

East Friesian germplasm: Effects on milk production, lamb growth, and lamb survival¹

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Abstract

East Friesian (EF) crossbred rams (1/2 to 7/8 EF breeding) and Dorset rams were mated to crossbred ewes from 1993 through 1996. Growth, reproduction, and lactation performance of their progeny were compared. East Friesian-cross lambs had greater birth, weaning, and postweaning weights than Dorset-cross lambs. When lambing at 1 and 2 yr of age, EF-cross ewes gave birth to and reared more lambs per ewe mated, had more days in lactation, produced more milk and more weight of milk fat and milk protein, and had a lower percentage of milk fat and protein than Dorset-cross ewes. With the levels of EF breeding evaluated in this study (up to 50%), EF-cross sheep were superior to Dorset-cross sheep for lamb and milk production in the north-central United States. Early results from other U.S. studies show advantages of sheep of 50% EF breeding over domestic breeds and crosses for commercial lamb production. However, sheep producers should be aware that in many other countries where the EF has been imported to improve commercial milk production of local sheep populations, sheep containing more than 50% EF breeding have had lower survival, lower lamb production, and, in some cases, lower milk production than local breeds. Countries that have reported poor performance of high-percentage EF sheep are in the Mediterranean region, and the EF breed seems poorly adapted to the high environmental temperatures of that region. Although the environmental temperatures of much of the United States may not place a stress on EF sheep, they have also been shown to be more susceptible to some diseases than local breeds, most notably to pneumonia. Even though we have not designed a study to evaluate the effects of the proportion of EF breeding on performance, lambs of greater than 50% EF breeding in our 1999 lamb crop had significantly lower survival rates than lambs of lower percentages EF breeding. Therefore, there is a need for evaluation of pure EF or EF-cross sheep of greater than 50% EF breeding to determine the optimum amount of EF breeding for commercial sheep farms in the United States. Other dairy breeds also should be evaluated as they become available in the United States.

Key Words: Sheep, Milk, Growth, East Friesian (Sheep Breed)

Introduction

Imports of sheep milk cheeses into the United States increased from 14.8 million kg in 1984 to 28.3 million kg in 1998 (FAO, 1999), a 91% increase in 14 yr. A small domestic dairy sheep industry is developing to serve this growing demand for sheep milk cheeses. A major production limitation has been low milk yields of domestic sheep breeds. Sakul and Boylan (1992) have reported that lactation yields of domestic breeds and their crosses range from 50 to 80 kg. There are, however, European and Middle Eastern sheep breeds that have been successfully selected for high levels of commercial milk production (e.g., Assaf [Gootwine et al., 1980], Awassi [Eyal et al., 1978], Lacaune [Barillet, 1995], and Lacha [Esteban Munoz, 1982]).

The East Friesian (EF) is generally regarded as the highest milk-producing breed in the world; yields of 550 to 650 kg have been reported in northern Europe (Sonn, 1979; Kervina et al., 1984). The breed was developed in the East Friesland area of Germany. Mature rams and ewes weigh 90 to 120 kg and 65 to 75 kg, respectively, and their faces and legs are white and free of wool. A distinguishing characteristic is a long, thin "rat" tail that is free of wool. A 230% lamb crop can be expected from mature ewes (Kervina et al., 1984).

In 1993, the University of Wisconsin-Madison, the University of Minnesota, and a few private breeders imported the

first EF-cross rams into the United States. The rams were born in Canada from semen imported from Switzerland. After 1993, the University of California-Davis; U.S. Sheep Experiment Station, Dubois, ID; and Oregon State University also initiated research programs with the EF breed. This article reports early results of our evaluation of EF-cross sheep in Wisconsin and also reviews work at other U.S. and foreign research institutions. Some results in this paper were reported earlier by Berger and Thomas (1995, 1997) and Thomas et al. (1999).

Materials and Methods

The study was conducted at the Spooner Agricultural Research Station of the University of Wisconsin-Madison, located in northwest Wisconsin (latitude: 45°49', longitude: 91°53', average minimum temperature in January: -19.1°C, average maximum temperature in July: 27.5°C). Crossbred ewes of 1/2 Dorset, 1/4 Romanov (or Finnsheep), and 1/4 Targhee breeding (commercial ewes) were randomly assigned to either an EF-cross ram or Polled Dorset ram in a single-sire mating pen during the late summers or autumns of the 4 yr from 1993 to 1996. Two 1/2 EF, 1/2 Rideau rams were used all 4 yr, one 3/4 EF, 1/4 Rideau ram was used from 1994 to 1996, and one 7/8 EF, 1/8 Rideau ram was used in 1996. The four rams were the result of artificial insemination from semen imported into Canada from Switzerland

from three EF rams. Three polled Dorset rams were used each year, and one or two rams were replaced each year. The Dorset rams were purchased from Wisconsin breeders from rams consigned to the Wisconsin Ram Test Station.

