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# Lamb and ewe performance of East Friesian x Coopworths relative to pure-bred Coopworths

N.B. JOPSON, K.G. DODDS, K.J. KNOWLER[1], R. WHEELER[1] AND J.C. MCEWAN

AgResearch, Invermay Agricultural Centre, Private Bag 50034, Mosgiel.

## ABSTRACT

Purebred East Friesians (EF) sires were used in both the 1996 and 1998 matings (n=2 and 4, respectively) to generate 62 and 66 progeny for the two years. These animals were compared with approximately 1000 COOP lambs in each year for growth, ultrasonic fat and muscle depths, wool, dagginess, host resistance to internal parasites, and reproductive performance. For the 1998 mating, one F1 sire and 24 F1 dams were mated to COOP ewes and rams respectively to produce approximately 73 paternal and 33 maternal backcross progeny. Twenty four EF cross ewes were mated in each of the 1998 and 1999 birth years, and reproductive performance recorded. On average, the EF cross progeny had a live weight advantage (P<0.001) of 1.9 and 4.2 kg at weaning and 6 months of age, respectively, compared to COOP. Ultrasonic eye muscle depth did not differ between sire breeds (P>0.05) after adjustment for live weight, but EF cross progeny had significantly lower C and GR measurements. EF cross progeny had lower fleece weight at 12 months (-0.46kg; P<0.001) than COOP. Average dag score differed between sire breeds with EF cross having lower scores (0.4 verses 1.2) compared to COOP. Sire breed differences in resistance to parasites were not significant. Analysis of the limited EF backcross data indicated positive EF direct and maternal effects for weaning weight, negative EF direct effects for dag scores, and negative EF direct and maternal effects for fleece weight. EF cross ewes performed significantly better (P<0.001) in lambs born per ewe lambing than the purebred COOP for both 2-tooth (2.57 cf. 1.84) and mixed-age (2.76 cf. 1.98) classes. The high lambing percentage in EF cross ewes meant that more than 70% of mixed-age ewes had three or more lambs per lambing, which could result in management difficulties. There was significant overlap in the sire-breed ranges for all traits, meaning selection of sire was more important than breed selection.

**Keywords:** sheep; Coopworth; East Friesian; growth; reproduction.

## INTRODUCTION

East Friesians (EF) were imported into NZ in 1992 with the expectation of improving performance in prolificacy and milk production in our traditional breeds and breed crosses (Meyer *et al.*, 1977). There has been considerable use of EFs in the industry since their release in 1996. While there are some reports on growth rate, and meat and wool production in New Zealand (Allison, 1995; Jopson *et al.*, 1999), the EF cross progeny are only now reaching the reproductive age classes in sufficient numbers to evaluate their reproductive performance relative to purebred contemporaries. This paper presents data on the growth, ultrasonic fat and muscle depths, wool, dagginess, host resistance to internal parasites, and reproductive performance of EF x Coopworth progeny relative to their purebred Coopworth (COOP) contemporaries at Woodlands Research Station.

## MATERIALS AND METHODS

### Animals

Purebred COOP and EF rams were mated to COOP ewes in the 1996 and 1998 birth years. In the 1996 birth year, 29 COOP and two EF rams were used to produce 942 COOP and 62 EF x COOP (EFxC) progeny. In the 1998 birth year, 12 COOP and four EF rams were used to produce 986 COOP and 66 EFxC progeny. In addition, one EFxC ram produced 73 EFxC x COOP progeny ((EFxC)xC), and eight of the 12 COOP rams were also mated to a total of 24 EFxC ewes to produce 33 COOP x EFxC progeny (Cx(EFxC)). All animals were grazed together at all times except for one cycle at mating, when they grazed similar pasture covers. All progeny were tagged and weighed at birth, and pedigree recorded. Live weights were recorded at weaning (WWT; 12 weeks) and at six months of age (LW6). Host resistance to internal parasites was tested in all progeny. The test involved two field exposures to parasites with the first test beginning at weaning, and the second challenge immediately after the first as described by McEwan *et al.* (1997). Briefly, both challenges were terminated when faecal egg count (FEC) in a randomly selected subsample of progeny reached an average of 800 eggs per gram. At this point, individual faecal samples were collected, and an anthelmintic drench administered. The amount of strongyle (FEC1, FEC2) and nematodirus (NEM1, NEM2) eggs were measured for challenges one and two, respectively. Animals born in 1998 were scored for dags twice using a five point scale (0, clean to 4, very dirty; McEwan *et al.*, 1992), first in January and then in March (DAG1 and DAG2, respectively). Carcass muscling and fatness indicators were measured ultrasonically in ewe hoggets in early June. Traits included the depth of the eye muscle over the 12$^{th}$ rib, the depth of fat over the eye muscle at the same site (C), and the tissue depth over the 12$^{th}$ rib 11cm from midline (GR). Hoggets were shorn at 12 months of age and their fleece weights recorded (FW12).

