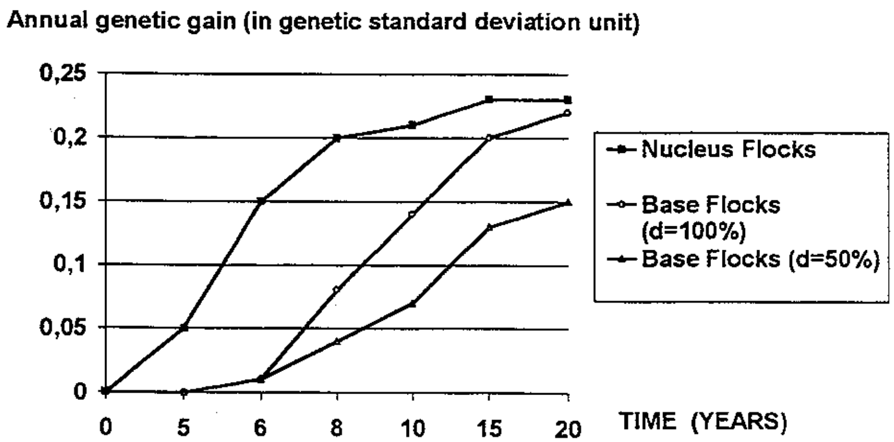
2) Optimization of the breeding program:

The main results of several studies, carried out for such a pyramidal breeding program, using the Lacaune demographic and genetic parameters (*Elsen et Mocquot., 1974; Barillet et Elsen., 1979; Vallerand et Elsen., 1979; Barillet et al., 1988)* can be summarized as follows *for the nucleus* :

- the optimum size of the nucleus ranges between 10 to 20 per cent of the whole population which is to be improved.
- the asymptotic annual genetic gain can be expected from 10 to 15 years after starting the breeding program. It is fifty per cent higher when AI is used rather than simply relying on natural mating in the nucleus.

- because proven rams have limited semen production, they cannot be as highly selected as in dairy cattle, and their superiority over young unproven rams is lower than in dairy cattle. Consequently, the best solution in order to maximize both the annual genetic gain and the discounted benefits is to progeny test quite a large number of males in the nucleus : in a pure AI optimal situation, forty to fifty per cent of the female population should be mated with sampling rams. Although such a program is quite different from the usual dairy cattle situation, it may provide the same expected annual genetic gain, for example 0.20 genetic standard deviations per year.

Figure 2 : Annual genetic gain for the nucleus and base flocks



The main results of the same gene flow studies *for the commercial flocks* are as follows :
- at the equilibrium, the annual genetic gain is the same in the nucleus and base population.
- this equilibrium is reached more or less rapidly, depending on the diffusion rate of the rams from the nucleus to the base population.
- at the equilibrium, the lag between the nucleus and base populations may be limited to 5 to 10 years if the diffusion rate (d) reaches one hundred per cent (figure 2).

3) Rationalization and simplification of milk recording:

The rationalization and simplification of milk recording is recommended because fixed costs are too high when using the standard A4 testing, which is considered to be the international reference in dairy cattle (ICAR nomenclature). Consequently, the official recording must be limited to those breeders who belong to the on-farm open nucleus, while a very simplified recording system can be implemented (unofficial recording) for commercial flocks. For instance, as practised in France (*Cottier., 1972*), a bimonthly recording can be carried out (for milk yield only) in order to rank ewes within-flock and plan matings with rams selected from the nucleus.

For the nucleus flocks, during the starting period of the breeding program (at least the first 10-15 years), it is recommended to record only milk yield in order to reduce the costs and implement the on-farm recording on a large scale. The first goal of this starting period is to reach the optimum size for the nucleus (10 to 20 % of the whole population to be improved). Since during the starting period the genetic gain for milk yield is small, milk composition, which is expensive to collect, may be neglected (*Barillet et al., 1986*). Logically ICAR regulations for milk recording in sheep describe qualitative tests as optional and recommend that it be implemented only in the framework of integrated selection schemes which are already efficient regarding milk yield.

Consequently fat and protein contents are expected to decline and should be included in the selection goal (*ICAR., 1992*).

Furthermore, to reduce the cost of the standard A4 official milk recording (monthly recording of the 2 daily milkings), simplified methods are suitable for achieving a large enough number of recorded animals to assure a genetic gain for the entire sheep population (*Flamant et Poutous., 1970; Barillet., 1985; Barillet et al., 1987; Barillet., 1990; Maria et Gabina., 1992; Sanna et al., 1994*) : two simplified testings (AT and AC method) are approved in ICAR regulations for sheep (*ICAR., 1992*). For these simplified methods only one of the two daily milkings is recorded : alternating a monthly test for the AT method, and a corrected monthly test for evening/morning differences for the AC method using the total volume of milk produced by the whole flock in the two milkings concerned (bulk tank weights).

In France, milk yield recording is carried out by means of the AC method (always at the morning milking) and for breeding programs at the equilibrium, qualitative testing is also practised using the following simplified design (figure3) : 3 to 4 times during the first four test-days for each ewe at morning milking only (*Barillet., 1985*).

Genetic parameters for dairy traits are similar for sheep and cattle (*Barillet, 1985; Barillet et Boichard., 1987; Barillet., 1989*). Milk, fat and protein yields have a moderate heritability (~0.30) and are highly correlated. Fat and protein contents have a high heritability (~0.50-0.60 when measured on a standard A4 testing), and are positively correlated (+0.6). Fat is more variable than protein, and the fat/protein ratio of genetic standard deviations reaches 1.3 for yields and 1.8 for content. The antagonism with milk yield is stronger for protein content (-0.4) than for fat content (-0.3). Genetic correlations between fat and protein content and fat and protein yields are close to zero, except that the genetic correlation between fat yield and fat content is clearly positive (0.3). All these parameter estimates are in general agreement with those in the literature for dairy cattle. When using the simplified recording design for milk composition described in figure 3, milk contents determined from these reduced samplings (or partial sampling) are highly correlated (0.98) with contents being determined from samples collected over the complete lactation period (A4 method) but are less heritable (*Barillet., 1985; Barillet. 1990*) : 0.35 to 0.45 for fat and protein contents with the reduced samplings (figure 3) compared to 0.50 to 0.60 for these traits with A4 method. Nevertheless genetic parameters for dairy traits recorded with the A4 or partial sampling are similar (except for heritability for fat and protein contents) as shown in table 3 (*Barillet et Boichard., 1994*). The balance between cost (and) genetic efficiency is clearly in favour of the simplified recording design for milk composition.

Figure 3 : Simplified recording design for milk composition

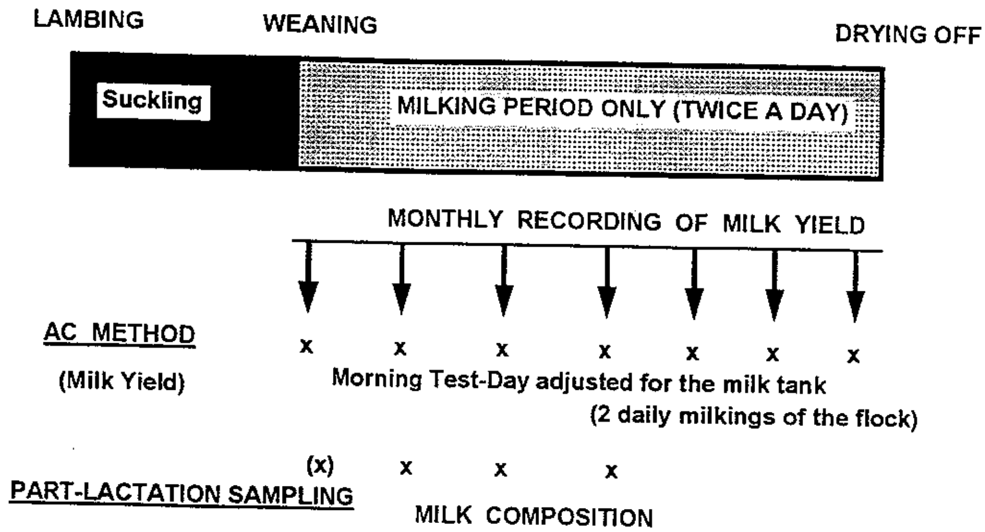


Table 3
Genetic parameters for Lacaune breed milk traits in first lactation (with a partial sampling of milk composition) :
(Heritabilities on diagonal and genetic correlations below diagonal)
(F. Barillet et D. Boichard, 1994)
[130,409 Lacaune ewe lambs born from 2,670 rams]

Traits (*)	Milk Yield	Fat Yield	Protein Yield	Fat content	Protein content
Milk Yield	**0.30**				
Fat Yield	0.83	**0.28**			
Protein Yield	0.91	0.89	**0.29**		
Fat content	-0.31	0.26	-0.06	**0.35**	
Protein content	-0.40	- 0.04	-0.03	0.63	**0.46**

(*) with partial sampling for milk composition (see Fig 3)

III) GENETIC IMPROVEMENT PROGRAMS FOR DAIRY SHEEP IN EUROPE

In the past, Western Mediterranean breeding programs for dairy sheep underwent a well-known evolution (as in dairy cattle) from on-station schemes to on-farm programs. This means that nowadays in Southern Europe several breeding programs are being carried out on a large scale using on-farm milk recording and artificial insemination (AI), combined with an accurate genetic evaluation of the animals.

1) Survey of milk recording in dairy sheep in ICAR member countries:

In 1994 the ICAR sheep working group carried out a survey on milk recording of dairy sheep in 31 member countries. From the 20 answers received (tables 4 and 5), it can be shown that (*Barillet et Astruc, 1994*) :

-Besides official milk recording, which is described in the ICAR International Regulations (*ICAR., 1992*) another type of milk recording is practised in some countries : in France (this type of milk recording started in 1966), in Belgium, in Israel and in Switzerland. It would be a good idea to describe precisely the objectives and methodology of these additional methods of milk recording. In France this non official milk recording was designed for technical and economical development within a commercial flock of the base population (bimonthly recording for milk yield only).

-The ratio of recorded ewes relative to the whole population has evolved relatively slowly since 1988 and remains in most cases insufficient to enable the organization of efficient breeding programs on a large scale for the whole population. Among the countries with large dairy sheep populations, the percentage of recorded ewes is less than 10 %, except for France which makes extensive use of milk recording (64.6% of recorded ewes). Countries with smaller dairy sheep populations, Switzerland (10.5%) and Israel (12.1%) have a percentage of recorded ewes up to 10%. If we now take a look at breeds (table 5), among the large breeds (up to 10 000 recorded ewes), the following are closer to or higher than 10% of recorded ewes: Comisana (Italy), Corsica (France), Karagouniki (Greece), Lacaune (France), Latxa (Spain) and Manech (France).

- The size of each on-farm nucleus (official milk recording) appears to be higher in breeds for which the standard A4 method has been replaced by the AC method (Lacaune, Manech and Corsica breeds in France) or the AT method (Latxa and Carranzana breeds in Spain) . This survey confirms that milk recording has to be simplified if is to be implemented on a large scale in dairy sheep (*Sanna et al., 1994*). If we look at the selection criteria for the Lacaune breed only among the large breeds (up to 10,000 recorded ewes) it has included both milk yield and milk composition (fat and protein yield) since 1987. For the other breeds, only milk yield is recorded and selected, but in Latxa and Manech breeds an experimental recording of milk composition is currently being carried out on a part of each on-farm nucleus (*Barillet et Astruc, 1994*), with the aim of preparing a future re-orientation of the breeding programs.

Table 4

Size of populations of dairy sheep, type of milk recording and number of recorded ewes in the member countries of ICAR

COUNTRY	SIZE OF POPULATION : TOTAL NUMBER OF FEMALES	OFFICIAL MILK RECORDING		OTHER MILK RECORDING	
		Number of recorded females (%populat.)	Number of recorded flocks (year)	Number of recorded females (%populat.)	Number of recorded flocks (year)
BELGIUM	1 000	-	-	95 (9.5%)	3 (1992)
FRANCE	1 235 000	259 318 (21.0%)	798 (1993)	539 005 (43.6%)	1 648 (1993)
GERMANY	59 421	1 460 (2.5%)	270 (1992)	-	-
GREECE	10 108 000	54 700 (0.5%)	675 (1992)	-	-
HUNGARY	64 860	1 154 (1.8%)	21 (1993)	-	-
ISRAEL	51 200	-	-	6 200 (12.1%)	6 (1992)
ITALY	5 408 361	211 247 (3.9%)	1 911 (1993)	-	-
THE NETHERLANDS	-	-	3 flocks	-	-
				-	-
PORTUGAL (*)	500 000	21 448 (4.3%)	460 (1992)	-	-
SLOVENIA	6 400	458 (7.2%)	24 (1993)		-
SPAIN	4 000 000	90 757 (2.2%)	384 (1992-93)	-	
SWEDEN	30 flocks	-	-	-	-
SWITZERLAND	3 250	-	-	340 (10.5%)	34 (1993)
TUNISIA	210 000	2 200 (1.0%)	10 (1992)	-	-

(*) see : second meeting of the FAO-CIHEAM network on animal resources in sheep and goats (December 9-10 1993, Zaragoza)

Table 5

Size of population and importance of milk recording for dairy sheep breeds accounting for more than 10 000 recorded ewes

BREED	SIZE OF POPULATION : TOTAL NUMBER OF FEMALE	OFFICIAL MILK RECORDING		OTHER MILK RECORDING	
		Number of recorded females (%populat.)	Number of recorded flocks (year)	Number of recorded females (%populat.)	Number of recorded flocks (year)
CHURRA (Spain)	1 400 000	26 099 (1.9%)	86 (1993)		
COMISANA (Italy)	990 000	84 621 (8.5%)	723 (1993)		
CORSICA (France)	100 000	17 480 (17.5%)	84 (1993)		
KARAGOUNIKI (Greece)	198 000	22 400 (11.3%)	336 (1992)		
LACAUNE (France)	725 000	156 624 (21.6%)	376 (1993)	511 100 (70.5%)	1501 (1993)
LATXA (Spain)	402 000	54 202 (13.5%)	242 (1992)		
LESVOS (Greece)	175 000	10 800 (6.2%)	130 (1992)		
MANECH (France)	410 000	85 214 (20.8%)	338 (1993)	33 833 (8.3%)	147 (1993)
SARDA (Italy)	3 761 000	102 967 (2.7%)	854 (1993)		
SERRA da ESTRELLA (Portugal)	280 000	15 420 (5.5%)	370 (1992)		

Although the dam-daughter selection pathway is not as negligible as in dairy cattle because of a higher prolificacy in sheep, the most efficient pathways are those for the dam-son, the sire-son and the sire-daughter (*Barillet et Elsen., 1979; Barillet., 1985*). Furthermore, in most cases, the average size of the dairy flocks ranges from 200 to 400 ewes. Thus an efficient breeding program cannot be organized on a strict within flock basis which allows in practice (accounting for the size of the flocks) managing only the dam-daughter and dam-son selection pathway. In other words, the breeding plan has to be carried out between flocks of the nucleus in order to be able to progeny-test rams, *i.e* to also make efficient use of the sire-son and sire-daughter pathways. Under these conditions, AI is a powerful tool for creating genetic connections between flocks, thus enabling inter-flocks organization of the breeding program. If the impact of AI is moderate in the nucleus flocks (AI rate in the range of 10 to 20 %) then natural mating (NM) and AI have to be combined to carry out progeny-test of rams and to plan assortative matings. When the AI rate increases up to 40-50 % in the nucleus flocks, it is then possible to rely more on AI rams for the breeding scheme, and the genetic gain can be 35 % higher than for the previous situation (Barillet and Elsen, 1979). Finally, if the AI rate reaches 70-80 % in the nucleus flocks, it also becomes possible to plan for a very efficient and fast diffusion of the genetic gain inside and outside the nucleus flocks (*Barillet et al., 1989*).