Lambs were born from the commercial ewes in the winters or springs of 1994 through 1997 and weaned at approximately 60 d of age. Most female lambs born from 1994 through 1996 were retained as replacements. They were mated to lamb first at approximately 12 mo of age and annually thereafter, except ewes born in 1994 were lambled only in 1995. They were mated to 1/2 EF or 3/4 EF rams in the autumn of 1994 and to Dorset rams in the autumns of 1995 and 1996. Ewes were randomly assigned to sires and mated in single-sire pens. Lambs born from these ewes were weaned at approximately 60 d of age in 1995 and at approximately 30 d of age in 1996 and 1997. Many of the ewe lambs were retained as replacements.

Lambs were raised in confinement on high-concentrate diets and marketed at an average age of 140 d at an average live weight of 57 kg. Male lambs were not castrated.

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

One- and two-year-old Dorset-sired and EF-sired ewes lambing in 1996 and 1997 nursed their lambs until approximately 30 d of age and were milked twice per day in an automated milking parlor at 0600 and 1700 starting on the day of weaning. Individual daily milk production was determined every 28 d at an evening milking and the milking the following morning. Individual milk samples were taken at the morning milking and analyzed for butterfat and protein percentage by a certified laboratory in both years and for somatic cells in 1997. An estimate of total milk, fat, and protein production for a lactation was calculated using the following formula:

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

Milking was discontinued on a ewe after a testing when the total milk production from both evening and morning milkings fell below .20 kg. Estimated total milk production and lactation length was for the milking period only with no estimate of milk production during the nursing period.

This study included full production year data for the years 1993/94, 1994/95, 1995/96, and 1996/97 and partial data for the production year of 1997/98. Data were analyzed using the GLM procedure of SAS (1995). Models used to analyze the data were as follows:

Body weights of lambs from commercial ewes = sex + sire breed + birth year + birth type + dam age (birth year) + various two-way interactions + residual.

Body weights of lambs from EF-cross or Dorset-cross ewes = sex + dam breed + birth year + birth type + dam age (birth year) + various two-way interactions + residual.

Reproductive traits of EF-cross or Dorset-cross ewes = ewe breed + production year + ewe age (production year) + various two-way interactions + residual.

Lactation traits of EF-cross or Dorset-cross ewes = ewe breed + production year + number of lambs produced + ewe age (production year) + various two-way interactions + residual (production year was deleted from the model for analysis of somatic cell count).

Survival of 1999-born lambs = category of % EF breeding of the lamb + residual.

In the above models, there are only two categories for sire breed, dam breed, and ewe breed (i.e., sire breed = Dorset or EF-cross, dam breed and ewe breed = Dorset-cross or EF-cross). The expected proportion of EF breeding in the EF-crosses varied from 50% to 87.5% for the EF-cross sires and from 12.5% to 50% for the EF-cross ewes. Animals of a specific percentage of East Friesian breeding were represented by only one or two sires or sired by only one or two EF-cross rams, so categories for each percentage of EF breeding were not included in the models because they would have measured individual sire effects rather than the effects of different percentages of EF breeding.