A total of 24 1996-born EFxC females were mated as two-tooths in 1998 and as four-tooth ewes in 1999, and compared with 274 two-tooth and 624 mixed-age COOP contemporaries. Reproductive performance was broken down into four traits, namely ewes present at lambing per ewe mated; ewes lambed per ewe present; lambs born per ewe lambed; and lambs weaned per lamb born (EP/EM, EL/EP, LB/EP and LW/LB, respectively).

[1] AgResearch, Woodlands Research Station, RD1, Invercargill.

**Statistical analysis**

Growth, parasite resistance, dag scores, ultrasonic carcass, fleece and reproductive traits were analysed using least squares methods models (SAS Institute Inc., 1992). Parasite resistance traits (FEC1, FEC2, NEM1 and NEM2) were transformed by log(x + 50) for analysis. Comparisons between COOP and EFxC progeny used the combined data from the 1996 and 1998 birth years, with models including year, breed, sex, birth rearing rank, sire and age of dam as fixed effects. Birth day was fitted as a covariate for all traits. The ultrasonic carcass measurements were also analysed in a weight-adjusted model that included the terms for breed, year, sire and sex as fixed effects. Breed and year differences were tested using sire nested within year and breed as the error term for both models. The comparison of COOP, EFxC, (EFxC)xC and Cx(EFxC) used the same statistical models with the exception of the fixed effect for year because no (EFxC)xC and Cx(EFxC) progeny were present for the 1996 birth year. Only the 1998 birth year data was analysed. Two-tooth and mixed-age reproductive performance were analysed separately, with EP/EM, EL/EP and LB/EP being analysed as Normal variates in a model with only the fixed effect of breed fitted. Data were not available to test breed differences in LW/LB.

## RESULTS

The results of the across-year comparison between COOP and EFxC progeny are presented in Table 1. Differences in birth weight between breeds were not significant. However, EFxC progeny were on average 1.9 kg heavier ($P<0.01$) than their pure COOP contemporaries at weaning, and 4.2 kg heavier ($P<0.001$) at six months of age. There was no significant difference between breeds for any of the parasite resistance traits. EFxC progeny had significantly lower dag scores than pure COOP on both scoring dates, being 0.72 ($P<0.001$) and 0.71 ($P<0.01$) scores less for DAG1 and DAG2, respectively. Of the carcass traits, eye muscle depth did not differ significantly between breeds ($P>0.05$) after adjustment year, sex and LW6. However, EFxC carcasses contained less fat than COOP. The fat depth C was 0.4 mm less in EFxC progeny than in COOP ($P<0.05$). Likewise, the tissue depth GR was 1.42 mm less in EFxC progeny ($P<0.05$).

Including the (EFxC)xC and Cx(EFxC) progeny in the analysis (analysing only the born 1998 data) produced the results summarised in Table 2. Of the growth traits, only WWT had significant breed differences. COOP progeny were significantly lighter than EFxC ($P<0.001$) and Cx(EFxC) ($P<0.01$), but not (EFxC)xC animals. EFxC animals were significantly heavier than all three other breed groups. There were no significant breed differences in any of the internal parasite resistance traits ($P>0.05$). Of the two dag score dates, significant breed differences were only found for the first. COOP animals had significantly higher dag scores at 1.10 compared to EFxC and (EFxC)xC animals at 0.36 and 0.46, respectively. No other breed comparison was significant for DAG1. EMD, GR and C did not differ significantly between breeds. COOP progeny had significantly heavier FW12 at 3.20 kg than either EFxC or Cx(EFxC) animals (2.54 and 2.53 kg, respectively). (EFxC)xC fleece weights were not significantly different from COOP animals.

**TABLE 1:** Growth, host resistance to internal parasites, dag scores, ultrasonic carcass measures and fleece weight in 1996- and 1998-born East Friesian x Coopworth lambs and their purebred Coopworth contemporaries.