The use of AI in the nucleus started in the early 70s and late 70s respectively for the Lacaune and Manech breeds in France, while in the dairy sheep nucleus flocks of Italian and Spanish breeds it started more recently in the middle or late 80s. Thus as shown in table 6, French breeds (Lacaune and Manech) make more use of AI than the other breeds from Western Mediterranean countries (*Sanna et al., 1994*).

Table 6
Artificial insemination (AI) carried out in 1993 in the nucleus flocks of several breeds

Country	Breed	Number of AI in official recorded flocks (1993)
Italy	Langhe	600
	Sarda	12,000
France	Corsica	1,000
	Lacaune	126,000
	Manech (*)	39,000
Spain	Churra	15,000
	Latxa (**)	10,000
	Manchega	10,000

(*) Manech (red and black face) (**) Latxa and Carranzana breeds

3) Genetic evaluation in dairy sheep:

Milk recording in private flocks, combined with the use of AI, and with an accurate evaluation of the animals, are the main tools for constructing an efficient breeding program. As BLUP applied to an Animal Model (AM) is now considered to be the international reference, AM genetic evaluation systems have been implemented for dairy sheep in countries such as France, Italy and Spain since 1991 (*Gabina et Barillet, 1991; Pagnacco et al., 1991; Barillet et al., 1992; Barillet et al., 1993*).

In theses countries, different organizations cooperate in the genetic evaluation of different breeds, as described in the first ICAR survey carried out in 1994 on this topic (*Astruc et al., 1994*). For breeds involved in this survey (table 7), at the end of 1993, the size of the data set for genetic evaluation ranged from 18,194 lactations (Langhe breed) to 1,682,531 lactations (Lacaune breed). The number of males evaluated varied from 31 in the Corsica breed to 10,619 in the Lacaune breed, according to the population size for each breed and its breeding program.

Table 7
Description of the data set for each breed involved in the ICAR survey for genetic evaluation in dairy sheep (year 1993)

BREED Country	LACAUNE France	MANECH (*) France	SARDA Italy	LATXA (LCN) Spain	CORSICA France	LATXA (LCR) Spain	LANGHE Italy
Years considered	1978 1993	1978 1993	1983 1993	1982 1993	1978 1993	1982 1993	1983 1993
Lactations processed number	1,682,531	647,207	501,539	234,664	92,592	41,482	18,194
Number of females with records	549,024	225,354	222,122	108,211	41,480	19,109	7,084
Number of females evaluated	668,111	239,020	275,512	120,597	42,188	21,250	8,224
Nomber of males evaluated	10,619	3,001	6,774	4,908	31	910	485
Official milk recorded population in 1993	156,624	85,214	102,977	28,739	17,480	5,526	3,748
Organizationr esponsible for genetic evaluation	INRA	INRA	IZCS Assonapa	CIMA	INRA	CIMA	ISZ Assonapa

(*) Red and Black Face

In all cases, evaluation is based on a repeatability animal model, which always includes an additive genetic effect, a female permanent environmental effect and a main effect such as the classical flock-year or flock-year-season effect, which is replaced by some authors by a flock-year-age or flock-year-parity effect. Other fixed effects may be included in the model. Regarding the survey, it appears that while all organizations are using the AM method, there are important differences in data editing and analytical models used for genetic evaluation of dairy sheep in France, Italy and Spain.

The previous evaluations have been based on the analysis of lactation yields (at milking period only). These lactation yields are derived from elementary test-day information combined with Fleischmann's rules (*ICAR, 1992*). An alternative, which has been studied for the Lacaune breed in first lactation (*Barillet et Boichard., 1994),* is to analyse individual test-day records. In sheep, because cost constraints are much more limiting than in cattle, a simplified recording design will be developed for milk composition (figure 3) justifying further research towards a test-day evaluation.

4) Published estimates of genetic trend:

For Lacaune, Manech (Red Face) and Sarda breeds, estimates of genetic trend were published (*Barillet et al., 1992; Barillet et al.,1993*) using AM evaluations. The main purpose of this study was to compare the efficiency of different breeding schemes according to the AI rate in the nucleus flocks (table 8).

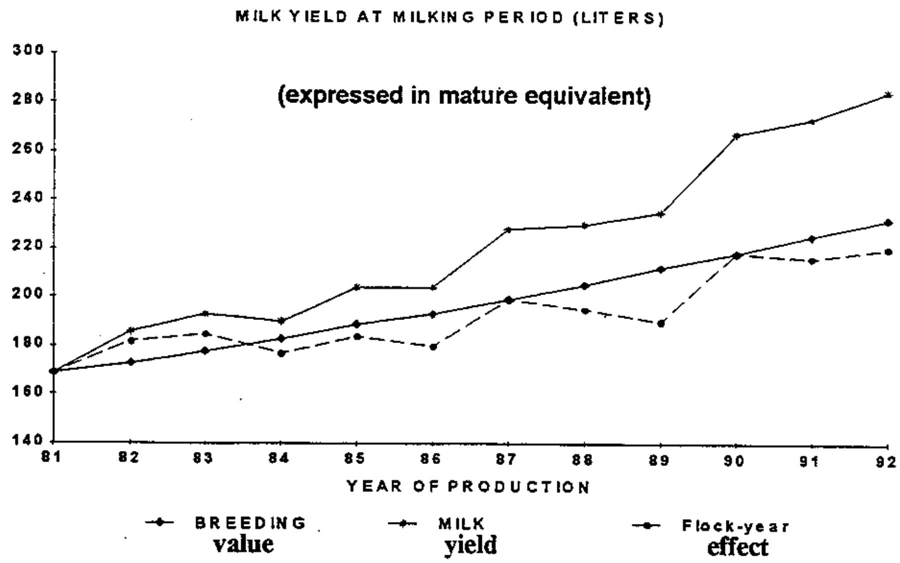
Results are consistent with the organization of the nucleus flocks for each breed. Pyramidal management of the population and AI within the nucleus flocks are emphasized, because they make it possible to accurately progeny test rams and apply high selection intensity. The AM evaluation confirmed the efficiency of the Lacaune breeding program, since the genetic gain for milk yield reached 5.7 liters per year in the eighties (figure 4), *i.e* almost two thirds of the phenotypic trend over the period analysed. Yearly, this genetic gain reached about 2.4 % of the population mean or 0.19 genetic standard deviations (table 8). This result confirms that the genetic trend of a sheep population may be of the same magnitude as in dairy cattle, despite the limitation of the sheep species for AI.

Table 8
Estimated annual genetic trend for milk yield in Sarda, Manech and Lacaune breeds.
(Barillet et al., 1993)

Breed	SARDA		MANECH (Red face)		LACAUNE	
Years	1986	1992	1985	1992	1985	1992
Official recorded ewes (n)	78,706	99,661	21,610	51,465	105,367	142,196
Milk yield (l)	187	203	82	104	189	257
Milking length (d)	162	162	117	133	162	166
Annual Phenotypic gain (%) *	1.6 %		4.0 %		3.9 %	
Annual Genetic Gain (%)*	0.3 %		2.0 %		2.4 %	
Annual genetic gain for the females (in liters)	0.5 1		2.0 1		5.7 1	
AI rate in the nucleus flocks (%)	2	6	30	44	70	80

* % of the population mean

Figure 4 : Genetic and environmental trend for Lacaune first lactation milk yield

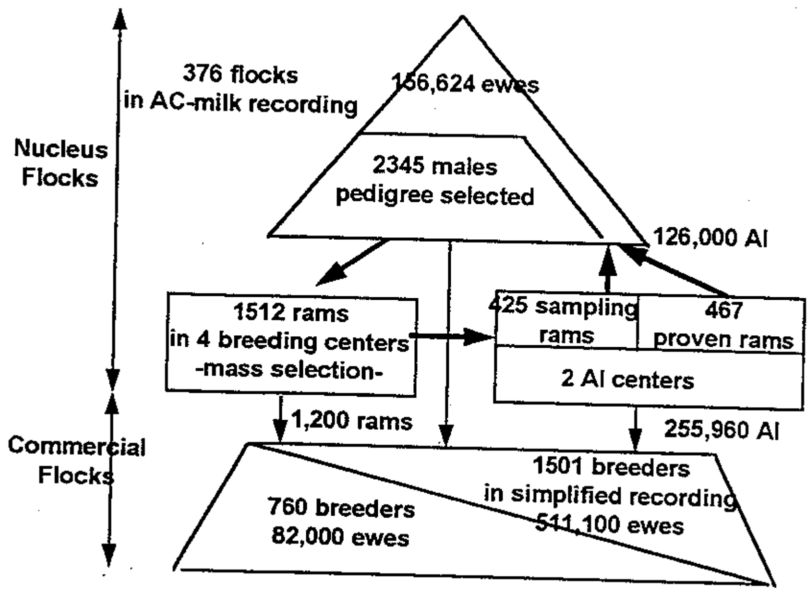


This possibility was confirmed with the Manech example: the Manech breeding program became really efficient in the nineteen eighties, when the AI rate was large enough (40%) for AI progeny testing of at least 80 males born from assortative matings in the nucleus : the estimated genetic gain was 2 liters per year, *i.e* half the phenotypic trend over the analysed period. For the Sarda breed, which already has an interesting milk yield level, the genetic gain is small because, in the 2-6 % range for AI rate, only the dam-son selection pathway within flock is really efficient. For the Sarda breed, the goal is to organize efficient selection pressure on the 4 gene transmission pathways, especially those from AI or NM sires, which means increasing the use of AI in the nucleus flocks.

<u>5) Lacaune breeding program:</u>

A close look at the Lacaune breed will be useful as it has the oldest and most efficient dairy sheep breeding scheme (Figure 5). The whole population includes 750,000 ewes on 2,637 farms while in 1993 the nucleus included 156,624 ewes owned by 376 breeders. Recording of fat and protein has been generalized for all nucleus flocks since 1987. The rate of AI reached 80 % in the nucleus in 1993. 126,000 ewes in the nucleus flocks were inseminated : 45% were used as mates of the 425 young rams on progeny testing, and the others were mated with 467 AI proven rams, especially the best 120 elite rams. These elite rams were mated with the elite ewes of the nucleus, giving 2,345 male lambs with selected pedigree. About 1,500 of these young rams born from assortative matings enter the breeding centers when they are one month old. Of these, 1,000 are sold to commercial flocks. After some mass selection of the young rams in the breeding centers on type and growth rate traits, the best 425 rams on pedigree index for milk traits entered the AI centers at 8 months of age to be progeny tested in the nucleus.

Figure 5 : Breeding scheme in the Lacaune breed (1993)



In the base population, about 40% of the adult ewes were inseminated with AI proven rams (255,960 AI in 1993), and one thousand pedigree selected rams were sold from the nucleus to base population. The diffusion rate (by AI plus natural mating rams) reached about 100 % for commercial breeders practising simplified milk recording (1,501 flocks in 1993). In conclusion, with the pyramidal framework, AI was dominant in the nucleus flocks for the genetic gain creation, while the diffusion to base population combined AI and natural mating.

The phenotypic trend for milk yield in the Lacaune nucleus and commercial flocks (in simplified recording) illustrates that the equilibrium was achieved at the beginning of the nineteen eighties, fifteen years after the start of the breeding program (figure 6). This result is in agreement with the studies carried out in the nineteen seventies to design and optimize the breeding scheme (*Elsen et Mocquot., 1974; Vallerand et Elsen., 1979*). Now the phenotypic trend is the same in the nucleus and base population, with a gap of about 40 liters corresponding to 5 to 7 years of gain.

Under these conditions, the selection objective in dairy Lacaune sheep moved from milk yield both to milk yield and milk composition in order to maintain satisfactory cheese-making properties (*Barillet., 1985*). Therefore, the dairy selection criterion used from 1987 to 1992, defined as the linear combination of fat and protein yield (called useful matter yield), enabled improvement in the genetic level for milk yield while maintaining fat and protein contents (*Barillet et Boichard, 1987*). The new goal at the end of the eighties has actually been reached : for the 3,825 AI Lacaune males born between 1984 and 1992, the genetic level for fat and protein contents was quite stable (figure 7), whereas the genetic gain for milk yield reached 51 liters during the same time (*Barillet et al., 1993*). From 1993, a new selection criterion will be used (fat yield, protein yield and content) in order to increase both milk yield, fat and protein contents in the nineties.

Figure 6 : Phenotypic trend for milk yield in the Lacaune nucleus and commercial flocks

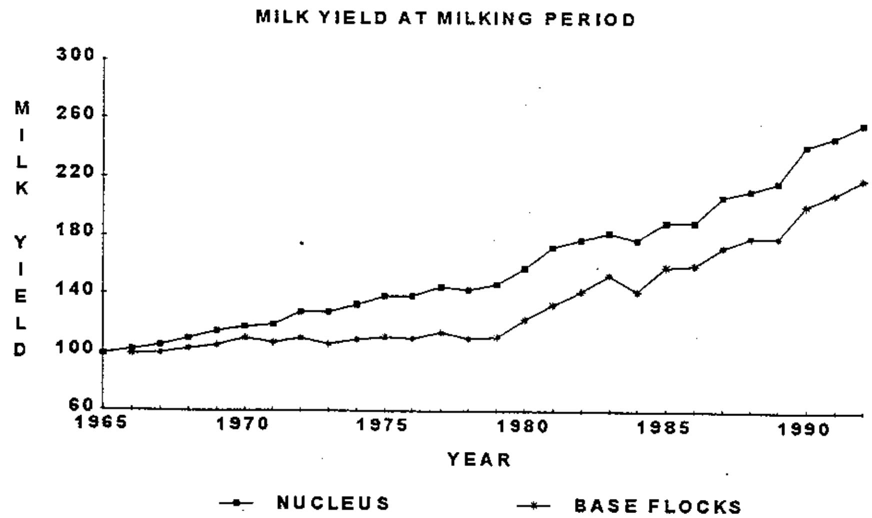
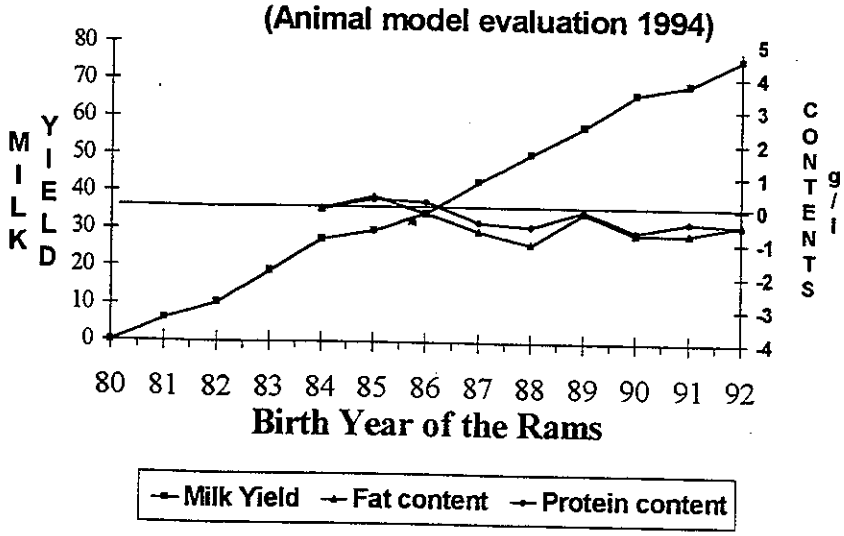


Figure 7 : Genetic trend for Lacaune rams (Animal model evaluation 1994)



CONCLUSION

There are large differences between breeding programs for the Mediterranean local breeds with respect to their levels of organization. Except for some countries and/or breeds, the use of milk recording in dairy sheep is often insufficient in terms of population size, and the fact that AI use is limited to a few breeds.

