COMPARISON OF EAST FRIESIAN AND LACAUNE BREEDS FOR DAIRY SHEEP PRODUCTION IN NORTH AMERICA

David L. Thomas[1], Yves M. Berger[2], Randy G. Gottfredson[1], and Todd A. Taylor[1,3]
[1]Department of Animal Sciences, [2]Spooner Agricultural Research Station, and [3]Arlington Agricultural Research Station, University of Wisconsin-Madison Madison, Wisconsin, USA

Summary

A study was initiated in the autumn of 1998 to compare the East Friesian (EF) and Lacaune (LA) breeds for performance in a dairy sheep production system typical of the upper Midwestern U.S. Matings were designed to produce breed groups of high percentage EF, high percentage LA, and various EF-LA crosses. This paper summarizes data collected through the summer of 2004. Based on these results, replacement of 50% EF breeding with 50% LA breeding will decrease lambs born per 100 ewes exposed by about 15, may result in a slight decrease in milk production (~7%), and will raise fat and protein content of milk by .3 to .6 percentage units. A two-breed rotational crossbreeding program with East Friesian and F1 East Friesian x Lacaune rams is proposed. This system will result in a flock in which about half of the ewes are 83%EF,17%LA and the other half are 67%EF,33%LA.

Background

The raising of sheep for milk is a new enterprise to North American agriculture (Thomas, 2004). Sheep in North America have been selected for meat and wool production. Therefore, one of the first major constraints to profitable sheep dairying was the low milk production of domestic breeds.

The East Friesian (EF) is a very high milk-producing breed with an origin in northern Germany (Alfa-Laval, 1984). The first importations of EF genetics into North America for the specific purpose of dairy sheep production were by Hani Gasser, British Columbia, Canada (semen in 1992) and Chris Buschbeck and Axel Meister, Ontario, Canada (embryos). The first crossbred EF rams were imported into the U.S. in 1993 from Hani Gasser by the University of Minnesota, the University of Wisconsin-Madison (UW-Madison), and Hal Koller, a dairy sheep producer in Wisconsin.

The EF cross ewes produced from these crossbred rams produced almost twice as much milk per lactation as domestic breed crosses (Dorset-crosses) under experimental conditions at the UW-Madison (Thomas et al., 1998, 1999, 2000). Continued experimentation with EF crosses at UW-Madison and their performance in commercial dairy flocks in the U.S. and Canada further showed their superiority for milk production, and most commercial operations moved quickly to crossbred, high percentage, or purebred EF ewes. The accelerated move to EF in North America was facilitated by further importations of semen, embryos, and live animals from Europe and New Zealand to both Canada and the U.S. after 1992.

A second dairy sheep breed, the Lacaune (LA) from France (Alfa-Laval, 1984), also is available in North America. Josef Regli imported Lacaune embryos to Canada from Switzerland in 1996 (Regli, 1999), and he remains the primary source of LA genetics in North America. The UW-Madison imported the first LA genetics into the U.S. in 1998; semen from three rams in the U.K. and two LA rams from Josef Regli. Subsequently, a few LA rams from the Regli flock were used by dairy sheep producers in Canada and the U.S., as well as some crossbred Lacaune rams from UW-Madison. Access of U.S. producers to LA genetics is now difficult due to the Canadian-U.S. border closure to movement of ruminants to the U.S. because of concerns about bovine spongiform encephalopathy (BSE), and the inability of either country to access additional LA genetics from Europe due to animal health import restrictions.

The LA is the most numerous sheep breed in France. It has been selected in France for increased milk production under a sophisticated selection program incorporating artificial insemination, milk recording, and progeny testing of sires for longer than any other dairy sheep breed in the world. Annual genetic improvement for milk yield in the French LA is estimated at 2.4% or 5.7 kg (Barillet, 1995).

British Milksheep also have been imported into North America, and they are a relatively popular breed in flocks in Ontario, Canada.