It should be noted that comparisons between lambs and ewes from EF-cross and Dorset rams and commercial ewes and between lambs and ewes from EF-cross and Dorset-cross ewes and EF-cross and Dorset rams are not unconfounded estimates of the effects of substitution of EF genes for Dorset genes (direct genetic breed effects). All these comparisons are confounded with the effects of individual and paternal heterosis, and some comparisons also are confounded with the effects of maternal heterosis. The major source of confounding from heterosis effects arises from the presence of Dorset breeding in both sires and dams in many of the matings. The commercial ewes are 1/2 Dorset breeding. Progeny resulting from the mating of the commercial ewes to Dorset rams will exhibit 50% of F_1 individual heterosis, and progeny resulting from the mating of the commercial ewes to the EF-cross rams will exhibit 100% of F_1 individual heterosis. Likewise, the matings of Dorset-cross ewes to Dorset rams will result in progeny with 25% of F_1 individual heterosis and 50% F_1 maternal heterosis, and the matings of EF-cross ewes to Dorset rams will result in progeny with 75% of F_1 individual heterosis and 100% F_1 maternal heterosis. For traits that tend to exhibit large amounts of heterosis, the mean values reported in this study for EF crosses are biased upward relative to Dorset crosses due to larger heterosis effects. The confounding of heterosis and direct genetic breed effects are probably of little importance for the growth and lactation traits because these traits exhibit moderate to low amounts of heterosis (Geenty, 1978; Nitter, 1978; Mavrogenis, 1996). However, they may be important for the reproductive traits that tend to exhibit large amounts of heterosis (Nitter, 1978).

Results and Discussion

Body weights of lambs sired by EF-cross or Dorset rams from commercial dams and of lambs from EF-sired and Dorset-sired dams born through 1997 are presented in Table 1. At all ages, lambs with an EF-cross sire or dam had heavier ($P < .05$) body weights than lambs with a Dorset sire or Dorset-cross dam.

In other studies in which EF genetics was introduced into local populations to increase milk production, crossbred lambs of EF breeding also had greater growth rates than lambs of local breeds (Ricoardeau and Flamant [1969a], in France with the Préalpes du Sud breed; Kalaissakis et al. [1977], in Greece with the Chios breed; and Katsaounis and Zygoyiannis [1986], in Greece with the Karamaniko Katsikas and Karagouniko breeds). In agreement with these results, G. Snowden (unpublished information) found that EF \times Polypay ewes had heavier breeding weights than either Suffolk \times Polypay or Polypay ewes at approximately 7 mo of age in Idaho. Results of H. H. Meyer (unpublished information) at Oregon State University were less conclusive. East Friesian \times Polypay lambs had heavier 90-d weights than Polypay lambs in 1998, but the reverse was true in 1999.

Presented in Table 2 is the reproductive performance of ewes sired by Dorset or EF-cross rams and lambing at 1 yr of age in 1995, 1996, and 1997 and at 2 yr of age in 1997. Young EF-cross ewes had a greater ($P \leq .05$ or $P < .10$) prolificacy and number of lambs reared per ewe lambing and per ewe mated than did young Dorset-cross ewes. Fertility was similar between the two breed groups. The rearing figures do not include the lambs successfully reared on milk replacer (EF-cross dams = 45 lambs, Dorset-cross dams = 5 lambs). Accounting for these lambs would increase the number of lambs reared per ewe lambing and per ewe mated to 1.83 and 1.76, respectively, for EF-cross and 1.60 and 1.50, respectively, for Dorset-cross.

Greater prolificacy of EF-cross ewes compared to local breed ewes also has been reported by Ricoardeau and Flamant (1969a) and Gootwine and Goot (1996, local breed was the Awassi). Kalaissakis et al. (1977) reported that F₁ EF-cross ewes were superior and ewes with greater than 50% EF breeding were inferior to local ewes for number of lambs reared per ewe mated. In the Idaho study of G. Snowden (unpublished observations), EF \times Polypay ewes produced more lambs per ewe lambing and per ewe exposed and had greater weight of litter weaned at 1 yr of age than either Suffolk \times Polypay or Polypay ewes. However, at 2 yr of age, numbers of lambs born per ewe lambing and per ewe exposed were similar between EF \times Polypay and Suffolk \times Polypay ewes, and both groups were inferior to Polypay ewes.

Presented in Table 3 is the lactation performance of 1-yr-old ewes in 1996 and 1997 and 2-yr-old ewes in 1997. The EF-cross ewes had lactations that were 33 d longer and produced 52 kg more milk, 2.2 kg more fat, and 2.2 kg more protein compared to the Dorset-cross ewes ($P < .05$, Table 3). Fat and protein percentage of milk from EF-cross ewes was approximately .5 percentage units lower ($P < .05$) than

that of milk from Dorset-cross ewes. This last result was expected; several authors (e.g., Casoli et al., 1989) have shown that there is a negative relationship between milk yield and percentage of milk fat and milk protein both within and between breeds. Somatic cell counts were similar between the breed groups and averaged approximately 100,000 cells/mL of milk.

