EWE AND LAMB EFFECTS ON LAMB BIRTH WEIGHT AND GROWTH RATE IN WEANING WEIGHT SELECTION LINES

G.N. HINCH, C.J. THWAITES and T.N. EDEY

SUMMARY

Lambs from divergent weaning weight selection lines, born and reared by their own dams, carried and reared by unselected embryo recipient dams or reared artificially, were used to assess ewe and lamb effects on birth weights and pre-weaning growth rates. Both birth weight and growth rate appear to be influenced to a large extent by direct lamb effects with the maternal contribution being relatively less important.

(Keywords: weight selection, lambs, birth weight, preweaning growth, rearing effects).

INTRODUCTION

Selection for increased weight and consequently mature size is a common practice in animal species throughout the world. However little is known about the influence of such selection on the relative contributions of direct and maternal effects on birth weight and preweaning growth.

This paper examines the effects on birth weight and preweaning growth rate of lambs of vastly different mature size; of rearing lambs on their own dams or on foster mothers of another genotype or by artificial rearing.

METHODS

A mixed age flock of Merino ewes from divergent weaning weight selection lines (Pattie 1965) was used in this study. The ewes were from three lines, selected over 12 generations for high (Weight plus) and low (Weight minus) weaning weight and a random-bred control (C) line.

In February 1984 sub-groups of 30 ewes from each of the Weight plus (W+) and Weight minus (W-) lines were used as donor ewes in an embryo transfer program. One or two embryos of similar genotype (W+ or W-) were transferred to unrelated Merino recipient dams (R). The recipient ewes were chosen at random from a mature age (3-6 years) flock in which the ewes were of similar weight to the Weight plus selection line ewes (Table 1).

One oestrous cycle after embryo transfer, selection line ewes (W+, W-, C) were joined to sires of their own genotype for three cycles after sponge withdrawal. Joining date was recorded for all ewes. All ewes from both recipient and selection flocks were run on improved pastures with sorghum grain supplement (300 g/d) during the last six weeks of pregnancy.

At lambing, lambs were weighed, date of birth recorded and gestation length determined. A sub-group of lambs from each of the selection lines (W+, W-, C) was taken from their dams and reared artificially to 6 weeks of age. Lambs from the recipient flock and the balance of the selection flocks were reared by their dams until weaning at 10 weeks of age. All ewes grazed ad libitum on phalaris/white clover pastures during the post partum period.

Department of Animal Science, University of New England, Armidale, 2351, N.S.W. Australia
Lambs were weighed at approximately fortnightly intervals from birth to weaning and milk intakes of artificially reared lambs were recorded. Milk production of ewes was assessed by weekly machine milking as described by Heath et al. 1984.

Analyses

Lamb birth weights and growth rates to 40 or 70 days were analysed using a least squares model incorporating lamb genotype, litter size, lamb sex, rearing category and ewe weight or birth weight as covariates for birth weight and growth rate analyses respectively. Date of birth was not included in the overall model as it was confounded with rearing group.

RESULTS AND DISCUSSION

The mean ewe joining weights and number of ewes included in this study are shown in Table 1, along with total milk production levels assessed at 40 days of lactation. Least square means for gestation length, birth weight and growth rates of lambs to 40 and 70 days are also shown in Table 1.

Table 1 Least square means and standard errors for ewe live weights and gestation lengths and lamb birth weights, preweaning growth rates and estimated milk intakes from different rearing x lamb genotype categories

<table>
<thead>
<tr>
<th>Rearing Ewe/Method</th>
<th>W+</th>
<th>W-</th>
<th>C</th>
<th>R</th>
<th>R</th>
<th>AR</th>
<th>AR</th>
<th>AR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamb Genotype</td>
<td>W+</td>
<td>W-</td>
<td>C</td>
<td>W+</td>
<td>W-</td>
<td>W+</td>
<td>W-</td>
<td>C</td>
</tr>
<tr>
<td>Ewe Joining Weight (kg)</td>
<td>44.2</td>
<td>32.3</td>
<td>36.9</td>
<td>43.9</td>
<td>44.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.33</td>
<td>0.41</td>
<td>0.24</td>
<td>0.42</td>
<td>0.49</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of Ewes</td>
<td>56</td>
<td>19</td>
<td>86</td>
<td>26</td>
<td>19</td>
<td>29</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Gestation Length (days)</td>
<td>148.4</td>
<td>147.0</td>
<td>147.8</td>
<td>148.1</td>
<td>147.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.19</td>
<td>0.39</td>
<td>0.17</td>
<td>0.28</td>
<td>0.29</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Estim. Milk Intake to 40 days (l)</td>
<td>45</td>
<td>42</td>
<td>40</td>
<td>69</td>
<td>59</td>
<td>65</td>
<td>61</td>
<td>59</td>
</tr>
<tr>
<td>Birth Weight (kg)</td>
<td>4.10</td>
<td>3.42</td>
<td>3.65</td>
<td>4.23</td>
<td>3.66</td>
<td>2.77</td>
<td>3.25</td>
<td>3.66</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.085</td>
<td>0.978</td>
<td>0.059</td>
<td>0.988</td>
<td>0.071</td>
<td>0.988</td>
<td>0.991</td>
<td>0.987</td>
</tr>
<tr>
<td>Growth Rate to 40 days (g/d)</td>
<td>263.6</td>
<td>205.6</td>
<td>233.1</td>
<td>277.7</td>
<td>225.2</td>
<td>225.5</td>
<td>170.1</td>
<td>188.3</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.71</td>
<td>1.98</td>
<td>0.63</td>
<td>1.15</td>
<td>1.34</td>
<td>1.43</td>
<td>2.19</td>
<td>1.70</td>
</tr>
<tr>
<td>Growth Rate to 70 days (g/d)</td>
<td>208.0</td>
<td>153.8</td>
<td>175.2</td>
<td>308.8</td>
<td>234.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S.E.</td>
<td>1.04</td>
<td>1.65</td>
<td>0.82</td>
<td>0.97</td>
<td>1.35</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* W+, Weight plus; W-, Weight minus; C, Control; R, Recipient dam; AR, Artificially reared.