Materials and Methods

During the autumns of 1998 to 2003, Dorset-cross ewes at the Spooner Station and Polypay and Rambouillet ewes at the Arlington Station of UW-Madison were artificially inseminated or naturally mated to EF or LA rams. Lambs sired by 14 purebred EF rams and six purebred LA rams representing all (or at least the vast majority) of the lines of these two breeds in North America were produced. Lambs were fed high-concentrate rations in confinement. Male lambs and a few cull ewe lambs were marketed at approximately 125 pounds liveweight, and the vast majority of the ewe lambs were retained for breeding.

First-cross (F1) ewe lambs born and raised at both locations from 1999 through 2003 were mated at the Spooner Station in their first autumn at approximately 7 months of age, and they lambed for the first time at approximately one year of age the following spring. Generally, young F1 ewes and their descendants were mated to either EF or LA rams to producer higher percentage EF or LA offspring or various crosses of EF-LA breeding. Most older dairy-cross ewes were mated to Dorset, Hampshire, or Suffolk rams to produce terminal market lambs. Each year, all replacement ewe lambs were sired by EF or LA rams. Ewes were retained in the flock for at least two seasons unless culled for a debilitating condition. Lambs were raised on their dams or on milk replacer until 30 days of age. After weaning at 30 days of age, lambs were raised on high-concentrate diets in confinement.

This mating system ultimately will result in the production of ewes of a high percentage dairy breeding with some ewes containing only EF dairy breeding, some ewes only LA dairy breeding, and some ewes various combinations of both EF and LA breeding. Currently, large numbers of animals of 1/2 dairy breeding (1/2EF or 1/2LA) and 3/4 dairy breeding (3/4EF; 1/2EF,1/4LA; 1/2LA,1/4EF; or 3/4LA) have been evaluated. Smaller numbers of animals of 7/8 and higher dairy breeding have been evaluated, and they have been grouped into two groups depending upon if they contain more EF (7/8+(EF,LA)) or LA (7/8+(LA,EF)) breeding.

Dairy ewes were milked on one of three weaning/milking systems: DY30, DY1 or MIX. The DY30 system is as follows: ewes nurse their lambs for approximately 30 days, after which lambs are weaned onto dry diets, and ewes are milked twice per day until a test day on which their total daily milk yield is less than .25 kg. The DY1 system is as follows: lambs are weaned from ewes within 24 hours of birth and raised on milk replacer until weaned onto dry diets at approximately 30 days of age, and ewes are milked twice per day from 24 hours postpartum until a test day on which their total daily milk yield is less than .25 kg. The MIX system is as follows: for the first 30 days postpartum, lambs are separated from their dams overnight, ewes are milked once per day in the morning, and lambs are returned to their dams for the day; lambs are weaned onto dry diets at approximately 30 days of age, and after their lambs are weaned, ewes are milked twice per day until a test day on which their total daily milk yield is less than .25 kg. The DY30 system is used more often with ewe lambs in their first lactation than with older ewes. Among older ewes, the DY1 system is used more often than the MIX system.

The number of observations included in the analysis of each trait was as follows:

1. Birth weight – 1,794 lambs
2. 30-day weight – 1,469 lambs
3. 150-day weight (majority are male market lambs) – 651
4. Fertility – 942 exposures on 483 individual ewes
5. Number of lambs born/ewe lambing – 877 lambings
6. Lactation traits – 796 lactations on 402 individual ewes

Data were analyzed with the Mixed Procedure of the Statistical Analysis System (SAS). For lamb growth traits, models included the effects of dam breed group, sire breed, sex of lamb, birth type of lamb, dam age, and year of record as fixed effects and dam and sire as random effects. Models for reproductive traits included the effects of ewe breed group or sire breed of ewe, ewe age, and year of record as fixed effects and ewe and sire as random effects. Lactation models include the effects of ewe breed group or sire breed of ewe, weaning/milking system, ewe age, and year of record as fixed effects and ewe and sire as random effects.