The Lacaune breed has the oldest and most efficient breeding scheme, as it is based on a large use of AI and is able to select for both milk yield and milk composition. For this breed, the next objective in the nineties will focus on increasing the selection intensity on milk composition, eventually including genetic polymorphism of milk proteins based on studies of this topic in progress in France (*Barillet et al., 1993*). A direct selection for milking ability and udder traits will probably also be implemented, using an automatic milk meter which has been designed and developed by INRA for dairy sheep and goats (*Guillouet et al., 1990; Astruc et al., 1993*). For other traits concerning dual purpose breeds such as the Lacaune breed, different studies are being carried out regarding the traits to be measured and the genetic improvement strategy (*Barillet et al., 1988*).

Except for the Lacaune breed, nowadays in Southern Europe other breeding programs are carried out using on-farm milk recording, artificial insemination (AI), and an accurate genetic evaluation of the animals, particularly for the Churra, Latxa, Manech and Sarda breeds. Nevertheless the efficiency of the breeding program depends directly on the rate of AI in the nucleus flocks. Thus it would appear to be fundamentally important to increase the use of AI, since it is a powerful tool for genetic improvement, as was done in the eighties for the Manech breed. However it is obvious that the local conditions of many Mediterranean areas reveal limiting factors for a wide use of on-farm milk recording and AI.

Under these conditions, the question of the breeding strategy has been an ongoing debate for Mediterranean areas (*Mavrogenis., 1992*). Different scenarios may be imagined for the future from the crossbreeding strategy to the implementation of local purebreed breeding programs. Moreover some authors propose an on-station nucleus flock if local conditions prohibit the development of an on-farm breeding scheme. This proposal requires a three level pyramidal organization, the first level being the on-station nucleus unit, a second multiplier level designed to provide breeding animals for the third level of commercial flocks. The use of modern reproduction techniques such as embryo transfer may be proposed for the on-station level (Comisana breed) to reduce the generation intervals and increase family size. But the actual gain may be far from what is expected, especially if inbreeding and reduction of genetic variance are not checked. Moreover past experience often showed that the transfer of improved animals to commercial flocks could be difficult, due to a lower adaptation of the improved material to traditional husbandry conditions, and/or due to the lack of a simultaneous evolution of the breeding system along with the genetic improvement (*Sanna et al., 1994*). Finally, regarding the wide range of local production systems for dairy sheep in Mediterranean areas, the on-farm selection of local breeds may be recommended. Nevertheless it should be kept in mind that in the nineties only some breeds show a real genetic trend for milk yield, which could modify the future situation for genetic improvement of dairy sheep.

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SHEEP DAIRYING IN FRANCE: PRODUCTION AND OBJECTIVES OF RESEARCH

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ABSTRACT

Milk production from dairy sheep is a tradition in three mountain areas in Southern France: the Roquefort area in the Massif Central plateau with 750,000 ewes (2,640 breeders), the Pyrenees Mountains on the Spanish border with 420,000 ewes (2,790 breeders), and the island of Corsica with 110,000 ewes (560 breeders). French breeding systems are characterized by an out-of-season lambing, from October to January. The ewes are milked after a one month long suckling period and dried-off in July or August when dairy factories stop their activity.

The lambs are either slaughtered at weaning as milk-fed lamb, or fattened up to 100-120 days of age. The milk produced during the milking period after lamb weaning is processed into high quality cheeses recognized and protected by regional labels. There is a complete association between a region of production, a brand name of cheese and a breed of dairy sheep:the Lacaune breed and Roquefort blue cheese in Roquefort area, the Basco-Bearnaise or Manech breeds and Ossau-Iraty cheese in the Pyrenees Mountains, and the Corsica breed and Brocciu cheese on the island of Corsica. Wine and cheese situations are quite similar in regard to brand name, origin and quality requirements, official control and label protection. This regulation appears to be well suited to the French way of life and is good guaranty for the tradition of food quality.

In 1993, sheep milk production reached 186.6 millions liters in France: the Roquefort area represented 77 % of the total (144.6 millions liters), the Pyrenees Mountains - 18 % (33 millions liters), and the island of Corsica - 5 % (9 millions liters). Most of the production is sold by the breeders to dairy companies : in 1993, 95 % of the milk production was processed into artisanal or industrial cheese by 15 companies, and 5% into farmhouse cheese (in the Pyrenees Mountains or the island of Corsica). Seventy percent of milk sold by the breeders to dairy companies was processed into Roquefort or Ossau-Iraty cheeses which are the most famous French sheep milk cheeses. The rest of the production was diversified into various cheeses or products such as Feta cheese.

In the 1960s, the dairy companies were worried because of the stagnation of milk production around 57 millions liters despite the increase of the sheep milk market. The main reason for this stagnation was the decline of the manual milking of ewes and replacement of dairy sheep by meat sheep. Consequently, the main objectives of research and development in the 1960s were to improve milk yield productivity of the ewes and flocks and to increase milking efficiency. To reach these goals, a cooperative effort was carried out between the breeders associations, the dairy companies and the French National Institute for Agricultural Research (INRA). This cooperation is still in progress today. Three main topics including breeding and genetics, reproductive physiology, and milking physiology and machine milking were defined, studied and experimented with in order to propose solutions applicable on-farm on a large scale.

Improving milk traits in dairy sheep may be achieved either with crossbreeding or through purebreed selection. These two alternatives have been studied and experimented with, especially with the French Lacaune, the Sardinian and the German East-Friesian breeds. Although the East-Friesian was initially considered as the most high-yielding breed, the crossbreeding results showed strong genotype by environment interactions and very disappointing performances for genotypes with more than 50% Friesian genes. Consequently, crossbreeding was disregarded, and within population breeding schemes have been implemented for each local breed in its specific area and its specific production system. Genetic improvement programs became fully efficient only after 1970, with the conception of pyramidal plans suited to the species. Each population was partitioned into two groups -a selection nucleus and the rest of the population. The breeding tools were exclusively or mainly used within the nucleus, firstly to create genetic gain (pedigree recording, official milk recording, artificial insemination, progeny test, assortative matings, etc...), and secondly to organize its diffusion by AI or natural mating towards the base population.

While official milk recording was used exclusively in the nucleus, a simplified milk recording was designed for the base population for within-flock comparison. This strategy to implement milk recording on a large scale has been very successufull since 49,814 and 804,250 ewes were recorded in 1970 and 1993, respectively. During the same period, AI with fresh semen after oestrus induction increased from 24,000 to 517,350 ewes per year. From 1980 to 1993, the rate of AI in the nucleus increased from 59% to 80% in the Lacaune breed, and from 10% to 44% in the Pyrenees breeds.

During the last twelve years, average milk yield (at milking period only) increased from 158 to 257 liters in the Lacaune nucleus. According to the official animal model genetic evaluation, the yearly genetic trend (+5.7 liters) represents two thirds of this phenotypic trend (+9 liters). The genetic trend in Lacaune dairy sheep reached 2.4 % of the mean per year, and therefore was of about the same magnitude as in dairy cattle. Similary, for Pyrenees breeds, half of the yearly phenotypic trend (+4 liters since 1984) was attributed to genetic gain (+2 liters per year).

The main objectives of the 1960s have been reached since sheep milk production tripled from 57 to 186.6 millions liters in 1993 due to both an increase in flock size and a doubled production per ewe. The percentage of milk from recorded flocks increased from about 10 % in 1970 to 79 % in 1993. Most of the breeders, especially in Roquefort area, are now specialized dairy sheep breeders with large flocks (average 300-500 ewes) with a rather high milk production level and using modern husbandry methods such as machine milking and AI.

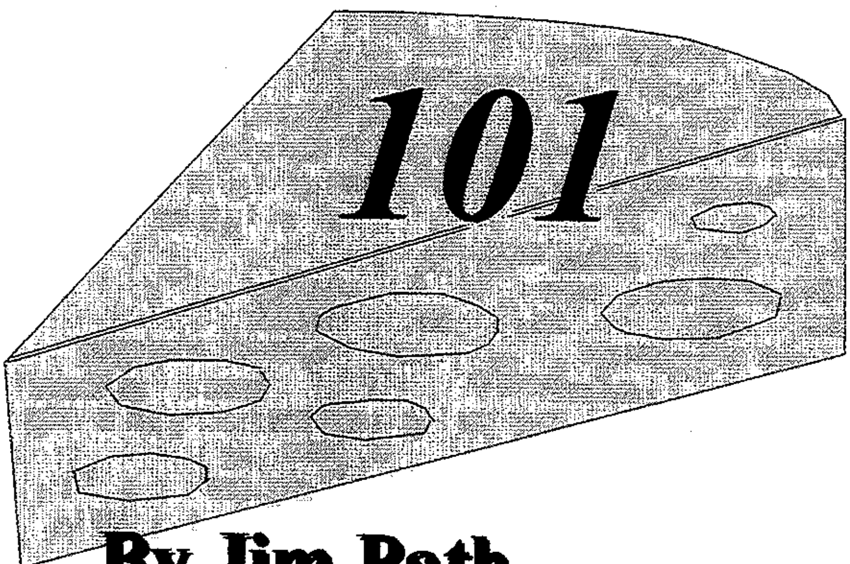
Recently, new objectives for research and developement have been defined as follows :
- improvement of milk composition related to manufacturing properties of milk, through both genetics and management,
- control of production costs, especially feeding costs, by optimizing voluntary forage intake,
- automation device development (such as electronic identification, automatic milk-meters, automatic feeding devices) in order to modify the management system of large flocks and, particularly, to feed more individually according to production level, and
- control of bacteriological milk quality .

Most of our experiments have been carried out to study these new issues.

Keywords : Sheep dairying, France, Products, Breeding, Genetics, Feeding, Research.

Cheese Making

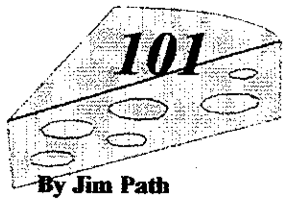
101



By Jim Path

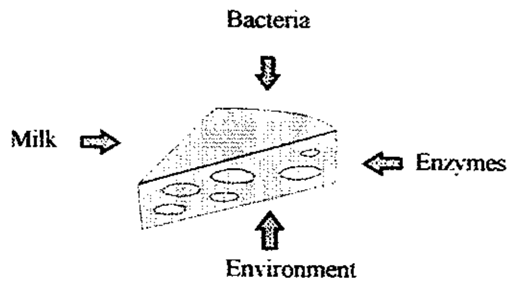
Center for Dairy Research

Cheese Making

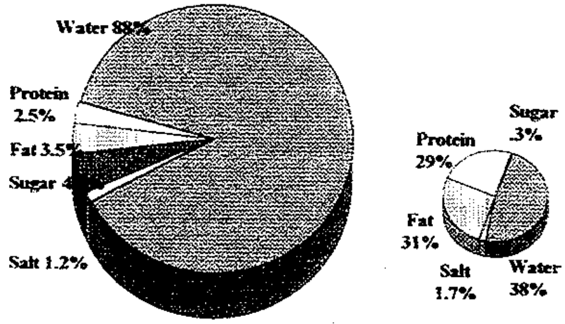


By Jim Path
Center for Dairy Research

Basics



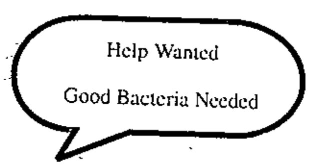
Transfer of milk constituents into cheese



Simple Terms

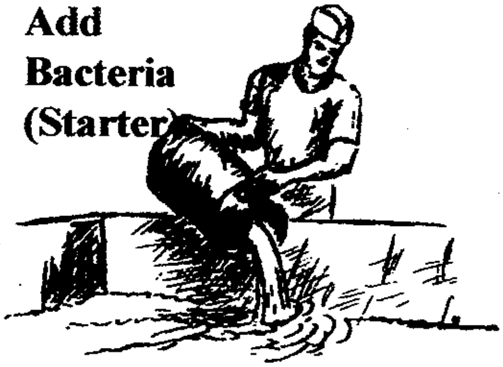
- Large removal of water and sugar
- 10 times reduction in size