| Trait | COOP | (n) | EFxC | (n) | s.e.d. | Signif. |
|---|---|---|---|---|---|---|
| BWT (kg) | 4.80 | (1926) | 4.99 | (129) | 0.15 | NS |
| WWT (kg) | 23.1 | (1924) | 25.0 | (128) | 0.6 | ** |
| LW6 (kg) | 36.3 | (1851) | 40.5 | (128) | 0.4 | *** |
| FEC1 (epg) | 554.5 | (912) | 619.2 | (72) | 66.6 | NS |
| FEC2 (epg) | 879.7 | (1847) | 948.0 | (128) | 72.0 | NS |
| NEM1 (epg) | 24.2 | (911) | 18.3 | (72) | 6.2 | NS |
| NEM2 (epg) | 19.8 | (1847) | 22.7 | (128) | 5.0 | NS |
| DAG1 | 1.10 | (960) | 0.38 | (66) | 0.17 | *** |
| DAG2 | 1.31 | (499) | 0.60 | (29) | 0.25 | ** |
| EMD (mm) | 23.6 | (824) | 23.2 | (107) | 0.3 | NS |
| GR (mm) | 5.94 | (824) | 4.52 | (107) | 0.24 | * |
| C (mm) | 1.91 | (824) | 1.51 | (107) | 0.07 | * |
| FW12 (kg) | 3.21 | (537) | 2.75 | (85) | 0.08 | *** |

**TABLE 2.** Growth, host resistance to internal parasites, dag scores, ultrasonic carcass measures and fleece weight in 1998-born East Friesian x Coopworth lambs, the maternal and paternal backcrosses with Coopworths and their purebred Coopworth contemporaries.

| Trait | COOP | EFxC | (EFxC)xC | Cx(EFxC) | Mean s.e.d. | Signif. |
|---|---|---|---|---|---|---|
| n | 986 | 66 | 73 | 33 | | |
| BWT (kg) | 4.97 | 5.42 | 4.93 | 5.07 | 0.16 | NS |
| WWT (kg) | 23.1 | 26.9 | 23.4 | 25.2 | 0.6 | ** |
| LW6 (kg) | 37.2 | 40.3 | 36.3 | 38.1 | 0.8 | NS |
| FEC1 (epg) | 525 | 580 | 717 | 857 | 111 | NS |
| FEC2 (epg) | 826 | 813 | 813 | 1024 | 103 | NS |
| NEM1 (epg) | 36.4 | 18.0 | 34.9 | 30.3 | 14.3 | NS |
| NEM2 (epg) | 29.8 | 32.3 | 24.3 | 8.0 | 11.0 | NS |
| DAG1 | 1.10 | 0.36 | 0.46 | 0.65 | 0.22 | ** |
| DAG2 | 1.31 | 0.58 | 0.78 | 1.41 | 0.30 | NS |
| EMD (mm) | 22.5 | 22.3 | 22.8 | 22.0 | 0.7 | NS |
| GR (mm) | 5.0 | 3.9 | 4.7 | 4.7 | 0.4 | NS |
| C (mm) | 1.7 | 1.4 | 1.7 | 1.8 | 0.1 | NS |
| FW12 (kg) | 3.20 | 2.54 | 3.15 | 2.53 | 0.24 | ** |

**TABLE 3.** Reproductive performance in two-tooth and mixed-age East Friesian x Coopworth ewes relative to their purebred Coopworth contemporaries.

| Year | | Coop | EFxC | s.e.d. | Sign. |
|---|---|---|---|---|---|
| 1998 (2th) | | | | | |
| | n | 274 | 24 | | |
| | EP/EM | 0.99 | 1.00 | 0.02 | NS |
| | EL/EP | 0.92 | 0.96 | 0.06 | NS |
| | LB/EL | 1.84 | 2.57 | 0.12 | *** |
| | LW/LB† | 0.89 | 0.86 | | |
| | LW/EM | 1.50 | 2.13 | | |
| 1999 (MA) | | | | | |
| | N | 624 | 24 | | |
| | EP/EM | 0.99 | 0.96 | 0.02 | NS |
| | EL/EP | 0.94 | 0.91 | 0.05 | NS |
| | LB/EL | 1.98 | 2.76 | 0.14 | *** |
| | LW/LB† | 0.86 | 0.91 | | |
| | LW/EM | 1.59 | 2.21 | | |

† Raw data were not available for this analysis

**TABLE 4.** East Friesian direct and maternal effects for weaning weight, dag score and fleece weight.

| | WWT | DAG1 | FW12 |
|---|---|---|---|
| EF direct | 7.6 | -1.48 | -1.32 |
| EF maternal | 3.6 | 0.38 | -1.24 |

Reproductive data were only available for COOP and EFxC ewes. In both the 1998 and 1999 years, breed differences were not significant for EP/EM or EL/EP (Table 3). EFxC ewes had significantly higher LB/EL as two-tooths and four-tooth ewes (1998 and 1999 data, respectively). Two-tooth EFxC ewes produced 0.73 ± 0.12 (P<0.001) more LB/EL than their purebred COOP contemporaries. One year later, the EFxC ewes produced 0.78 ± 0.14 (P<0.001) more LB/EL than the COOP ewes. EFxC and COOP ewes appears to have similar average LW/LB for both two-tooth and mixed-age ewes, although the individual data were not available to analyse this. The overall result was an increase of 0.63 and 0.62 LB/EM as a result of crossing EF rams with COOP ewes in two-tooth and four-tooth ewes, respectively, compared to their COOP contemporaries.