Results and Discussion

Growth. Table 1 presents birth, 30-day, and 150-day weights for lambs born to ewes of different ages and dairy breed composition and sired by rams of different breeds. Lamb weights are given in English (pounds) units whereas the lactation traits presented later are given in metric (kilogram) units. While the U.S. is on the English system, some reliance on foreign information for dairy sheep has resulted in us thinking somewhat in the metric system when dealing with lactation production.

Item	Birth wt, lb.	30-day wt, lb.	150-day wt., lb.
<u>Dam age, yr</u>			
1	10.2±.3[c]	30.5±.6[b]	111.8±2.7[b]
2	11.3±.3[b]	31.4±.6[a]	118.4±2.8[a]
3+	12.2±.3[a]	32.2±.7[a]	113.0±3.3[ab]
<u>Dam breed group</u>			
Non-dairy	10.7±.4[a]	34.2±.9[a]	129.8±3.8[a]
1/2EF	11.1±.3[a]	31.7±.6[b]	120.1±2.9[b]
1/2LA	11.2±.3[a]	31.0±.6[bc]	113.0±3.0[c]
3/4EF	11.2±.4[a]	30.1±.8[c]	108.4±3.8[c]
1/2EF,1/4LA	11.7±.4[a]	31.1±.9[bc]	108.7±4.1[c]
1/2LA,1/4EF	11.3±.4[a]	32.1±.9[ab]	109.3±4.1[c]
3/4LA	11.1±.4[a]	30.9±.8[bc]	111.5±3.9[c]
7/8+(EF,LA)[e]	11.5±.4[a]	29.6±.9[c]	112.7±4.9[c]
7/8+(LA,EF)[f]	11.3±.5[a]	31.6±1.0[bc]	116.0±5.5[bc]
<u>Sire breed of lamb</u>			
EF	11.1±.2[a]	31.4±.5[abd]	106.4±2.5[c]
LA	10.2±.2[b]	29.2±.6[c]	107.6±2.6[bc]
Suffolk	11.7±.5[a]	33.7±1.2[a]	120.7±4.2[a]
Hampshire	11.6±.5[a]	30.9±1.3[abcd]	118.6±5.3[ab]
Dorset	11.5±.7[a]	31.6±1.5[abcd]	118.6±8.0[ab]

Table 1. Lamb growth traits (mean ± SE)

[a,b,c,d]Means within a column and within an underlined and bold item group with no superscripts in common are significantly different ($P < .05$).
[e]Dams are at least 7/8 dairy breeding with 3/4 or greater of EF breeding. A few ewes contain no LA breeding.
[f]Dams are at least 7/8 dairy breeding with 3/4 or greater of LA breeding. A few ewes contain no EF breeding.

First-lambing ewes produced lambs that were lighter ($P < .05$) at birth, 30 days, and 150 days than lambs produced by older ewes.

Dam breed group had no effect on birth weight. For both 30-day and 150-day weight, lambs born to non-dairy ewes had heavier ($P < .05$) weights than lambs born to dairy-cross ewes. The lambs born to non-dairy ewes were all raised on their dam and weaned at approximately 60 days of age, whereas the lambs born to the dairy-cross ewes were weaned onto dry diets at approximately 30 days of age, and many were raised artificially on milk replacer from shortly after birth. This difference in rearing systems may be the reason for these observed differences. Among lambs from dairy-cross ewes, there does not appear to be any consistent effect of the amount of dairy breeding in the dam or the EF or LA breeding composition of the dam.

Overall, Suffolk-, Hampshire-, and Dorset-sired lambs tended to have heavier weights than the EF- or LA-sired lambs. Between the dairy breeds, EF sires produced lambs with heavier ($P < .05$) birth and 30-day weights than did LA sires. Differences between the two dairy sire breeds for 150-day weight of their lambs were small and not statistically different.