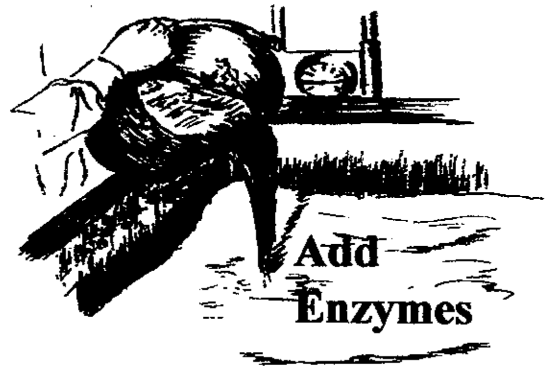
Next Step
Hire Bacteria

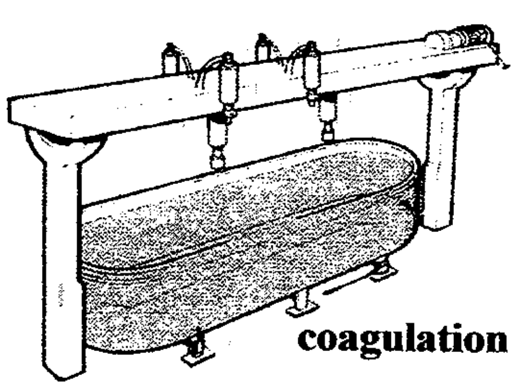


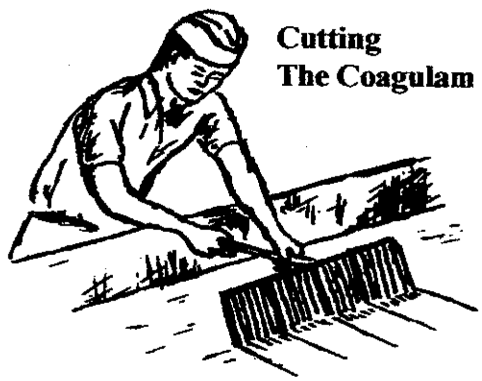
Characteristics of Some Dairy Bacteria

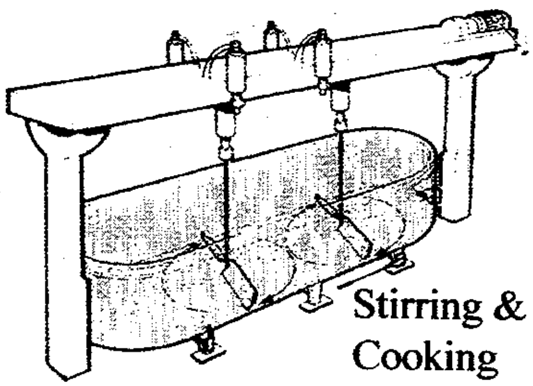
Type	Growth Optimum Temp. C	Max Salt Tolerance for Growth
Str. Cremoris	25 -30	4
Str. Lactis	about 30	4 - 6.5
Str. Thermophilus	40 - 45	2
Lb. Helveticus	40 - 45	2
Lb. Bulgaricus	45 - 50	2

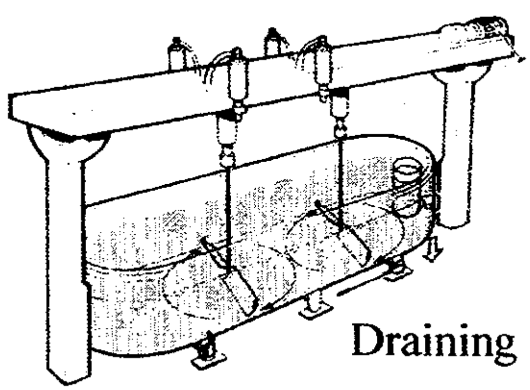

Add
Bacteria
(Starter)

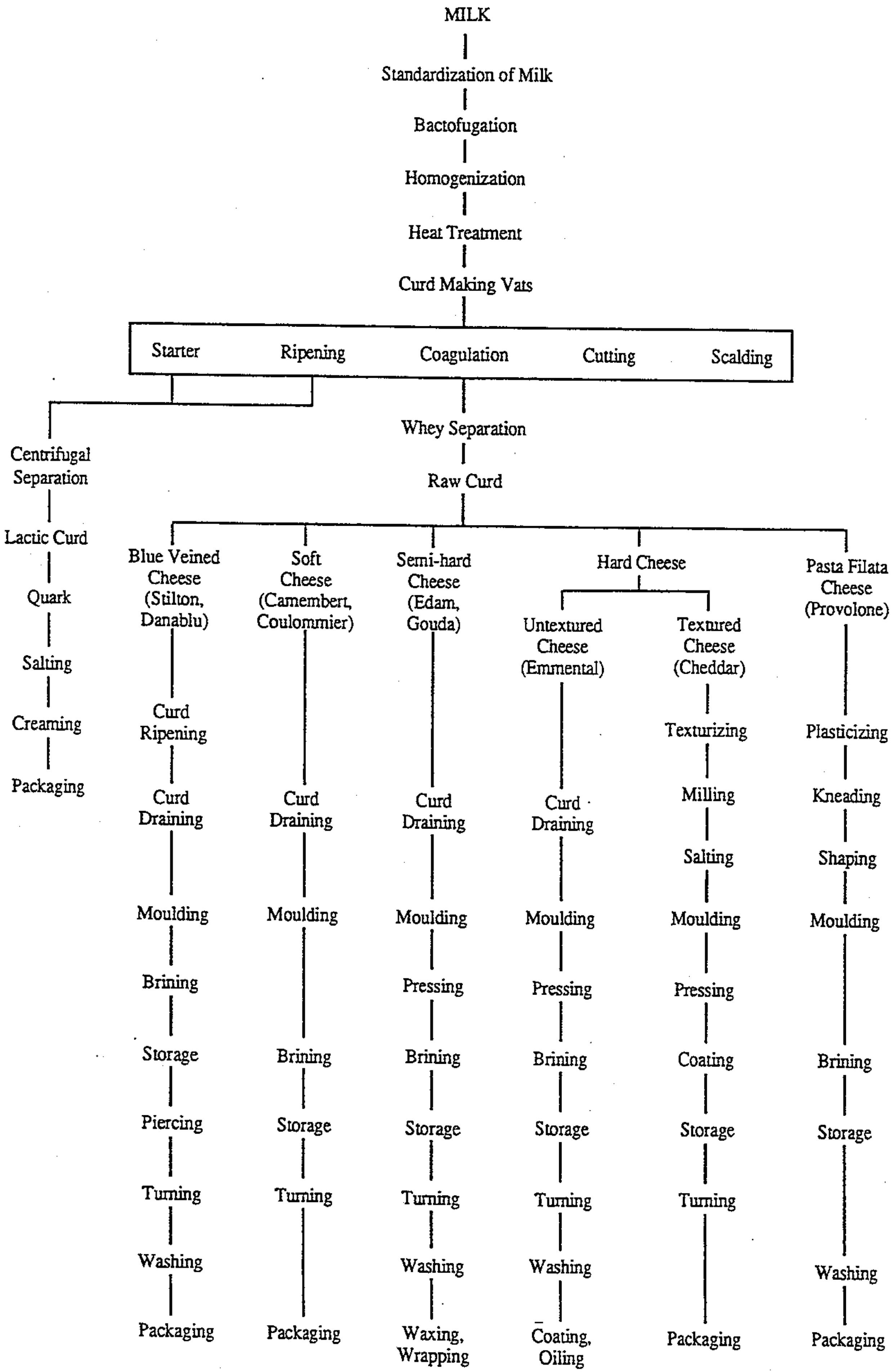

Add
Enzymes


coagulation

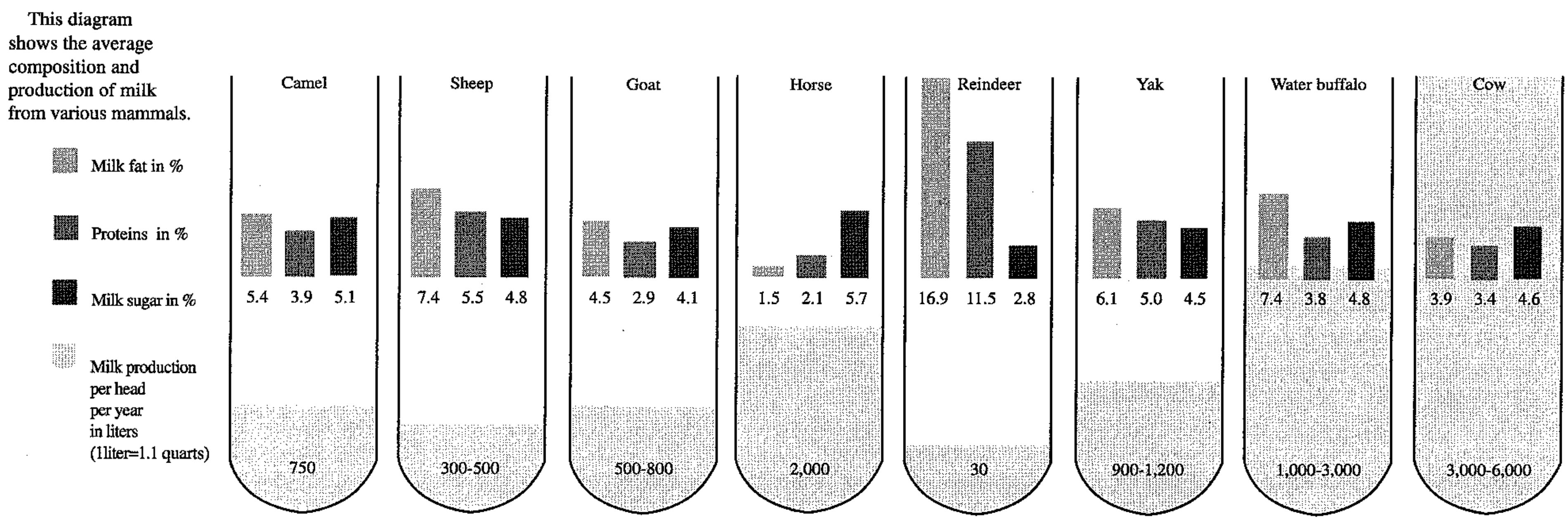

Cutting
The Coagulam


Stirring &
Cooking


Draining


MILK
Standardization of Milk
Bactofugation
Homogenization
Heat Treatment
Curd Making Vats
Starter
Ripening
Coagulation
Cutting
Scalding
Centrifugal Separation
Lactic Curd
Quark
Salting
Creaming
Packaging
Whey Separation
Raw Curd
Blue Veined Cheese (Stilton, Danablu)
Curd Ripening
Curd Draining
Moulding
Brining
Storage
Piercing
Turning
Washing
Packaging
Soft Cheese (Camembert, Coulommier)
Curd Draining
Moulding
Brining
Storage
Turning
Packaging
Semi-hard Cheese (Edam, Gouda)
Curd Draining
Moulding
Pressing
Brining
Storage
Turning
Washing
Waxing, Wrapping
Hard Cheese
Untextured Cheese (Emmental)
Curd Draining
Moulding
Pressing
Brining
Storage
Turning
Washing
Coating, Oiling
Textured Cheese (Cheddar)
Texturizing
Milling
Salting
Moulding
Pressing
Coating
Storage
Turning
Packaging
Pasta Filata Cheese (Provolone)
Plasticizing
Kneading
Shaping
Moulding
Brining
Storage
Washing
Packaging

Composition of Milk from Various Mammals



DEVELOPING A MARKET FOR DAIRY PRODUCTS

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Milking sheep and making products is all about making a profit. This profit may be primarily made from lamb sales with milk an added bonus, or it may be made from milk with lambs the added bonus. However, I am mainly interested in selling milk in whatever form I can and do not bother too much about the lambs. Therefore, it will be found that labour and loss of product due to poor quality milk are two of the most expensive features that lead to lack of profit.

It is likely that the production of the milk will not often be done by the same person who makes the product, probably not even on the same farm or by the same family. There are product makers who also employ marketing people to consider as well. Some small producers may feel they can do it all, but to make money there are just too many jobs to do and a hierarchy has to be set up as in any big business.

In Britain, and I am sure it is the same in the States, ignorance about the source of milk at all is the biggest problem in marketing. In our big cities, most of the children in a survey did not know where cow milk came from. Answers like "from a carton," "from the supermarket," "from the milk man," but not one even vaguely suggested it might have come from a cow. So how do you educate people to sheep milk? Goat's milk they may have heard of, but "sheep don't give milk". This has until recently been even more confusing in Britain as the law said, "Milk only comes from cows," "Sheep and goats give food." This regulation so confused the poor housewife that she did not understand when the Greeks put "Pure ewe's milk with added cream" on their pots. The word cream in the English language could only mean cream from cow milk. Hence the court case we finally brought against the importers of Greek yogurt revolved initially around the exploitation of this word "cream." Later, of course, we found they were adding over fifty percent skimmed cow milk powder to the so-called "pure ewe's milk yogurt."

CUSTOMER EDUCATION

Before any marketing can take place a strategy has to be worked out on how to convince the housewife/customer that she should pay at least twice as much for this very ordinary looking product. What do you say to convince her? What scientific evidence have you to prove it is better than anything else? What steps can you take to promote this white liquid, which may equally be solid, but still looks like ordinary cow milk?

There are a number of ways:

1. Piggy backing There will always be a few people who have heard of goat milk and maybe need it for allergy reasons. These people can be persuaded to at least try sheep milk products. Also in the allergy market there will be people who will only buy cheese provided it looks and tastes like say cheddar, but is guaranteed to be made from sheep milk. We have one dairy that makes "Nanny's Cheddar" from goat milk and "Sheep's Cheddar" from sheep milk as well as a cow milk cheddar. All are made in block, cut and vac-packed and sell well in shops that cater to the unimaginative and conservative housewife.

2. Shows, Farmers Markets, etc. Offer iced milk to drink on a hot day, often not telling people until after they have drunk it that it came from a sheep. The same can be done with cheese and ice cream. Shows and Markets are the best way to sell your products at first as you can discuss their merits with the customer. Always have a variety of products on offer because the old saying that, "One man's meat is another man's poison" seems to apply to selling cheese. Some like it strong, mouth burning and really aged. Some like it bland, soft and salt free, while others love Feta for its high salt content or the soft cheeses because they are so creamy. It is a revelation in what people really like (and dislike).

3. Nostalgia In the States, more than in Britain, there must be many people who remember sheep milk back where ever they came from and are not afraid to try it. In Britain, the "package tour" has helped enormously. People travel to the Mediterranean and sample these sheep cheeses and yogurt and come back delighted to find them again. I believe in the States only about five percent of the population own passports and eighty percent take their holidays within 60 miles of their homes so they will not get any education on sheep milk products unless you give it to them in the form of an "Open farm experience" where they can come and see the milking, product making and enjoy themselves at the same time. In Britain we have many such places, the most famous being the "Big Sheep" in Devon.

4. Niche marketing Produce a product that is different to any made from cow milk, that is superbly presented and sold through a high class delicatessen. There are many better off people, what I used to call the Dallas and Dynasty set, who will happily pay a lot of money for something that other people cannot afford, BUT it has to be superb. Probably a soft, Brie-like cheese, blued if possible, packaged to set off it's high quality and sold at a ridiculously high price. These are the people who need something different for their Cheese board, eat cheese as a course at dinner and not just for cocktails or cooking and demand taste experiences. Word quickly gets round if the taste is right.

QUALITY CONTROL

The best quality controller is your pocket. If the product doesn't sell, find out why and change it. The quality of a product depends mainly on the quality of the milk. No antibiotics, no taint due to poor feeding regimes, no dirt, no subclinical mastitis and high Somatic Cell Counts. But the other half of quality means that the product is worth the money you are asking for it. In other words it has to be delicious, moreish, addictive or whatever other word you like that will get people hooked on to it and come back time after time to buy it. One bad batch and you have lost all your customers and all your hard work and they are not easy to win back BECAUSE in this modern world they have so much CHOICE. Customers do not HAVE to buy your product, they must WANT to buy it because it is to their taste.

EYE CATCHING PACKAGING

There is a saying that "The first mouthful is taken with the eye" and this could not be more applicable to sheep milk products. The presentation and packaging has to be above average and this is expensive. However, we have learnt in Britain that there are many ways of presenting our products without it costing too much.