## DISCUSSION

Results from first-cross EF progeny in the NZ industry from the 1992 EF importation have indicated that there were advantages in both live weight and carcass traits, albeit at the expense of wool production (Allison, 1995; Jopson *et al.*, 1999). Results of the present study are consistent with these reports, with the addition of EF genes in an improved Coopworth flock resulting in an improvement in the average performance in WWT, LW6, live weight adjusted GR and C, no change in live weight adjusted EMD and a decrease in FW12. Differences in host resistance to internal parasites were not significant. Heterosis effects could be estimated by comparing differences in the F1 and backcross progeny, but the estimates would be expected to be unreliable given the low number of animals. The likely magnitude of the heterosis effects could be predicted from averages of published estimates over a number of across-breed studies (using half of the estimates from Clarke (1982) as COOP is a Romney x Border Leicester). The expected level of heterosis for WWT, LW6, and FW12 used (as a proportion of the mean) were 2.7, 4.3, 6.2 %, respectively. Given these figures for heterosis, the proportion of the difference between the EFxC and pure COOP explained by heterosis was 34.0, 39.8 and 34.9 for WWT, LW6 and FW12, respectively. There are few reports of heterosis in carcass fat depths for sheep. Evidence across species indicates that heterosis is generally small and positive, but the significance varies from study to study (Serra *et al.*, 1992; Teehan, 1974), so heterosis effects were ignored for GR and C. No published estimates of heterosis for dag score were available.

The results for the juvenile traits of the maternal and paternal quarter EF crosses were more variable, with few consistent trends. Only WWT, DAG1 and FW12 were significantly different between breed crosses. In each trait, one of the quarter EF crosses performed at the same level as the half EF and the other cross at the same level as the COOP, but for dag score, inheriting EF genes from the paternal side gave the same performance as the half EF and for WWT and FW12 the maternal EF genes resulted in the same performance as the half EF. The direct and maternal EF effects derived for WWT, DAG1 and FW12 are presented in Table 4. The EF maternal effect for WWT was 3.6kg, presumably a consequence of the superior milk production in EF ewes (Allison, 1995). For DAG1, the EF direct effect was for less dags (-1.48 dag score units), but the maternal effect was 0.38 score units. While this is positive, the effect is not significant. For FW12, both the EF direct and maternal effects were negative. It is difficult to account for the negative EF maternal effect on FW12, but the fact that only 1 EFxC sire was used means that all of the EF maternal effects should be interpreted with caution.

Data have not been available until now to test any improvement in prolificacy. The data in the present study suggest that EF genetics do improve prolificacy by between 0.73 and 0.78 LB/EM. Based on published data across breeds, average heterosis in ewe prolificacy for EF - COOP crosses was estimated at 4.1%. This equates to heterosis accounting for 0.14 of the difference between the COOP and EFxC ewes. Some of the differences in ewe prolificacy may have been due to differences in ewe live weight. Each kilogram difference in live weight between the breeds theoretically increases the proportion of ewes with multiple ovulations by 0.02 (Smith *et al.*, 1983) or the number of lambs born by approximately 0.01. The difference in prolificacy can not be accounted for by differences in adult ewe live weight alone as a difference 50 to 60 kg would be needed on the basis of the above figures. The economic value of this improvement in prolificacy is approximately $14.60 per ewe lambed in an average New Zealand flock with approximately 1.20 LB/EL (Amer *et al.*, 1999). Amer *et al.* (1999) indicated that the value of the improvement was almost zero when the flock LB/EL was already around 1.8 because LB/EL over 2.3 resulted in undesirable increase in quadruplets. However, it would appear from this study that breed may well influence the economic value as EFxC dams weaned more lambs per ewe than COOP dams under the same management system.

The comparisons made in this paper indicate that, on average, the use of EF rams will improve performance in growth, reduce dagginess, carcass fatness and fleece weights. Use of the cross-bred ewes as replacements in the flock will also significantly improve prolificacy. Previous work with EFxC and COOP animals has shown that the within-breed variation is greater than the between-breed variation (Jopson *et al.*, 1999), and the same was true in this study (results not presented). Traditional quantitative genetic selection must be used to identify the higher-performing EF sires that will introduce the improved performance into existing Coopworth flocks.

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