These data suggest that the EF and LA breeds are slightly inferior to some common terminal sire breeds (Suffolk, Hampshire, Dorset) for growth rate. This is to be expected. A dairy sheep producer can take advantage of this fact by mating only the number of dairy ewes needed to produce replacement ewe lambs to dairy rams and mating the remainder of the ewes to terminal sires for market lamb production. The EF breed may be slightly superior to the LA breed for preweaning growth rate, and the LA breed may be slightly superior to the EF breed for post-weaning growth rate, but the differences are small. Growth rate is not an important consideration when dairy sheep producers decide between the EF and LA breeds.

Reproduction. Table 2 compares the reproductive performance of ewes of different ages, ewe breed groups, and sire breeds.

Percentage of ewes lambing of ewes exposed (fertility) was not significantly affected by any of the factors. Even though the differences are not significantly different, it is interesting to look at the fertility of the ewe breed groups within each percentage of dairy breeding subgroup. In each subgroup, the ewe breed group with the highest percentage of LA breeding had the lowest fertility (1/2 dairy breeding:1/2LA = 92.0%, 3/4 dairy breeding: 3/4LA = 91.2%, and 7/8 or greater dairy breeding: 7/8+(LA,EF) = 89.3%). Averaged over all ewe breed groups, ewes with a LA sire had a lower (not statistically significant) fertility (94.6%) than ewes with an EF sire (96.7%).

Litter size was different ($P < .05$) among ewes of the three age groups with older ewes giving birth to larger litters than younger ewes.

As with fertility, there are no significant differences among ewe breed groups within a percentage of dairy breeding subgroup for litter size. However, within each subgroup, an increase in LA breeding resulted in a decrease in litter size.

Averaged over all ewe breed groups, ewes sired by LA sires had smaller ($P < .05$) litter sizes than ewes sired by EF sires (1.69 vs. 1.85 lambs, respectively) (Table 2). When the number of lambs born per ewe exposed is calculated from the fertility and litter size values presented in Table 2, values for ewes sired by LA and EF sires are 1.60 and 1.79, respectively.

Differences between EF and LA breeds in reproduction should enter into a decision on which of these breeds to use. EF breeding can be expected to result in 10 to 20 more lambs born 100 ewes than LA breeding.

Item	Fertility, %	Lambs born/ewe lambing, no.
Ewe age, yr		
1	94.3 ± 1.5^{a}	$1.56 \pm .04^{c}$
2	92.6 ± 2.1^{a}	$1.65 \pm .05^{b}$
3+	92.7 ± 3.2^{a}	$1.89 \pm .08^{a}$
Ewe Breed group		
1/2EF	95.4 ± 2.6^{a}	$1.89 \pm .06^{a}$
1/2LA	92.0 ± 2.5^{a}	$1.79 \pm .06^{ab}$
3/4EF	94.6 ± 3.6^{a}	$1.82 \pm .09^{ab}$
1/2EF,1/4LA	91.3 ± 3.9^{a}	$1.67 \pm .09^{b}$
1/2LA,1/4EF	96.0 ± 4.0^{a}	$1.63 \pm .09^{b}$
3/4LA	91.2 ± 3.4^{a}	$1.50 \pm .08^{b}$
7/8+(EF,LA)[e]	95.7 ± 3.9^{a}	$1.66 \pm .09^{b}$
7/8+(LA,EF)[f]	89.3 ± 4.3^{a}	$1.64 \pm .10^{b}$
Sire breed of ewe		
EF	96.7 ± 1.4^{a}	$1.85 \pm .06^{a}$
LA	94.6 ± 1.4^{a}	$1.69 \pm .07^{b}$

Table 2. Reproductive traits (mean ± SE)

[a,b,c,d]Means within a column and within an underlined and bold item group with no superscripts in common are significantly different (*P* < .05).
[e]Ewes are at least 7/8 dairy breeding with 3/4 or greater of EF breeding. A few ewes contain no LA breeding.
[f]Ewes are at least 7/8 dairy breeding with 3/4 or greater of LA breeding. A few ewes contain no EF breeding.

Lactation. The effects of lactation number, weaning/milking system, ewe breed group, and sire of ewe are presented in Table 3. Only milk, fat, and protein obtained from ewes while they were machine-milked were used to determine performance for lactation traits. Milk produced during any nursing period was not estimated.