1. Colour Sheep milk products are white and in order to exploit their healthy, green grass image, the packaging should be in subdued, countryside colours. A little gold with green is very stylish, a tiny touch of red catches the eye, but never package your products in hard colours thinking they will attract people, because they give out the wrong messages.

2. Shapes Cheeses particularly can be made in various shapes. One or two people have bought the traditional basket moulds of Italy and used them. One person was making a cheese in Ireland the shape of a Celtic cross. There are people now making cheeses the shape of fruit, like apples, pears and bananas and coating them with coloured wax. Another puts cheese into mugs and covers with black wax to look like black coffee. These are fun cheeses. Even soft cheeses can be rolls or round banons or balls, coated in green herbs, black pepper or a white mold.

3. Point of sale information People like to know about the food they are buying. A clever and informative leaflet with photos and on good coloured paper is essential. Has it a vegetarian rennet, what is the fat content and what type of fat, where does it come from, what sort of sheep, is there a history to the recipe, etc.? This is an excellent opportunity to do some marketing by word of mouth. People will tell their friends what they have bought and all about it. It is a kind of social one-up-man-ship. "Guess what I bought today?" Another point here is the Product Price List and Invoices, both should be inviting and informative, not just a computer printout or a cheap copy book. It gives the wrong impression.

WHAT SHEEP MILK PRODUCTS TO MAKE?

It may be that the processor who buys the milk already makes other products from other milks and so has experience, this can save a lot of time and energy as they already have a distribution round and merely slip the new product in with the others. But to start from scratch selling sheep milk products only is much harder.

DISTRIBUTION IS THE NAME OF THE GAME

In the UK, we started with milk. We were lucky in having a number of doctors and dietitians who had begun to realise that many allergies and intolerances were caused by diet. We sold it frozen in pint bags or cartons and over ten years this has become a great success story. Once tasted, most are hooked. Children particularly love it. We have also done flavoured milks, fruit milk shakes, thick shakes made with milk and ice cream, it all sells well, but still constitutes less than 20% of sales.

Then the easiest thing to get into looked like yogurt. Some was being imported from Greece and Cyprus and was a known product. This now probably accounts for up to 35% of sales, but it has been a struggle. The lobby against high fat products had to be convinced that they would not all die of heart disease, oddly enough they bought the Greek cow yogurt at 10% fat more readily than our sheep milk one at 6% fat. There is no logic among consumers. Now some very interesting and unusual flavours are being added and the bigger producers have got it into the supermarkets.

Yogurt is a short shelf life, easily contaminated product. It has to be continually made and delivered, so should only be made and marketed where it is possible to get it delivered fast and ALL YEAR ROUND. Again flavours popular in cow milk yogurts will equally be liked in sheep, but it is advisable to raise the quality of the fruit (which is cheap) to justify the higher price of the yogurt. Strawberry should have strawberries in it, black cherries should be identifiable, blueberries should be genuine and so forth and not just a cheap puree with essence. Honey, maple syrup and toffee are popular. Health conscious people buy sheep milk yogurt on the no added sugar ticket, but they never seem to mind if it has honey in it!

The size of the pot is critical. Small pots of flavoured, enough for one person should not exceed 150 ml and maybe 140 ml is better. Large yogurts of 500 ml natural are very popular, any in-between size does not seem to sell as well. Yogurt eaters divide into single persons and families. If you have made too much, why not drain it? This yogurt curd mixed with apricots is a real winner. It is similar to German Quark and ideal with fruit or with herbs.

Cheese is usually the last item made and marketed, not because it is not easy to make, but because it is only worth making with much larger amounts of milk. When I first wrote my book on sheep dairying, the publisher said I must mention Roquefort as it was the only cheese people had heard of made from sheep milk. I later discovered very few people had any idea it was made with sheep milk. People tell me everyone has heard of Feta, but most Feta is now made from cow milk, whereas Roquefort can never be. Maybe under the new EU legislation the Greeks will establish once and for all Feta can only be made in Greece and only from sheep and goat milk. So you have the dilemma, do you piggy back and get your cheese in as a known type of cow milk cheese made with sheep milk, or do you call it "Pecorino" and trust someone has heard of that.

Naming the cheese is also important. The name must catch people's imagination, be easy to pronounce and remember and leave a memory of a good taste experience.

Will you sell cheese in the round or in portions? From a quality control angle, cut and vacuum packed pieces of hard cheese, attractively labelled are safe and easy, but are not suitable for specialist cheese shops. It is also not suitable for soft cheeses which if they lose their shape and bloom are unsaleable. Soft cheeses need more rigid packaging so they are protected from being squashed.

The natural by-product of cheese making is Ricotta. So popular in Mediterranean cooking, it is almost impossible to sell in UK unless there has been a TV programme on it's use to slimmers. Then we get a deluge of orders which tail off rapidly when they find it is tasteless and uninteresting. No one told them how to use it. Not only can it be delicious, but is an important added profit to the milk processed as sheep milk has 1% of whey protein against cow milk at 0.3%. It can be vacuum-packed fresh, or smoked, or even dried and salted.

This leads on to an extra which is much appreciated in UK of providing recipes. I have people ringing up and saying they have been put on to sheep milk, what do they do with it? When I say it is just milk use it as you would cow milk, they are amazed. So cash in with clever and unusual recipes which you can sell.

If you have a bad time selling cheese and it dries out and goes too hard, why not sell it as grated cheese to go over pasta? After all this is the third stage of "Pecorino" and much more tasty than parmesan.

Another product which is selling very well is Fromage Frais made from sheep milk. It is designed for a niche market of allergy sufferers and also gourmets. It is less acid than yogurt and more versatile for cooking. In France they make "Caille" which is potted, rennetted sheep milk with flavours. This looks like yogurt but without any acid taste. One has to have so many products on hand to please the wide variety of people and justify delivery to shops.

The next product we went for in UK was ice cream. We started with frozen yogurt, but that never took off, so pure ice cream with few additives was developed. There are a few tricks in getting it right like separating the afternoon milking to get extra cream and using the skim either as low fat drinking milk or added to cheese milk. Here again the flavours must be of the highest quality as the price is going to be considerably higher than for that made from cow milk. Some of our members have worked out such exotic flavours as "champagne," "black currant and cassis," "whisky and ginger," etc. and got on to the Gourmet market where, like the Dallas and Dynasty set, people want expensive, unusual and truly gorgeous ice creams. But without stabilsers and other ice cream additives, the ices melt very quickly and there are many problems in distribution.

The last product we sell in the UK is "fudge," called "tablet" in Scotland; candy made of sugar and milk. This is very popular with children and safe for the ones with allergies. There is a version in South America which is even more delicious called "Dolceleche" which with peppermint essence added is divine.

HOW TO GET HELP WITH PRODUCT PERFECTION

The B.S.D.A. recognised that many people making products either had little idea of how they compared with other products or feeling that they themselves thought they were marvellous were angry and surprised they did not sell well. So we instigated yearly competitions. Although the States is a huge area, it is amazing how many people would come to a yearly meeting with their products in cold containers. The judges are important. We have one technical judge who comments on the actual making of the product and the other judge is often a buyer/consumer of note. They have to judge the product on customer appeal. The two sets of marks are added up and you have a winner. We now add a cup to be won by the best cheese in four classes as well. We have classes for yogurt and ice cream judged by a different person. BUT after the judging is over, all these judges remain and must be prepared to answer questions from the processors, as to why they didn't win, what could they do to win next time, etc. The standard has risen beyond all possible expections since we started and members are fascinated to see the inventiveness of some other processors and how they got over problems they thought insurmountable.

MARKETING

Sheep milk products until recently have only been sold on the traditional markets of the world where there have been few other dairy products and several thousand years of continuous production and sale. Now untraditional countries like the States, Britain, Australia, New Zealand, South America and Canada are all starting to milk sheep and sell the products. Some countries find it easier than others. Australia has a large Greek and Italian population to sell to while New Zealand has not the same Mediterranean mix. In Britain the Milk Marketing Board had done such a good job selling cow milk that at first there was only the cow milk allergy people to sell to. But slowly, bit by bit, day by day, show by show, shop by shop, we have educated our customers and improved our products so we now are in the desperate situation where we have markets far beyond our ability to produce the milk and may have to import milk from France.

Sadly, there is a very fine line between being a good salesman and being a Con man so people are wary now of new products. Almost all marketing is done on personality. But the first rule in marketing is to believe in the product. The second is to know all about it. Never be stumped for an answer to a question either about the product, the milk or the sheep. This is the big problem with wholesalers who will, doubtless, sell your products in larger volume, but as yours will be one among many hundreds also being sold by this wholesaler, who is going to answer these questions? Until your product has a state-wide or further reputation, you have to be involved yourself with its sale. The paramount art of selling is never to let the customer down. If you say you are going to deliver, you must deliver. If there is a shortage of milk, find some. Customers now do not understand seasonality. So if you neglect to fill your shelf space in any week, someone else will.

The best way to sell cheese is to get the customer to taste it first. I remember visiting a cheese shop in New Jersey belonging to one of the speakers at an American Cheese Society Conference held in Pennsylvania in 1985. She had a prodigeous turn over in monetary terms and claimed that her success was entirely due to putting out tasters with all her cheeses, what in England we call "a sprat to catch a makerel". A small price to pay for a much larger sale. One hint from long experience of this at Shows, never put out tasters in large quantities or people will just eat them and pass on. Try to get the customer to ask for a taste and then cut one off specially.

People must have the opportunity to sample and taste. If their first impression is good, you have a sale. Only the slightest thing has to be wrong and you have lost a sale. A good way to get people to taste the products is to persuade Chefs to put them on the menu. This works both ways as the consumer will also see how to serve them. Shops are very willing to let you do promotional days, you sell your own products in their shop and they do the advertising. You may well bring extra people into the shop, so everyone is happy.

The golden rule is never to make a product that is already on the market made much more cheaply out of cow milk. Only better quality and different products should be made from sheep milk unless you are making solely for the allergy market. But do not rely on the allergy market or the ethnic market to buy all your products. You need converts. Never be afraid to change your product to suit popular demand, after all they are buying. Listening to your customers is vital. You may find the difference between success and failure is no more than a pinch of salt.

WHAT OUTLETS TO AIM FOR

Many people do not know where to start selling their product. They haven't time to go round to lots of shops, they don't really know how to slot in their products. Obviously the easiest place to start is with a market stall, but these are time consuming. Then there are the Health Food Shops, most have never heard of sheep milk, though they know goat milk. Here a real selling job has to take place convincing them that sheep is best. Such places as Specialist Cheese Shops also need persuading and may take very little cheese at a time.

Chains of shops are better than supermarkets. The mentality of the supermarket is to buy cheap and few can be bothered with niche market products. However a little stall inside a supermarket can sometimes be arranged where you sell your products taking advantage of the passing flow of customers and the supermarket has no work to do except take their profit.

In the UK, I was very lucky. There must have been little of interest to the media at the time when I started and I attracted a lot of media attention. Millions of pounds worth of advertising was given to me on a plate providing I either milked a sheep or made cheese for the cameras. This has continued and most of our members have had local or national radio, television or magazine coverage given to them. You must be prepared to be funny or interesting. They love a crazy character who cracks jokes and entertains as he puts over the benefits of his products.

Mail Order is another way to sell certain products. Feta in oil, hard cheese, etc. can be boxed and sent by post or carrier. This allows you to cover a greater field. Adverts can be put into magazines or national papers. Good for Christmas.

By far the easiest way to sell your products is at the Farm Gate. However, not everyone lives on a main road or next to some beauty spot or popular resort.

INCENTIVES

Once in marketing in a bigger way, incentives are expected from both wholesalers and shops. These are dangerous, but may be necessary. Sale or return on the first few orders will sometimes get a shop to stock your products when they don't believe they will sell. If the product is good, it should sell itself. And this is where good labelling and point of sale information is essential. Your product must be distinctive, it must stand out, it must appeal. Many shops push it to the back of the shelf, so go in from time to time and check how it is going. Good personal relations with the shop owner are essential. Make special friends with them, ask them to come and see where you make the products, ask them out to a meal, cosset them, persuade them to eat your product themselves and then they are likely to promote them for you.

GETTING THE PRICE RIGHT

This is the single most difficult problem. It is easy to do a calculation of the cost of the milk, the cost of production, the cost of delivery and add on your profit. But is this enough? Milk may be variable in price and you cannot alter your prices like a yoyo. Your cost of production may be less than other people's, and you may sell cheaper, but is a cheap price the image you want for your product? Regardless of production cost, you have constantly to see what is on the market that is slightly similar. In time there will be both competition and consumer resistance, but until that happens you must balance the quantity sold at a lower price with the profit made at the higher price. To be exclusive and high priced can work with excellent products. Image is everything. The consumer must feel they are getting something very special if the price is high.

One last word on what we call "killing the goose that laid the golden egg." Many shops will take your product, but fearing it will not sell fast, put such a large mark-up on it that no one can afford to try it. It is very important you check the retail price of your products in the shop and if you find them excessive, do not sell there in future.

ECONOMIC POTENTIAL FOR SHEEP DAIRY PRODUCTS IN THE U.S.

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In previous papers, we have concentrated on production of sheep milk and potential development of dairy sheep products. This paper will concentrate on the economic potential for some of these sheep dairy products in the United States. The real economic potential is affected by the unique composition of sheep milk. Table 1 shows the composition of sheep milk in comparison to cow and goat milk. Sheep milk has about twice the fat and about 40% more protein than cow or goat milk. Lactose content is about the same in all three types of milk. The casein:fat ratio of sheep milk is about the same as that for jersey cows. Cow milk in the U.S. tends to be fairly uniform in composition throughout the year because of uniform calving. However, goat and sheep milk will vary in composition throughout the year due to the seasonal breeding patterns for these two species. Sheep milk at the end of lactation may have over 10% fat (Mills, 1989).

CURRENT SITUATION

World

Currently, the total production of sheep milk in the world is about 7.7 million metric tons (FAO, 1994). The top ten sheep milk producing countries are listed in Table 2. The majority of sheep milk produced is used for the manufacture of cheese. Table 3 lists the major types of sheep milk cheeses produced in the world. Most of these cheeses are produced from sheep milk only, however, there are several major cheeses produced from blended cow and sheep milk. In Spain, 8500 tons of cheese are produced from sheep milk only while 65,000 tons of cheese are produced from cow/sheep milk blends (Ballester, 1986).

U.S.

In the U.S., dairy sheep production is in its infancy. A recent survey (Table 4) identified 16 dairy sheep producers with the potential for 35 producers within the next 5 years. There currently are 7 sheep cheese producers, 2 sheep yogurt manufacturers and 1 ice cream manufacturer (Wolf & Tondra, 1994). The major cheese producer processed about 1000 lb. of milk per week in 1990. However, the market for sheep milk cheeses is well established. Table 5 lists the U.S. imports of Pecorino and Roquefort cheeses into the U.S. in 1993. Values reported for the cheeses indicate Pecorino at $1.74/lb. and Roquefort at $4.71/lb. Other sheep cheeses are currently being imported but figures on amounts are not readily available.