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

Survival and Fitness. The early years of our study showed good viability of lambs of EF-cross breeding compared to lambs of Dorset-cross breeding. However the EF-cross lambs in those early years were all of 50% or less EF breeding, and producers should not extrapolate these results to sheep of greater than 50% EF breeding. There are a number of reports in the literature of poor viability of pure EF and EF-cross sheep of over 50% EF breeding. Katsaounis and Zygoyiannis (1986) report especially poor viability of EF sheep in Greece. They imported a total of 52 ewes, 10 rams, and 18 lambs of the EF breed in the years 1956, 1960, and 1965. They were kept on their experimental farm along with sheep of two local breeds. Of these imported EF sheep, all the lambs died within 2 mo, and all the adults had died by 1970. Of the EF lambs born in the flock, 38.3% were still-born or not viable at birth, 29.6% died before the age of 2 mo, and of those weaned, 69.2% died before 1 yr of age. Ewes of 1/2 EF breeding lived for a respectable 5.1 yr, but ewes of higher percentages of EF breeding had very short lifespans: 2.6 yr for 3/4 EF, 2.7 yr for 7/8 EF, 2.5 yr for 15/16 EF, 2.5 yr for 31/32 EF, and 2.09 yr for pure EF. The most common cause of death was pneumonia with a high incidence of Maedi (ovine progressive pneumonia-like disease) in adult ewes. Ricoardeau and Flamant (1969a) also reported an increased death loss to respiratory disease of EF-cross lambs in France. In different years and with percentages of EF breeding varying from 50% to 87.5%, they reported a 2.2 to 22.2% increased death loss in EF-cross lambs from pasteurellosis and pneumonia compared to Préalpes du Sud lambs.

We have some early indications that lambs of over 50% EF breeding have reduced survival rates. Table 4 presents the survival rates to July 1, 1999, of all lambs born alive in our flock in the winter/spring of 1999, grouped by breed of sire and expected proportion of EF breeding in the dam. The survival rates varied from 100% to 70% among the groups, and lambs with EF sires and EF-cross dams had the lowest survival rates. As Table 4 indicates, the various groups also differ for age of dams and lambing dates, which may also

have had some effect on lamb survival. However, given these limitations of the data, the data have been regrouped by expected proportion of EF breeding in the lamb and presented in Table 5. In all lamb growth intervals, lambs with over 50% EF breeding had lower ($P < .05$) survival rates than lambs of lower percentage EF breeding, and there was a tendency ($P < .10$) during the postweaning period for lambs of 50% EF breeding to have lower survival rates than lambs of less than 50% EF breeding. The relative survival rates of lambs of higher percentage EF breeding need to be determined from studies designed better than the one presented here, but this preliminary evaluation under a U.S. production system combined with the results from other countries suggests that sheep producers that move to over 50% EF breeding in their flocks should be prepared to deal with possible increased health problems in their lambs.

G. Snowden (unpublished data) has reported a greater incidence of mastitis in EF × Polypay ewes than in Suffolk × Polypay or Polypay ewes when used for commercial lamb production (14.0, 3.6, and 5.4, respectively, for 1-yr-old ewes and 5.9, 2.6, and 0.0%, respectively, for 2-yr-old ewes).

Implications

Until another dairy breed is shown to be superior to the East Friesian, U.S. dairy sheep producers should incorporate up to 50% East Friesian breeding into their commercial dairy flocks because a sizable increase in milk yield will result. Up to 50% East Friesian breeding also may improve ewe reproduction and lamb growth in commercial lamb production and dairy sheep operations, but East Friesian crosses have not always been superior to domestic breeds and crosses for these traits in experimental trials. Producers should be cautious about increasing the proportion of EF breeding above 50% due to reports from other countries and a preliminary observation in the United States that lambs of over 50% EF breeding have significantly reduced survival rates.