All measures of lactation performance increased ($P < .05$) as the ewes progressed from 1[st] through 3[rd] and greater lactations. The effects of weaning/milking system have been reported by our group previously (McKusick et al., 2001). The ranking of the systems from highest to lowest for lactation length and yield of milk, fat, and protein was: DY1, MIX, and DY30. The lowest percentage of milk fat was found in MIX milk. This is due to an especially low fat content of milk obtained during the once-a-day milking during the first 30 days of lactation when the ewes spend half of their day nursing their lambs. During this period, MIX ewes do not have complete milk ejection in the parlor, and milk fat is retained in the udder; supposedly to be released to their lambs later (McKusick et al., 2002).

There did not appear to be large breed effects on milk yield or lactation length. Within the dairy breeding percentage subgroups of ½ and ¾ dairy breeding, LA breeding tended to reduce milk yield, but in the 7/8+ dairy breeding group, the higher percentage LA ewes had somewhat greater yields. Averaged over all ewe breed groups, ewes with an EF sire produced 14.6 kg more milk over a 6.2 day longer lactation period than ewes sired by a LA sire, but these differences were not statistically significant.

Table 3. Lactation traits (mean ± SE)

Item	Milk, kg	Lactation length, d	Fat, kg	Fat, %	Protein, kg	Protein, %
Lactation						
1st	162.1 ± 8.3^{c}	137.8 ± 3.6^{c}	$9.1\pm.5^{c}$	$5.61\pm.08^{c}$	$7.6\pm.4^{c}$	$4.67\pm.05^{b}$
2nd	219.5 ± 9.0^{b}	160.3 ± 3.9^{b}	$12.8\pm.6^{b}$	$5.79\pm.09^{b}$	$10.9\pm.4^{b}$	$4.97\pm.05^{a}$
3rd+	254.4 ± 11.9^{a}	174.9 ± 5.5^{a}	$15.6\pm.7^{a}$	$5.95\pm.12^{a}$	$13.0\pm.6^{a}$	$5.00\pm.07^{a}$
Weaning system						
DY 1	234.1 ± 8.9^{a}	173.9 ± 3.7^{a}	$13.9\pm.5^{a}$	$5.80\pm.09^{ab}$	$11.6\pm.4^{a}$	$4.84\pm.05^{b}$
MIX	215.6 ± 11.6^{b}	164.2 ± 5.7^{a}	$12.5\pm.7^{b}$	$5.66\pm.11^{b}$	$10.6\pm.6^{b}$	$4.85\pm.07^{ab}$
DY30	186.4 ± 9.7^{c}	134.9 ± 4.4^{b}	$11.1\pm.6^{b}$	$5.90\pm.10^{a}$	$9.4\pm.5^{c}$	$4.94\pm.06^{a}$
Ewe Breed group						
1/2EF	208.5 ± 11.1^{bcd}	165.9 ± 4.6^{ab}	$12.5\pm.7^{b}$	$5.88\pm.12^{b}$	$10.3\pm.5^{b}$	$4.83\pm.07^{bc}$
1/2LA	190.2 ± 12.0^{d}	155.0 ± 4.7^{bcd}	$12.6\pm.7^{b}$	$6.55\pm.12^{a}$	$10.1\pm.6^{b}$	$5.28\pm.07^{a}$
3/4EF	199.0 ± 13.5^{bcd}	152.4 ± 6.0^{cd}	$10.9\pm.8^{b}$	$5.27\pm.14^{d}$	$9.5\pm.7^{b}$	$4.59\pm.09^{d}$
1/2EF,1/4LA	252.6 ± 14.3^{a}	170.6 ± 6.4^{a}	$14.9\pm.9^{a}$	$5.86\pm.15^{bc}$	$12.5\pm.7^{a}$	$4.90\pm.09^{b}$
1/2LA,1/4EF	217.2 ± 15.3^{abc}	160.2 ± 6.5^{abc}	$12.4\pm.9^{b}$	$5.59\pm.16^{cd}$	$10.7\pm.8^{b}$	$4.84\pm.10^{bc}$
3/4LA	197.3 ± 14.1^{cd}	146.8 ± 5.9^{d}	$12.1\pm.9^{b}$	$6.03\pm.15^{b}$	$10.1\pm.7^{b}$	$5.01\pm.08^{b}$
7/8+(EF,LA)[e]	205.8 ± 14.3^{bcd}	150.8 ± 6.5^{cd}	$11.1\pm.9^{b}$	$5.25\pm.15^{d}$	$9.9\pm.7^{b}$	$4.65\pm.09^{cd}$
7/8+(LA,EF)[f]	225.3 ± 16.6^{ab}	159.6 ± 5.9^{abcd}	13.2 ± 1.0^{ab}	$5.84\pm.17^{bc}$	$11.2\pm.8^{ab}$	$4.91\pm.11^{b}$
Sire breed of ewe						
EF	209.4 ± 9.8^{a}	161.4 ± 3.8^{a}	$12.3\pm.6^{a}$	$5.75\pm.10^{b}$	$10.3\pm.5^{a}$	$4.81\pm.06^{b}$
LA	194.8 ± 11.5^{a}	155.2 ± 4.0^{a}	$12.5\pm.7^{a}$	$6.31\pm.11^{a}$	$10.1\pm.6^{a}$	$5.15\pm.06^{a}$

