GENETIC PARAMETERS IN 6-MONTH BREEDING SYSTEMS

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INTRODUCTION

Genetic improvement of reproductive efficiency has been attempted by many. Results of these attempts have been variable, mainly due to the low heritabilities of reproductive traits. Matos *et al*. (1997) reported an adjusted heritability of 0.17 for fertility in Finnsheep. Lee *et al*. (2000) reported a heritability of 0.06 for number of lambs born. Composite breeds may provide increased genetic variance in low heritability traits (Smith *et al*., 1979).

Genetic parameters are necessary for construction of selection indexes and for understanding of the complex associations among important traits. Objectives of this study were to obtain estimates of overall and within breed heritabilities, overall and within breed genetic correlations and their standard errors. Further, conception rate for dry and lactating ewes may be viewed as two separate traits. Hence, the genetic correlation between conception rates in dry and lactating ewes was obtained.

MATERIALS AND METHODS

Data were collected from fall 1984 to fall 1989 on 9419 lambs produced by 2 334 ewes and 257 rams at the U.S. Meat Animal Research Center, Clay Center, NE. The experiment consisted of five cycles. About 100 ewes of Dorset, Finnsheep, Composite I (0.50 Finnsheep, 0.25 Dorset, 0.25 Rambouillet) and Composite II (0.50 Finnsheep, 0.25 Suffolk, 0.25 Targhee) were assigned to each breeding schedules. Ewes were exposed for 32 d starting on August 13 and February 5 for schedule I, on September 15 and March 10 for schedule II, and on October 22 and April 11 for schedule III. A report on this experiment described management practices, defined traits and gave detailed description of data collection (Pala *et al*., 2001).

Within breed heritabilities were estimated for conception rate, litter size at birth, litter weaning weight, litter weaning weight per ewe exposed, weaning weight and weaning weight adjusted for conception rate. Data were analyzed with a derivative-free algorithm (Smith and Graser, 1986 ; Graser *et al*., 1987) using MTDFREML (Boldman *et al*., 1995). In addition, SAS V8 (SAS Institute Inc., 1999) was used for bootstrapping. REML procedures executed by SAS (1999) did not involve the relationship matrix.

Fixed effects included lactation stress (no stress, 1 lamb, 2 lambs, 3 lambs), age of ewe (1, 2, 3, 4, 5 and older), breed (dorset, finnsheep, composite I, composite II), cycle (1, 2, 3, 4, 5), season (fall, spring) and schedule (1, 2, 3) for conception rate, litter size at birth, litter weaning weight, litter weaning weight per ewe exposed, weaning weight and weaning weight adjusted for conception rate. Lactation stress was used only for conception rate and litter size analyses. Heritability estimates for conception rate were adjusted to heritability in normal scale using the equation suggested by Dempster and Lerner (1950).

Standard errors for heritability of conception rate were calculated using bootstrapping with REML including the relationship matrix and without the relationship matrix. Also, they were

calculated with classical REML method, including the relationship matrix. The bootstrap procedure involved 50 bootstrap samples. Bootstrap samples were prepared using macros in SAS (1999) and analyzed using both MTDFREML (Boldman *et al*., 1995) and SAS (1999).
Genetic correlations between lactating and dry ewes for conception rate and litter size was calculated using the following equation :

$$r_g = \sigma^2_S / [\sigma^2_S + \sigma^2_{S*ENV} - \text{var}(\sigma_{SI})] \quad (1)$$

where σ^2_S is the sire variance component and σ^2_{S*ENV} is the sire by environment (lactating or dry) component and Var(σ_{SI}) is the variance of sire standard deviations within each environment (lactating or dry).
Overall and within breed spearman rank-order correlations (Spearman, 1904) between conception rate and litter weaning weight, conception rate and litter weaning weight per ewe exposed, litter size and litter weaning weight, and litter size and litter weaning weight per ewe exposed were calculated. Standard errors were calculated using 50 bootstrap samples (Efron, 1982).

RESULTS AND DISCUSSION

Heritabilities were calculated (table 1) using REML procedures (Boldman *et al*., 1995). Smith *et al*. (1979) reported that composite breeds may have increased heritabilities due to either higher genetic variance or lower environmental variance. Heritabilities for litter weaning weight and litter weaning weight per ewe exposed were similar across breeds and ranged from 0.31 to 0.36. Overall heritability for litter weaning weight (0.33 ± 0.02) was approximately the same as that for litter weaning weight per ewe exposed (0.35 ± 0.01).