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Notes

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Table 1. Least squares means for body weights of lambs^a

Breed	Number of lambs born	Body weight (kg) at			
		Birth	30 d	60 d	140 d (males only)
Breed of sire					
EF-cross ^b	420	5.02 ± .10 ^c		24.7 ± .4 ^c	59.7 ± 1.3 ^c
Dorset	216	4.51 ± .14 ^d		21.7 ± .7 ^d	53.4 ± 2.0 ^d
Breed of dam					
EF-cross	546	4.68 ± .05 ^c	14.0 ± .2 ^c		59.8 ± 1.1 ^c
Dorset-cross	150	4.45 ± .07 ^d	13.0 ± .3 ^d		55.2 ± 1.7 ^d

^aFrom Thomas et al., 1999.^bEF = East Friesian.^{c,d}Within a column and breed of sire or breed of dam, means with a different superscript are different ($P < .05$).**Table 2.** Least squares means for reproduction of ewes lambing at 1 and 2 yr of age^a

Breed of ewe	Number of matings	Fertility, %	Prolificacy, no.	Lambs reared per ewe lambing, no.	Lambs reared per ewe mated, no.
EF-cross ^b	338	96.2 ± 1.3 ^c	1.93 ± .04 ^c	1.69 ± .05 ^e	1.62 ± .05 ^c
Dorset	146	93.5 ± 1.7 ^c	1.66 ± .06 ^d	1.56 ± .06 ^f	1.47 ± .06 ^d

^aFrom Thomas et al., 1999.^bEF = Eastern Friesian.Within a column, means with a different superscript are different: ^{c,d}($P \leq .05$), ^{e,f}($P < .10$).**Table 3.** Least squares means for lactation performance of young Eastern Friesian (EF)-cross and Dorset-cross ewes

Trait	Breed of ewe	
	Dorset-cross	EF-cross
Number of lactations	76	246
Lactation length, d	92.7 ± 4.2 ^b	126.2 ± 2.6 ^c
Milk yield, kg	56.9 ± 5.5 ^b	109.1 ± 3.4 ^c
Fat, %	5.54 ± .07 ^b	5.02 ± .05 ^c
Fat yield, kg	3.3 ± .3 ^b	5.5 ± .1 ^c
Protein, %	5.42 ± .05 ^b	4.97 ± .03 ^c
Protein, kg	3.2 ± .3 ^b	5.4 ± .1 ^c
Log somatic cell count	4.99 ± .09 ^a	5.03 ± .04 ^a

^aFrom Thomas et al., 1999.^{b,c} Within a row, means with a different superscript are different ($P < .05$).

Table 4. Arithmetic means for survival of lambs born alive by breed of sire and dam's percentage of East Friesian breeding (1999 lamb crop)

Breed of sire	Dam's EF breeding, %	Dam age, yr	Lambing dates ^a	No. lambs born alive	Survival rate, %		
					Birth to weaning	Weaning to 7/1/99 ^a	Birth to 7/1/99 ^a
East Friesian	0	1-9	3/4-5/28	60	95.0	93.0	88.4
East Friesian	> 0 to < 50	2-4	3/13-4/13	19	84.2	93.7	78.9
East Friesian	≥ 50	1-2	3/4-5/18	132	82.1	85.5	70.2
Lacaune	0	3-5	4/7-5/1	45	95.5	100.0	95.5
Suffolk	0	2	2/26-3/20	10	100.0	100.0	100.0
Suffolk	> 0 to < 50	2-4	2/2-3/27	135	97.0	99.2	96.2
Suffolk	≥ 50	2-4	2/2-3/26	70	97.1	99.0	96.1
Texel	0	2	1/10	1	100.0	100.0	100.0
Texel	> 0 to < 50	2-4	3/25-4/5	11	90.9	100.0	90.9
Overall lamb survival of the flock				483	91.7	94.6	86.7
Percentage of dead lambs that died from pneumonia during each of the three periods					45.9	91.3	63.3

^aDates are of the form month/day or month/day/year.

Table 5. Least squares means for lamb survival by percentage of East Friesian (EF) breeding of the lamb (1999 lamb crop)

Lamb's EF breeding, %	No. lambs born alive	Survival rate, %		
		Birth to weaning	Weaning to July 1, 1999	Birth to July 1, 1999
0	56	96.4 ± 3.5 ^a	100.0 ± 2.9 ^a	96.4 ± 4.2 ^a
>0 to <25	146	96.6 ± 2.2 ^a	99.3 ± 1.8 ^a	95.9 ± 2.6 ^a
≥25 to <50	70	97.1 ± 3.1 ^a	98.5 ± 2.6 ^a	95.7 ± 3.8 ^a
50	60	95.0 ± 3.4 ^a	93.0 ± 2.8 ^{a,b}	88.3 ± 4.1 ^a
>50	151	83.4 ± 2.1 ^b	86.5 ± 1.9 ^b	72.2 ± 2.6 ^b

^{a,b}Within a column, means with a different superscript are different ($P < .05$).