[a,b,c,d]Means within a column and within an underlined and bold item group with no superscripts in common are significantly different (*P* < .05).

[e]Ewes are at least 7/8 dairy breeding with 3/4 or greater of EF breeding. A few ewes contain no LA breeding.

[f]Ewes are at least 7/8 dairy breeding with 3/4 or greater of LA breeding. A few ewes contain no EF breeding.

Large and significant differences between the two breeds were observed for percentage fat and protein, with the LA superior to the EF. Within each of the percentage dairy breeding subgroups, the ewes with the highest percentage of LA breeding had the greatest percentage fat and protein. Averaged over all ewe breed groups, ewes sired by LA rams had greater (P < .05) percentage fat (6.31 vs. 5.75%, respectively) and percentage protein (5.15 vs. 4.81%, respectively). Even though the higher percentage LA ewes often had lower milk production than other breed groups, the higher fat and protein content of their milk resulted in the production of similar amounts of fat and protein.

The LA breed will increase the content of fat and protein in milk compared to the EF breed. Producers selling milk on a component basis or farmstead cheese makers may benefit from the use of LA genetics.

The single ewe breed group with the most outstanding lactation performance was the 1/2EF,1/4LA group. These ewes produced from 27.3 to 62.4 kg more milk than any other group. In addition, they had some of the highest fat and protein contents so their fat and protein yields were the highest among the breed groups.

Conclusions

Based on the results of this study, replacement of 50% EF breeding with 50% LA breeding will have a small effect on lamb growth, will decrease lambs born per 100 ewes exposed by about 15, may result in a slight decrease in milk production (~7%), and will raise fat and protein content of milk by .3 to .6 percentage units.

Since most sheep milk in North America is not sold on a component basis, the infusion of large amounts of LA breeding into EF flocks will likely result in a decrease in net income – primarily from fewer lambs produced. However, infusion of smaller amounts of LA breeding into an EF flock may result in increased lamb and ewe survival due to hybrid vigor while at the same time taking advantage of the positive effect of LA breeding on milk composition. A simple approach to accomplish this would be to use a rotational crossbreeding program with purebred EF and F1 EFxLA rams. Any ewe sired by an EF ram would be mated to an EFxLA ram, and any ewe sired by an EFxLA ram would be mated to an EF ram. A similar number of replacement ewe lambs would be selected from each sire breed. This system would result in a flock in which about half of the ewes would be 83%EF,17%LA and the other half would be 67%EF,33%LA.

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