Table 1. Overall and within breed heritabilities

	Breed					
Item	Dorset	Finnsheep	*Composite I*	Composite II	Overall	SE[d]
Litter weight	0.33	0.33	0.33	0.36	0.33	0.02
Litter/exp[a]	0.35	0.35	0.31	0.35	0.35	0.01
Weaning weight	0.65	0.41	0.57	0.41	0.64	0.01
ww/c[b]	0.34	0.37	0.60	0.37	0.64	0.01
Conception rate[c]	0.17	0.20	0.27	0.24	0.24	0.01
Litter size	0.08	0.19	0.14	0.13	0.16	0.01

[a] Litter weaning weight per ewe exposed.
[b] Weaning weight adjusted for conception rate.
[c] Adjusted to normal basis according to Van Vleck (1972).
[d] Pooled standard error based on most conservative number in a breed group.

Heritability for weaning weight was higher for Dorset than for Composite I. Finnsheep and Composite II had similar heritabilities which were lower than that for Composite I. Overall heritability estimates for weaning weight and weaning weight adjusted for conception rate were the same, 0.64 ± 0.01.
Heritabilities adjusted to normal scale for conception rate were highest for Composite I and for Composite II. Finnsheep and Dorset had lower heritabilities. Overall heritability estimate for conception rate in binary scale was 0.17. Adjustment of the estimate to normal scale resulted in

an estimate of 0.24. Matos *et al*. (1997) reported an adjusted heritability estimate of 0.17 for fertility in Finnsheep. Heritability of conception rate estimated using REML (Boldman *et al.,* 1995) was 0.17 ± 0.011 (binary scale). Fifty bootstrap samples yielded a standard error of 0.016. Heritability calculations with SAS (method=REML) resulted in h^2= 0.08 (binary scale). The standard error calculated using 52 bootstrap samples was 0.019, which was higher than the two previous numbers.

Heritability estimates for litter size (0.08 to 0.19) were lower than heritabilities of weight traits. Lee *et al*. (2000) reported that the heritability for number of lambs born was 0.06.

Genetic correlation between conception rates in dry and lactating ewes was 0.009 ± 0.026. The small correlation estimate is an indication of inconsistent rank of sires under different environments. Genetic correlation between litter sizes in dry and lactating ewes was 0.108 ± 0.018, which is a small estimate also. Selection should be practiced among lactating animals for conception rate and litter size.

Spearman rank-order correlations between conception rate and litter weaning weight, conception rate and litter weaning weight per ewe exposed, litter size and litter weaning weight, and litter size and litter weaning weight per ewe exposed were calculated (table 2). Overall correlations were high and favorable, indicating those traits can be improved together in a 6 month lambing program. Spearman rank-order correlation between conception rate and litter weaning weight was 0.83 ± 0.01. Litter size had high correlations with the litter weaning weight traits also. This suggests that litter weaning weight can be increased along with conception rate and litter size in a selection program. Correlations between litter size and litter weight traits were higher than correlations between conception rate and litter weight traits. Al-Shorepy and Notter (1996) reported a genetic correlation between spring fertility and fall litter size per ewe lambing of 0.56. All correlations were consistent within breed and overall. They were highest for Dorset and lowest for Finnsheep. Composite II ranked higher than Composite I for conception and litter weight traits correlations while Composite I surpassed Composite II for correlations between litter size and litter weight traits. Selecting for these traits together can be useful for all the breeds used in this study.

Table 2. Overall and within breed genetic correlations

	Breed				
Item	Dorset	Finnsheep	*Composite I*	Composite II	Overall
Conception and litter weaning weight	0.825 ± 0.005	0.830 ± 0.005	0.856 ± 0.006	0.810 ± 0.009	0.834 ± 0.003
Conception and Litter/exp[a]	0.825 ± 0.005	0.830 ± 0.005	0.856 ± 0.006	0.810 ± 0.008	0.834 ± 0.003
Litter size and litter weaning weight	0.850 ± 0.005	0.843 ± 0.007	0.883 ± 0.008	0.815 ± 0.009	0.850 ± 0.004
Litter size and Litter/exp[a]	0.850 ± 0.005	0.843 ± 0.008	0.883 ± 0.007	0.815 ± 0.011	0.859 ± 0.003

[a]Litter weaning weight per ewe exposed ; litter weights multiplied by their respective breed conception rates.

CONCLUSION

Heritability estimates indicated that selection in 6-month lambing programs is feasible. Litter weaning weight may be increased along with conception rate and litter size in a selection program based on 6 month lambing. Small genetic correlation between dry and lactating ewes indicated that grouping sires according to the lactation status of the ewes is necessary in a selection program.

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