OPPORTUNITIES FOR GENETIC IMPROVEMENT OF DAIRY SHEEP IN NORTH AMERICA

David L. Thomas
Department of Meat and Animal Science
University of Wisconsin-Madison

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

Foreign Dairy Breeds

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

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

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

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

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

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

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

Selection for Dairy Traits

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 2. Heritabilities of lactation traits.

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

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

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

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

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

Wisconsin Efforts

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

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