FUTURE POTENTIALS

Fluid products

Sheep milk has some unique nutritional qualities that could be used in specific markets. It is richer in B vitamins, calcium, phosphorus, potassium and magnesium than cow milk. Sheep milk contains 1.08-1.44% whey proteins while cow milk contains only .54-.88% (Nunez, et. al., 1989). It is also richer in C_4-C_{12} fatty acids. Sheep milk provides some relief for allergy sufferers that cannot tolerate cow milk proteins. In spite of the added nutritional qualities, only small quantities of sheep milk are consumed as fluid milk. In Spain, 7.2% of the sheep milk is consumed as fluid milk. With the high solids content of sheep milk, it is more readily accepted for manufacturing of semi-solid or hard dairy products, e.g., yogurt or cheese.

Dried products

In spite of the high solids content of sheep milk, there is little activity reported in the area of dried sheep milk or non-fat milk products. There appears to be a significant demand, at the current time, for dried sheep milk for blending with cow milk for specialty cheese production. Some of the concerns about these products would be the stability of the milkfat and shelf-life of the dried milk products.

Yogurt

The solids content of sheep milk make it a natural for production of premium yogurt products similar to the Greek-style yogurts (Mills, 1989). With solids content of 16-18% in the milk, yogurts can be produced without the need of added solids or stabilizers. With the higher fat in the sheep yogurt, the potential harshness of the lactic acid may be lessened. Sheep yogurt also shows a greater cold storage stability as shown in Table 6. Sheep yogurt needs to be marketed as a premium specialty product to avoid competing with commodity yogurts produced from cow milk.

Cheese

Traditionally, production of cheese has been the greatest market for sheep milk throughout the world. With the high solids and smaller fat globules, sheep milk is an outstanding substrate for manufacturing cheese. Normally, 15% solids in milk is about the most efficient for obtaining maximum output per vat per day and while allowing for sufficient syneresis of the curd for proper moisture control in the final cheese. Typical cheese yields for cow and goat milk are 9-10 lb. of cheese per 100 lb. (cwt.) of milk while sheep milk will yield approximately 20-25 lb. per cwt. of milk. To better assess the economic potentials for sheep cheese in the U.S., we will evaluate both commercial and farmstead plants.

Commercial Plants

Currently operating cheese plants can offer some real advantages for getting into the production of sheep cheeses. With the excess of processing capacity in Wisconsin and upper Midwest cheese plants, many small plants are finding it difficult to compete for a sufficient supply of cow milk to keep their plants operating efficiently. With the high milk prices and the increased cost of milk procurement and testing, small plants find that they must shift to producing specialty cheeses that have a higher profit margin in order to stay in business. These small plants have licensed facilities, knowledgeable and licensed operators, and approved equipment that can produce sheep cheeses with a very short developmental period. They also will have potentially lower operating costs than farmstead plants and may have some marketing links in place that could facilitate quicker introduction of product to the consumer.

Some of the concerns with using a commercial plant for sheep cheese production would include the potential cross-contamination of products if the plant is producing several different types of cheeses from different milk sources, possible lack of knowledge in sheep milk chemistry and whey disposal. With a close relationship between sheep milk producers and the cheesemaker, information on the composition of sheep milk and cheesemaking processes could be exchanged to facilitate the development of sheep cheeses with a minimum of development time. The problem of whey disposal at the plant where significant volumes of milk may be processed is one that we are currently addressing at the University of Wisconsin-Madison. Whey from sheep cheese production contains higher solids and more albumins and immunoglobulins than cow whey. We are hoping to develop the potential for producing food grade components from sheep whey so as to reduce the environmental problems of disposing sheep whey and obtain a greater yield of salable products from the incoming sheep milk.

The economic potential for marketing sheep cheese products in the U.S. will depend on the cost of producing those sheep cheeses. With sheep milk, the increased solids and increased cheese yield will impact favorably on production costs. However, the initial cost of the milk will be the greatest factor impacting the cost of producing cheeses. Table 7 lists current or potential costs of milk from the three major dairy species in Wisconsin and projects the anticipated milk cost per lb. of cheese produced. With some of the sheep milk prices shown, milk cost per lb. of cheese is very comparable to that of goat milk. With the current annual production of about 600,000 to 700,000 lb. of goat cheese in Wisconsin, one could easily anticipate the potential for an equivalent amount of sheep cheese to be produced if the milk supply existed. The other significant cost of producing cheese is the cost of manufacturing the cheese. These costs will be size-dependent and variety-dependent. Table 8 shows the cost of production for small Cheddar plants and two specialty cheese plants. By producing a commodity cheese, e.g., Cheddar, on days that the plant does not have enough milk for specialty cheese, the plant can spread the overhead costs to ultimately lower the cost of production for the specialty cheese.

Table 9 shows a comparison of costs of producing a Cheddar-type cheese from cow, goat and sheep milk. Obviously the cost of milk impacts the production costs to a great extent. Currently, goat and sheep milk processors do not have established markets for whey and processors are losing potential revenue from those components. Cheddar cheese is most efficiently produced from milk with a casein:fat ratio of .70. With a casein:fat ratio of .60 in sheep milk, the processor would be losing some of the excess fat in the whey unless some separation of cream took place prior to cheesemaking. If sheep milk were priced close to the estimated breakeven price of $45./cwt. (Steinkamp, 1994), then the final cost per lb. of cheese would be $2.52.

If we try to maximize our cheese yield by designing a high-moisture cheese that uses the casein:fat ratio of .60, the estimated cost of production of that cheese would be as shown in Table 10. The cost of producing this sheep cheese is slightly lower that the Cheddar-type primarily due to more efficient use of the protein and fat in sheep milk. Here again, if there were a market for the whey cream and whey, the cost of production could be lowered to allow for a better margin on the milk processed. With a market price of $6.00 per lb. for sheep cheese, there is a fair margin for the processor and marketer. To be competitive with goat cheese, the price of raw sheep milk may have to be slightly lower than $65./cwt. In comparing the U.S. cost of production for an ideal sheep cheese with the cost of imported Pecorino, it is obvious that domestic sheep producers will have a difficult time in competing with subsidized imported sheep cheeses. Domestic processors must develop unique products that are not in direct competition with commodity cheeses or imported sheep cheeses.

Farmstead Plants

Farmstead processing plants can also offer some real advantages for specialty cheese production. Farmstead operations can develop a unique marketing slant to the local area, provide potentially fresher products to the market, and find easier means for disposing of small quantities of whey. In farmstead operations, the producer/processor has a day to day feel for changes in milk production and the milking environment that may impact quality in the cheese operation.

The biggest concerns for the farmstead plants are the initial capital for the plant and equipment, licensing and approvals for the plant, training and licensing of the plant operators, scale of production costs, and market development. Reported costs in Table 11 shows that equipment costs for cheese manufacture are scale dependent. Potential used equipment may be used to reduce initial costs, but be sure that the equipment will be acceptable to the regulatory inspectors. Many times, modifications on used equipment to meet regulations end up costing more than new equipment. Licensing and operator training are becoming a greater challenge for farmstead operations. The plant and equipment must be approved by the Dept. of Agriculture prior to startup. Production of cheese must be done under the supervision of a licensed cheesemaker and, as of Jan. 1, 1997, a certified pasteurizer operator must be present whenever milk is being pasteurized.

With the numerous small cheese plants in Wisconsin struggling to survive, most sheep milk producers may find it more economical to work with a small plant that has the capacity to produce cheese for them on a toll or custom basis. Many of these small cheesemakers are very creative and should be able to produce quality cheeses designed for a specific market. Two good examples of this type of operation are Wisconsin Meadows with sheep cheeses and CROPP with their organic cheeses. The ideal is if the sheep milk producer can concentrate on producing quality milk at a reasonable price and the processor can concentrate on making a quality cheese to meet the purchase specifications of the critical customers.

In conclusion, there are potentials for development of markets for U.S. produced sheep dairy products. However, the size of that market will depend on the ability of the U.S. dairy sheep producers to produce milk at a slightly lower cost than at present and the development of potential markets for sheep whey components to gain a better return from the sheep milk processed.

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Table 1

Comparison of milk composition for cow, goat and sheep

	Sheep	Goat	Cow
Fat, %	7.8	3.9	3.5
Protein, %	5.6	3.3	3.25
Casein, %	4.2	2.5	2.6
Lactose, %	4.7	4.4	4.6
Minerals, %	.87	.80	.75

Source: Mills, 1985(?).

Table 2

Ten top sheep milk producing countries - 1993

Rank	Country	1000 metric tons
1	Turkey	1050
2	Iran	826
3	Italy	630
4	China	630
5	Greece	620
6	Syria	510
7	Sudan	505
8	Romania	390
9	Spain	275
10	Algeria	235
Total World Production - 1993		7690

Source: FAO, 1994.

Table 3

Sheep milk cheeses produced in the world

1. White fresh cheeses

    Burgos (Spain)
    Villalon (Spain)
    Cachat (France)
    Arabic cheeses

2. Brined cheeses

    Feta (Greece)
    Teleme (Romania)
    Sirene (Bulgaria)
    Halloumi (Cyprus)

3. Hard and semi-hard cheeses

    Pecorino (Italy)
    Kefalotyri (Greece)
    Manchego (Spain)
    Roncal (Spain)

4. Blue-veined cheeses

    Roquefort (France)
    Cabrales (Spain)

5. Stretched-curd cheeses

    Kashkaval (Bulgaria/Romania)
    Kaseri (Greece)

6. Whey cheeses

    Ricotta (Italy)
    Manouri (Greece)
    Requeson (Spain)
    Broccio (Corsica)

Source: Nunez, et. al., 1989.

Table 4

Sheep dairy survey results

7 cheese producers
2 yogurt producers
1 ice cream manufacturer

16 current sheep milk producers
35 producers within 5 years

Source: Wolf and Tondra, 1994.

Table 5

U.S. imported sheep cheese - 1993

Cheese	Quantity (million lb.)	Value (1000 $)
Pecorino	11.4	19,800
Roquefort	0.8	3,773

Source: USDA, 1994.

Table 6

Cold storage stability of yogurts

Type	Separated serum (ml.) 1 day	10 days
Cow	41	40
Sheep	6	7
Goat	23	15

Source: Kehagias, et. al., 1986.

Table 7

Current or potential cost of milk from cow, goat and sheep

Milk cost	Milk cost per cwt. of milk	Milk cost per lb. of cheese
Cow - WI[a]	$12.75	$1.28
Cow - CA[a]	10.47	1.05
Goat - WI[b]	22.00	2.20
Sheep - WI[c]	60.00	2.40
Sheep - MN[d]	65.00	2.60
Sheep - UT[e]	85.00	3.40
Sheep - France[f]	35.00	1.40
Sheep - breakeven[g]	45.00	1.80

[a] Jan. 1995
[b] May 1994
[c] May 1991
[d] May 1990
[e] Ward & Bailey, 1992
[f] Fyksen, 1990
[g] Steinkamp, 1994

Table 8

Cost of producing specialty cheese

Type of cheese	lb. of cheese produced per day	Manufacturing costs per lb. of cheese[a]
Cheddar only	48,000	$.30-.35
Jarlsberg only	9600	.715
Jarlsberg only	6500	.927
Jarlsberg + Cheddar	7700	.60
Havarti only	9600	.549
Havarti + Cheddar	7700	.49

[a] excluding the cost of milk

Source: Martin, et. al., 1989.

Table 9

Comparison of costs of producing Cheddar cheese from cow, goat and sheep milk (38% moisture, 54.6-55.1% FDB)

	Cow[a]	Goat[a]	Sheep[a]
Raw milk costs/cwt.	$12.75	$22.00	$65.00
Cheese mfg. costs/cwt. of milk[b]	3.50	3.50	3.50
Credit for excess cream	(.29)	---	---
Credit for whey cream	(.19)	---	---
Credit for whey solids	(.50)	---	---
Total cost/cwt. of milk processed	15.27	25.50	68.50
lb. of cheese/cwt. of milk[c]	10.34	10.72	18.79
Cost per lb. of cheese	1.48	2.38	3.64

[a] Milk composition assumed to be: cow, fat = 3.95%, protein = 3.33%; goat, fat = 3.9%, protein = 3.3%; sheep, fat = 6.9%, protein = 5.7%.

[b] Small processors cost of $.35 @ lb. production cost for Cheddar.

[c] Assuming 93% fat recovery, 96% casein recovery and a solids recovery factor of 1.09.

Table 10

Comparison of costs of producing a Manchego-type cheese from cow and sheep milk (45% moisture, 54.4% FDB)

	Cow[a]	Sheep[a]
Raw milk costs/cwt.	$12.75	$65.00
Cheese mfg. costs/cwt. of milk[b]	7.15	7.15
Added cream costs	.36	---
Credit for whey cream	(.33)	---
Credit for whey solids	(.71)	---
Total cost/cwt. of milk processed	19.22	72.15
lb. of cheese/cwt. of milk[c]	12.96	20.74
Cost per lb. of cheese	1.48	3.48

[a] Milk composition assumed to be: cow, fat = 3.95%, protein = 3.33%; sheep, fat = 6.9%, protein = 5.7%.

[b] Small processors cost of $.55 @ lb. production cost for Havarti (high fat cheese).

[c] Assuming 90% fat recovery, 96% casein recovery and a solids recovery factor of 1.12.

Equipment costs for cheese manufacturing

Type of plant	$/1000 lb. of daily processing capacity
Farmstead[a]	$13,700
Small commercial[b]	$5000-6000
Large commercial[b]	$2000-2500

[a] Heimerl, 1993.
[b] Wendorff, 1993.

MANAGEMENT OF DAIRY EWES IN A FORAGE BASED SYSTEM

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Entering the budding sheep dairy industry is becoming more intriguing to people who want to make a living from their farms. Sheep can be fairly forgiving of management lapses in other aspects of the industry, but in the DAIRY, you'll find that your management must be faultless. If not, your bottom line will suffer.

Management can be broken down into 3 areas: Shepherd's Ability, Farm Infrastructure, and the Calendar Year.

Shepherd's Ability

Many entering sheep dairying have never milked an animal before; some may never have had sheep before. This has the unfortunate effect of making the first years "on-job training."

Even if you have the most charming group of ewes imaginable, they can turn into sheep from hell when you try putting them on the stand for the first time. Learning sheep behaviour and proper milking technique will minimize the amount of stress for both the ewes and the milker.

Some people just seem to naturally have 'stock sense' while others really need to work on it. If you have no experience with animals, get your stock sense before you try to make your ewes do something they never would have thought of by themselves, like trapping themselves in a stanchion to have their udders manipulated. Stock sense means understanding sheep behaviour and making it work to your advantage.

Proper milking techniques will maximize the amount of milk the ewe will give you. I try to handle the ewes' udders with the same consideration that I would like to be given if the udder were part of my anatomy. A firm yet gentle touch is essential. If a ewe is kicking, question how you are handling her before you label her unmanageable. A light, hesitant touch could be mistaken for a fly; something to kick at. Especially when training ewes, we follow a routine that lets the ewe know that we are behind her; by placing one hand on her upper rear leg we tell her we're there and about to handle her udder. We find that this reduces the stress our ewes experience.

Udder massage is important in maximizing milk letdown. A gland in the back of the udder secretes oxytocin, a hormone which stimulates milk letdown. Proper massage of this area will often result in a second letdown of milk. Each ewe is an individual, with her own set of likes and dislikes, and her own quirks and fancies. The individuality of the ewe will have a bearing on the timing of her letdown. Some ewes 'just gush milk' right away, and others can be 'sleepers', who, with proper udder massage will surprise you with large quantities of milk.

Farm Infrastructure

A forage based sheep dairy may require more in the way of infrastructure. Several groups of sheep move through different pastures at the same time. You need to plan for this. Fencing is an important management tool. To keep ewes separated from just weaned lambs, we have found that we need to have woven wire between them. Our very maternal ewes are intensely attached to their lambs, and do not want to be separated from their precious offspring. Electric fencing just doesn't do it, as the lambs, particularly, squirt right through. We have a pasture completely fenced with woven wire, which is used by ewes who have just been put on the milking stand. This works wonders until ewes and lambs have adjusted to the idea of separation, usually about 48 hours. 'Career girl' ewes may adjust sooner and easier. Ideally, weaned lambs stay on their accustomed pasture, out of sight and hearing of the ewes who have been pulled for the milking stand. We utilize rotational grazing; the milking flock does not rejoin the rest of the flock until the end of the season. Sufficient paddocks need to be provided to facilitate this practice.

Pasture plantings are an important part of our dairy management. Our farm is marginal farmland, with heavy clay soil. We needed to make planting decisions that would work with rotational grazing as well as fit our soil and our climate. Our growing season is very short (65 days) and we have 30 to 32 inches of precipitation annually. We chose birdsfoot trefoil for our legume, as it thrives in our more acidic soil, is winter-hardy, and doesn't cause bloat. We have established stands of semi-upright Norcen or Leo trefoil. They do well as pasture, and are also more easy to make into hay than the vining varieties. Our fields also contain red and white clover, orchard grass, brome, timothy, and quackgrass. This mix of legumes and grasses keeps our pastures productive all summer.

Forage utilization is a major consideration in our management. We have a heavy snow cover due to "lake effect" from Lake Superior. Thus, winter pasturing is not possible. We winter our ewes on hay which we make. We feed round bales through a hay feeding fence. This virtually eliminates waste and results in cleaner fleeces. We test the hay yearly and feed supplements according to NRC requirements.

Our facilities consist of a 1920's dairy barn where we have our milking parlor, and an area that is divided in half to make holding areas for staging ewes pre and post milking. This area is also used as winter shelter in times of severe storms. We shear there, and jug ewes at lambing time. A large milk room is attached to the barn, adjacent to the milking parlor. We built our parlor large to allow for expansion to two 12-place stanchions. We also use an old garage as additional shelter, and in 1993 added a 13 x 36 foot 3-sided loafing barn which faces south. A twin to this loafing barn will be built in 1994, to accommodate planned expansion of the flock.

The Dairy Calendar

We think of our farming year beginning in October, as we prepare for breeding. We pull the sheep off pasture in mid-October. In our area, a most important consideration is Giant liver fluke. Valbazen, used on our vet's recommendation, kills the adult liver fluke. The ewes are dewormed as they leave pasture, and then again, 5 to 6 weeks later. The second deworming will catch flukes which were immature in mid-October. Both dewormings are done before turning in the ram.

We begin flushing the ewes for breeding in November, 2 to 3 weeks pre-breeding. The ewes are vaccinated against abortion diseases. By the first week of December, breeding decisions have been made. The sheep are sorted accordingly, and the appropriate ram turned in, or preparations for artificial insemination are made. We use a single sire mating, and typically have 3 or 4 different breeding groups. The rams are left with the ewes for 6 weeks. Corn is fed to the breeding groups until the rams are removed. Ewe lambs also receive some supplemental soybean meal. While the ewes go off grain when the rams come out, the ewe lambs continue to be fed, as they are still growing themselves.

Thirty days after the rams come out, the ewes can be ultrasounded. This will reveal if the ewes have settled, and sophisticated machines can count fetal numbers. The sheep can be separated into groups bearing triplets or twins, and fed accordingly. Open ewes can be sent to market.

Six weeks pre-lambing, the late gestation ration balanced to our hay test is begun. We feed the sheep their grain twice a day, which has kept ketosis from being a problem. As soon as possible, we send the ewes out on pasture, in a quick rotation. They end up at the hay feeding fence but this activity of being out, rummaging around much of the day gives them a good workout, and helps to keep lambing problems to a minimum.

The ewes are kept in good physical condition year-round, to a score of 3 to 3.5. The demands placed on them throughout the year warrant it, and our lambs and milk production reflect this management practice. Sound, healthy sheep hold this condition score much better, with fewer supplements. It is important to feed the flock properly, and to be sure that they have adequate mineral and water supply year-round.

We schedule shearing about a month before lambing. We trim any long toenails then so we don't have to tip the ewes up again pre-lambing. We vaccinate the ewes with Covexin-8 within the month prior to lambing. If one wants to vaccinate to control soremouth, this should be done not less than 8 weeks pre-lambing. OPP blood samples are more easily drawn from slick shorn ewes; about a month pre-lambing is a good time to do this test.

To best utilize our pastures, the ewes lamb in late April and May, as our grasses are beginning to grow well. About 75% of our ewes lamb in the first cycle, and the rest lamb in the second cycle. We use what I call a MODIFIED PASTURE LAMBING SYSTEM. Since we need our ewes to be amenable to being handled on a daily basis, we cannot afford to let them drop their lambs on pasture, with little or no human interaction. We allow the ewes to lamb on pasture if they wish, although they seem to gravitate to the barn. Our experienced ewes easily follow their lambs as we carry them back to the barn for their bonding period. The first time lambing ewes are a bit more scatty, and prefer to remain by their lambing bed. Bringing the ewes back to a jug in the barn gives the inexperienced ewe lambs an opportunity to be handled prior to being milked. Triplet bearing ewes also have the opportunity to bond closely with the lambs prior to going out to a mixing group and then to pasture.

In the jug, the lambs' birth weights are recorded. Navels are clipped and dipped in 7% iodine. We make sure each lamb has had a meal of colostrum. Each lamb gets a metal ear tag; ewe lambs and intact rams get a Roto tag color coded to the year of birth. Ears are notched for birth type. Wethers are banded, and tails are docked with an electric docking iron.

Ewes are dewormed in the jug. The milking flock cannot be dewormed again until they come off line; the only exception is using a dewormer called Rumatel, which is approved for dairy cows. Deworming in the jug and leaving the lambs on for 30 days gives a withdrawal time for the dewormer.

Before we turn the ewe and her lambs into a mixing group, we paint brand the lambs with their metal tag number and put the same number on the ewe. This helps to quickly sort out any lost lambs. Mixing groups are made of 5 or more ewes and their lambs, depending on mom's experience level. After we see that all is going well, these ewes and their lambs can be mixed with another group, and thus into the main flock of ewes and lambs. One triplet bearing ewe this year held herself and three daughters out for an extra day till she felt confident that they could keep track of each other.

Not only do our ewes raise triplets on pasture, they also milk well off pasture. The lambs are left with the ewe for 30 days, and are out learning how to forage from their mothers from the very beginning. The lambs typically weigh 30 plus pounds at weaning. At weaning, we vaccinate with an 8-way clostridial, as they will now begin to eat creep more heavily. Because the lambs are weaned at this early age, we offer an ad lib creep mixture for their first 60 days. They don't start eating any significant quantity until their 3rd or 4th week, as they are getting sufficient nutrition from their mothers. The creep, which we mix on farm, changes according to the lambs' age and NRC protein requirements. The lambs are provided with a free choice mineral containing a coccidiostat, which is not available to the ewes, as it is not approved for lactating dairy animals.

The lambs continue on pasture after their first 60 days on creep, by which time they have adjusted well. Ewe lambs to be retained for breeding are fed corn, as are lambs we will direct market. In September, we typically sell the balance of the wethers as feeders.

Proper dairy nutrition will result in good milk production, and lengthened lactations. The ewes being milked receive, in addition to their pasture diet, a whole shelled corn ration fed on the stand, about 1 1/2 pounds per day, or .75 lbs per milking. Barley or oats are other excellent choices if they are more economical than corn. The grain serves as a source of energy. The pasture, a high quality birdsfoot trefoil, clover, and grass, provides protein, and tests about 18%. The amount of pasture consumed may need to be regulated. Dairy ewes in a forage based system during the flush of grass growth may not eat enough fiber to make sufficient butterfat. Our holding area is divided by a hay feeder from which the ewes can munch while waiting to be milked. They can also eat from it after exiting the milking parlor prior to going back out to pasture. Milking at 6 and 6 cuts into the time when ewes would normally be out grazing, so having this fiber source available is working out very well. It also helps to keep the ewes standing after milking, allowing the teat sphincter to close. We utilize probiotics and yeast cultures in the diet at weaning or whenever stress could be a factor in reducing food intake. A rumen buffer is offered free choice; if that starts disappearing too fast we need to determine what is upsetting their digestion. We monitor the physical condition of our ewes during milking to be sure that they are getting the correct amount of feed. Ewes who are getting fat are putting on weight at the expense of milk production. Water must be provided to the ewes; it must be clean, fresh, and plentiful. A water source is located in each paddock. An additional source is in the barn for ewes who are waiting to be milked.

Our first group of ewes usually goes on the stand on Memorial Day weekend, and we milk for over 100 days post weaning. More ewes are added to the milking string according to their lambing dates. As she comes on line, each ewe is tested for mastitis, using the California Mastitis Test, or CMT. We thus identify problem ewes immediately, and deal with them according to the individual situation. CMT's are done weekly on all ewes, as well as an as-needed basis. Some ewes are tested more frequently based on their last CMT test. This process is time consuming, but it is important to udder health, and to the production of a quality product. If the number of ewes being milked becomes quite large, we will CMT a sample of milk from each bucket at each milking, rather than the weekly individual test. One elevated ewe can raise the entire bucket's test result, and she can usually be found quickly at the next milking. Obviously sick ewes are spotted as we inspect and clean udders prior to milking each morning and evening.

We weigh the milk production of each ewe at least monthly during the morning and evening milking. This is just one part of our record-keeping routine. We used to keep all our data on handwritten ewe production cards but are working on putting all that information into our computer, on *Flockmaster* software. Our enrollment in the Volunteer Scrapie Certification program also requires good records.

One management tool which cannot go unmentioned is our dogs. Our border collie, Sadie, lives to milk sheep. She is invaluable in helping to get reluctant participants up on the stand. Our Maremmas guard each group of sheep on pasture from predators in our Northwoods location.

Sheep dairying isn't for everyone. Dairying definitely increases your workload and the amount of time spent with your sheep. It takes patience, hard work, a sense of humor, commitment, long-range planning, and MANAGEMENT, MANAGEMENT! We have found, however, that through selection of suitable stock and progressive management, a low input, sustainable, forage based system of sheep dairying can greatly maximize the return per ewe.

SURVIVAL, GROWTH AND FEED EFFICIENCY OF 1/4 EAST FRIESIAN LAMBS

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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. The East Friesian breed of sheep is considered by many to be the best dairy sheep in the world. Its milk production can reach 1000 lbs. on a 200 day lactation. It is a very prolific breed (210-220%) with a white fleece of average quality. The East Friesian could possibly bring some real advantages to American dairy sheep producers and also to any producers wanting to increase the milk production of prolific ewes giving birth to three or four lambs.

In October-November, 1993, Dorset-Romanov-Targhee and Dorset-Finn-Targhee crossbred ewes were exposed to either pure Dorset rams or to 1/2 East Friesian rams in single sire pens. The ewes lambed in March-April 1994. Routine lambing practices were followed: jug for 48 hours, tying, clipping and dipping of umbilical cord as soon after birth as possible. Lambs were given 1 cc of a selenium complex, ear tagged, weighed and the tail docked in the first 24 hours. Male lambs were not castrated. After 48 hours, lambs and ewes were put in pens containing no more than 25 ewes. Lambs had early access to a 19% CP creep ration.

Table 1 shows the lambing performance of the ewes, 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 better 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. Two ewes raised single lambs, 14 ewes raised twin lambs and 12 ewes raised triplet lambs. Among the ewes raising 3/4 Dorset lambs, only 1 lamb from a set of triplets was raised on milk replacer. Thirteen 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 and 100.1 lbs., respectively).

Two weeks after weaning, ram lambs from both genotypes were switched to a 14% CP ration composed mainly of whole corn, rye, oats, molasses, soybean meal, lasalocid, minerals and ammonium chloride. Lambs had no access to forage other than fresh straw bedding given approximately every other day. Feed was given on a free choice basis. Daily consumption of feed was calculated by weighing the amount given and weighing the amount refused. All lambs were weighed on a weekly basis. The composition of the ration given to the lambs is presented in Table 2.

Twenty-eight 1/4 East Friesian and 20 3/4 Dorset ram lambs were placed in two adjacent pens. 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. Table 3 shows the daily gains by week, and the amount of feed consumed for 1 pound of gain.

East Friesian lambs grew faster than Dorset lambs (.95 and .76 lbs./day, respectively) with similar feed efficiency of approximately 4.6 pounds of feed per pound of gain. The fastest growing East Friesian had a total ADG of 1.19.

Table 4 shows the weekly variation in ADG and feed efficiency. From week to week, ADG and feed efficiency varied tremendously, although the daily feed intake was fairly constant in both groups of lambs at around 3 - 3.5% of their body weight in dry matter. For both groups, feed intake as well as energy intake were quite adequate. The daily consumption of crude protein was below the recommended level given by NRC (1985) for animals of this weight and growth potential. Dorset lambs consumed 77% of their protein requirements and East Friesian lambs 83%. It is possible that the low protein level of the ration might have had a detrimental effect on the growth of the lambs.

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.

Table 1. Lambing performance, survival and weight at birth and at 60 days (+ standard errors)

	Breed of sire of lambs: Dorset		1/2 East Friesian
# ewes at breeding	52		26
# of ewes at lambing	52		26
# of ewes aborted	0		0
# of ewes lambed	50		26
# of lambs born	105		62
Fertility	96%		100%
Litter size	2.10		2.38
# of lambs alive at weaning	98		61
Survival rate	93.3%		98.4%
Average Birth Wt.	9.4		10.04
Birth wt. of single	(13)[a] 10.8 ± .38	NS	(2) 11.04 ± .93
of twins	(40) 9.4 ± .2	**	(24)10.6 ± .27
of triplets	(48) 7.9 ± .2	NS	(36) 8.5 ± .23
of quadruplet	(4) 6.1		
Adjusted wt. at 60 days	53.14 ± 94	**	62.76 ± 1.22
Total wt. of lambs weaned per ewe present at breeding	100.1		147.2

[a]Numbers in parentheses are the number of lambs of the corresponding birth type

Table 2. Composition of the Ration

Ingredient	lb/t as fed	DM	TDN (lb.)	CP (lb.)	Ca (lb.)	P (lb.)
Whole corn	1500	1335	1254.9	133.5	2.67	4.67
Rye	100	89	75.7	11.9	.06	.34
Oats	100	89	66.8	11.7	.10	.34
Bovatec	170	153	127.0	74.5	.46	1.07
Molasses	80	62	46.5	5.4	.13	.02
Mineral	10	---	---	---	1.0	.5
Lime	30	---	---	---	3.38	.002
Ammonium Chloride	10	---	---	---	---	---
	2000	1728	1570.9	237	5.4	7.0
per lb of DM		100%	91%	14%	.3%	.4%

Table 3. Postweaning average daily gain and feed efficiency (± standard error)

	Dorset		East Friesian
# of ram lambs	20		28
Age at start (days)	80.4 ± 1.18	NS	N78.8 ± 1.03
Wt. at start	74.2 ± 3.11	NS	78.3 ± 2.7
Length of trial	48 d.		48d.
Wt. at end	110.9 ± 4.02	**	123.8 ± 3.49
ADG, start - end	.76 ± .04	**	.95 ± .04
Feed efficiency	4.57	NS	4.55

Table 4. Weekly ADG and feed efficiency (± standard error

Weeks	ADG, lb./day			Feed efficiency, feed/gain		
	Dorset		East Friesian	Dorset		East Friesian
1	.68 ± .11	NS	.73 ± .10	4.17 ± .20	NS	4.42 ± .20
2	.47 ± .09	**	.67 ± .08	6.79 ± .21	**	5.32 ± .21
3	1.13 ± .11	*	.96 ± .10	3.05 ± .21	**	5.32 ± .21
4	.89 + .11	**	1.35 ± .10	4.06 ± .10	NS	3.20 ± .21
5	.59 ± .10	*	*.84 ± .09	5.17 ± .21	NS	4.85 ± .21
6	.81 ± .08	*	*.98 ± .07	3.97 ± .21	NS	4.56 ± .21
7	.76 ± .11	**	1.12 ± .10	4.94 ± .20	NS	4.07 ± .25

Health Concerns In Dairy Sheep

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Dairy animals of any species are often asked to "go the extra mile." In a conventional flock the ewes are asked to raise lambs and to grow wool. The dairy ewe is often asked to raise her lambs for a short period -- then suddenly leave them behind yet continue to provide milk for an extended period of time. In intensive systems she may be expected to rebreed while still on the milking string to maximize her production of lambs and milk. All of these elements of dairy production systems make it critical to practice effective health management such that the ewe can reach her genetic potential and ensure the sustained profitability of the dairy.

Introduction of newly acquired sheep

The dairy shepherd's initial flock health concern should be with the selection and acquisition of healthy sheep. Possible diseases of specific concern to the dairy sheep are Ovine Progressive Pneumonia (OPP), Johnes Disease (Paratuberculosis), Caseous Lymphadenitis, Contagious Ecthyma (Soremouth), Brucellosis, Tuberculosis, and bacterial mastitis. There are numerous other diseases that are of a more general and perhaps less milk specific nature, but these need to be considered on a flock and regional basis.

OPP can cause an indurative mastitis when the virus targets the mammary gland. Changes caused by infection include a loss of milk secreting glands, an increase in fibrous connective tissue, and enlargement and active lymph tissue within the affected mammary gland.

Johnes disease can cause a loss of milk production due to malabsorption and the resultant fatal progressive weight loss. The dairy cow industry is presently studying the tentative relationship between the presence of Mycobacterium paratuberculosis in retail milk and the occurrence of Crohn's disease in humans.

Caseous Lymphadenitis is a contagious, infectious bacterial disease of sheep and goats caused by Corynebacterium pseudotuberculosis. This bacteria causes the formation of abscesses in external and internal lymph nodes. If the udder or its associated supramammary lymph nodes are infected, then this organism can be excreted into the milk. Consumption of contaminated raw milk can result in human infection.

Contagious ecthyma or soremouth virus can cause mild to severe painful sores on the teats. Often when ewes are suckled by lambs, these sores are colonized by bacteria and because the ewe does not allow the lamb(s) to freely suckle, bacteria from the sores multiply in the residual milk in the gland resulting in mastitis.

Brucellosis and tuberculosis are not major problems for U.S. dairy sheep. Bacterial mastitis will be addressed later in the paper.

In every flock, sheep develop immunity to resident pathogens based on periodic exposure to these microorganisms and parasites. Whenever new sheep are introduced into an established flock, there is a risk of bringing in a new infectious pathogen. Also new sheep may not be immune to the resident pathogens. Regardless, newly purchased stock ought to be isolated from the resident flock for a minimum of one month. If sheep are pregnant when purchased or introduced, the best practice is to keep them separate for the remainder of their pregnancy. During this period of isolation, the new sheep should be prophylactically dewormed, treated for external parasites, and vaccinated for common or at-risk diseases. These sheep ought to have their feet examined for infectious footrot. If there are suspicious lesions, the feet ought to be examined and a diagnosis made by a qualified individual. Cultures can be submitted to the lab to assist with the diagnosis when indicated. Sheep suspected of having a contagious and/or infectious disease should not be introduced into the resident flock without an awareness of the possible risks.

Flock Health Management

Every dairy sheep flock needs to develop their own health management calendar and commit it to paper. Every year this program should be critiqued based on a review of the production, health, and financial records. The specifics of the flock health program should be dictated by both documented and perceived flock health issues as well as by the flock's production system.

General guidelines in the development of a flock health management program are:

1) Divide the sheep into production groups such as ewes, lambs, rams. Further subdivide these groups, such as dividing lambs into pre-weaned lambs, weaned growing lambs, replacement breeding stock lambs, etc. Address health issues common in each age/production group.

2) For each group, maintain the group's average body condition score such that it is appropriate for the stage of production. Re-adjust your mind set as we begin to work with imported dairy breeds, because they may have different body proportions than our domestic breeds.

3) Consider selecting for key characteristics of a dairy sheep from a health viewpoint. Important attributes may include: fertility, milkability, udder and teat conformation, freedom from teat lesions, sound feet and leg structure, sound mouth, freedom from chronic disease that may affect body condition, productivity in terms of milk and lambs, and longevity.

4) Provide, maintain and promote flock immunity to specific diseases.

5) Adjust ration to prevent nutritional deficiencies and toxicities and contaminants that may affect milk quality.

6) Perform diagnostics when dealing with disease concerns.

7) Promote, maintain and monitor individual and flock udder health through initial selection, regular screening, and proper udder care.

8) Layout and maintain the farm such that udder environment is hygienic year round. Modify farm management and sheep housing if inclement weather makes for unsanitary conditions.

Care of the Ovine Mammary Gland

It is important to stress that anything that impacts upon the health status and well being of the ewe will have a negative bearing upon milk production. However, due to the intensive nature of dairying, the mammary gland of a dairy ewe is under special stresses different from those of a ewe raising her lambs. This can predispose to the development of mastitis. Some forms of mastitis can be treated, but the best approach to treating mastitis in the dairy ewe is to prevent it. This is accomplished by establishing and maintaining a proactive udder health program.

Udder health is influenced by the environment in which the milking sheep is kept and to some extent the genetic make-up of the sheep. Udder cleanliness is affected by environmental factors such as the type of housing, environmental sanitation, type of bedding, pasture management, pre- and post-milking "holding" areas, climate (particularly rainfall), and drainage of the environment. Genetic make-up can play a roll in determining the coverage and length of the wool around the udder, the degree to which the udder is pendulous and may be prone to injury, and sheep temperament. The man in management can improve these factors such that udders are kept clean. Clean, dry, well suspended udders are less likely to develop infections, consequently these sheep will be able to produce high quality milk over a number of lactations.

Udder health is also vulnerable to human decisions that affect premilking preparation, milking technique, post-dipping, mastitis monitoring and control, and equipment maintenance. Much can be learned from progressive dairymen, fellow dairy shepherds, and dairy science specialists in the cow and sheep arenas.

Despite our best efforts at maintaining a disease free flock, mastitis can occur and its importance to the dairy flock **cannot** be overstated. Not only does the incidence of mastitis in the infected ewe lower her productivity, but contagious pathogens can endanger the udder health of the whole flock. In addition, some mastitis organisms can pose a food-safety risk to the consumer, and thus a liability to the producer.

Mastitis is by no means a problem that is confined to dairy animals. This malady gains a special meaning, however, when milk production and hygiene reflect more directly on the producers livelihood and reputation. It can not only lower the ability of the mammary gland to produce milk, but also change the composition of the milk such that it is unsalable and unsafe for human consumption.

Mastitis is generally divided into clinical and subclinical. This is really just a distinction between apparent and inapparent disease in the mammary gland and is generally a reflection of the severity of the infection. Subclinical, however, **does not mean unimportant.** Both clinical mastitis and subclinical mastitis can lead to the formation of scar tissue in the udder which prevents a ewe from reaching her milk production potential.

There are a multitude of organisms capable of causing mastitis in the ovine udder - each of which tends to have characteristic ways of causing disease while invading the mammary gland. Staphylococcus aureus is one of the most common pathogens isolated from dairy sheep worldwide. This organism and Pasteurella haemolytica are commonly associated with acute gangrenous mastitis which can kill a ewe due to toxins released into her body during rapid bacterial multiplication. Alternately, the affected half of the udder may die and eventually fall off. Either way, she has lost her usefulness as a dairy ewe. Severe clinical mastitis characterized by swollen, hot painful udders and accompanied by systemic illness is also a hallmark of infection with Staph. aureus. In recovered ewes it can remain in small abscesses in the udder and escape later to cause disease. It is extremely important to be vigilant against this organism as it is extremely contagious and can be passed from ewe to ewe by the milking machine. Some Staph. aureus strains will elaborate toxins which can cause severe gastrointestinal disease in humans. Sometimes these toxins will survive heat treatment even if the bacteria themselves do not. It is imperative that milk from ewes with Staph. aureus mastitis not be milked into the bulk supply. Sheep cheese has been the source of Staphylococcal food poisoning twice in the last 10 yrs.

E. coli and Streptococcus species are organisms which are normally present in the environment, but can take advantage of ideal conditions in the udder to set up housekeeping. E. coli can cause a watery mastitis accompanied by a very inflamed gland and systemic toxicity. It can also cause a more chronic subclinical mastitis. Streptococcus species are more apt to cause chronic subclinical mastitis.

Coagulase negative Staphylococci spp. have, until recently, been considered non-pathogenic for the ovine udder. These are the most common bacteria isolated from cases of subclinical mastitis and several workers have recently shown that they can cause an increase in somatic cell counts (SCC) and other inflammatory parameters. More research is indicated to establish the role of these bacteria in production losses and udder damage.

As mentioned above, OPP virus can lead to a diffuse hardening of the udder known as indurative mastitis or "hard-bag." The loss in production may be so slow and subtle as to make it difficult to realize that it is happening.

The most important tool for on farm monitoring is visual and manual inspection of the udder. The best way to utilize this tool to your advantage is establish a regular routine of examining the udder and forestrippings before applying the milking machine. Irregularities in shape, size, temperature or color of the udder can be signs of mastitis, and subtle changes can be recognized by a shepherd who is familiar with what is normal for each ewe. The forestrippings are the first milk to come from the teat as it is prepared from milking. Abnormal color, consistency or odor can reflect a problem inside the mammary gland.

An additional way to evaluate udder health is by determining the quantity of somatic cells present in the milk. A somatic cell is a nucleated cell present in the milk. This includes white blood cells and occasional epithelial cells. SCC are important for two reasons: they are an indication of udder health; and high SCC have a detrimental effect on cheese yield and quality.

Research has shown that regular monitoring of SCC can be an excellent means of managing udder health in a dairy flock. This can be accomplished with rapid on farm methods or with more sophisticated tests performed on the milk at a dairy lab.

On farm monitoring with a California Mastitis Test (CMT) can identify subclinical mastitis. This test utilizes a reagent which reacts with the DNA in the sample and forms a gel. The amount of gelling correlates with the number of somatic cells. This method has been proven to be an effective screening tool and is widely used in dairy flocks. The CMT has been found to be most accurate in predicting infections caused by the major mastitis pathogens. This screening test correlates highly with positive bacteriology in ewes. Milk from ewes with high CMT scores should be cultured to identify the pathogen involved and formulate a plan for control. However, in some instances inflammation is not due to bacterial infection and can be the result of trauma to the udder. For this reason, it is not recommended to cull a dairy ewe on the basis of one high CMT score.

Dairy labs have sophisticated electronic counters to count the number of SCC in milk samples. In the goat industry, certain methods of counting SCC have been problematic due to the nature of the particles in goat milk. Even though sheep milk is secreted in a similar fashion there have been fewer difficulties with the use of electronic counters. The two most commonly used are the Coulter counter and the Fossomatic counter. The differences are outlined below.

Fossomatic:
In this method, the milk is treated such that the DNA in the cells is flourescently labeled. The milk then flows past an electronic eye and the particles are counted. This is considered by most to be the most accurate method as only nucleated cells are counted.

Coulter Counter:
In this method, all particles of a certain size are counted as they flow past an electronic eye. This method is acceptable for sheep milk, but a special defatting procedure needs to be employed with some Coulter counters due to the high fat content of sheep milk (which can be double the fat content present in cow milk for which the equipment is generally standardized).

In comparing any electronic method for enumerating somatic cells, the "gold standard" is the Direct Microscopic Somatic Cell count (DMSCC). This is performed on sheep milk using the pyronin-Y methyl green stain. This procedure is more expensive and time consuming than an electronic count and is generally only used to confirm that a questionable sample is within regulatory limits.

Drug Use

Often when considering pharmaceutical treatment of a milking ewe, we must realize that we may not have the information necessary to determine an appropriate milk withdrawal time. Because drugs may clear a sheep differently than a cow, it is not reliable to extrapolate drug withdrawal time using data from other species. One also needs to realize that most of the antibiotic residue tests have been developed as a means for detecting antibiotic residues in a bulk tank. These tests are not well validated for use on individual animals. Antibiotic residues which surpass regulatory standards will necessitate the rejection of that milk by the processing plant. This could be an economic disaster for the individual producer and a threat to the safety of the product that the industry provides to the consumer.

This re-emphasizes the importance of taking a proactive approach to dairy sheep health management. A preventive health management plan should be in place before milking begins and should be reviewed for its effectiveness at the end of each milking season. Ensuring the health and well being of the dairy ewe will help to guarantee her continued ability to produce maximal levels of high quality milk.

Treatment Record

Sheep ID	Diagnosis	Drug Name	Dose	Route	Frequency	Milk Withdrawal	Milk Use	Meat Withdrawal	Initials	Treatment Response	Location Pre Tx	Treatment Location	Comments

Preventive Health Practices

Sheep ID	Lamb Date	Date on Milk Stand	Vaccinations	Anthelmintics	External Parasiticides	Foot Treatment	Intrammary Dry Treatment	Coccidiostats	CMT Score