Birth weight

There were significant differences between lamb genotypes in birth weights, Weight plus lambs being heavier than Weight minus and Control lambs (P<0.001). Within ewe genotypes the Weight minus lambs born to recipient dams (R, W-) were not significantly heavier (6.5%, P<0.10) than those born by their own genotype ewes (R, W+). Lambs in recipient ewes (R, W+) were not significantly heavier (4.6%) than lambs born to their own genotype dams (W+, W+).

There were significant differences between singles (3.83 kg) and twins (3.42 kg) in birth weight (P<0.001), while the difference between males (3.85 kg) and
females (3.63 kg) was not significant (P<0.10). The influence of ewe weight on
birth weight, although significant (P<0.001) did not alter the pattern of other
effects, the complete model explaining only 39.2% of variation in birth weight; of
this 18.2% was explained by lamb genotype, 5.8% by maternal effects and 9.5% by
sex and litter size.

Since the early embryo transfer studies of Hunter (1956) and Dickinson et
al. (1962) little has been done to examine the relative contribution of maternal
and lamb genotypes to birth weight. In the between-breed comparisons conducted by
these authors they concluded that the relative contribution was much weighted to
the lamb. In this present study, where lambs of similar breed but different
mature size were used, a similar conclusion arises, birth weight being largely
determined by lamb breed rather than maternal environment.

The mechanisms which may contribute to this are unclear but appear not to be
attributable to changes in gestation length (Table 1) as reported for inter-breed

**Growth rates**

Lamb genotype differences in growth rate were evident at both 40 and 70 days
of age (P<0.001). Lambs of the Weight plus genotype grew faster than Control
lambs which in turn grew faster than Weight minus lambs. There was a significant
effect of rearing category (P<0.001) at both 40 and 70 days. To 40 days lambs
reared by recipient dams tended to have greater growth rates than lambs reared by
their own dams (P<0.10) which in turn grew faster than artificially or twin reared
lambs (P<0.05). At 70 days the difference between growth rates of recipient and
own genotype-reared lambs was significant (30.8, 34.5% respectively) for both
Weight plus and Weight minus lambs (P<0.01). The growth rates of own genotype
reared lambs declined markedly between 40 and 70 days (23.7% singles, 17.1% twins)
while for recipient reared lambs changes in growth rate were small (5-9%).

The effect of birth weight on growth rate was significant (P<0.001) at both
40 and 70 days. However the effect did not alter the pattern for other factors
except to render the effects of litter size and sex at 70 days not significant.
The complete model explained some 45.2% of variation in growth rate to 40 days and
75.9% to 70 days.

If artificial rearing was excluded from the model the majority of variation
in growth rate to 40 days was attributable to lamb effects (29.3%) with rearing
effects explaining only 10% of variation. With artificial rearing included in the
model, 23.3% of variation is attributable to lamb effects and 13.5% to rearing.
At 70 days 34.4% of growth rate variation is attributable to lamb genotype and
35.4% to rearing.

In his review of maternal effects on growth in sheep, Bradford (1972)
concluded that about half of the response to selection for weaning weight is
associated with improved milk production, a conclusion also reached by Barlow
(1978) in his review on cattle. However to a large extent the conclusion of
Bradford (1972) was based on a study of Yates and Pattie (1970) on crossbred lambs
born to ewes from weaning weight selection lines. Our data from the same
selection lines after a further seven generations of selection, suggest that some-
what more than 50% of the difference between lines may be attributable to direct
effects of the lamb. This is shown by the fact that the relative and absolute
differences between lines change little with different rearing systems. This
effect is evident over a wide range in growth rates to 40 days, the optimal time
for determination of maternal effects (Gjedrem 1967).
At 70 days rearing effects appear to be equal to direct lamb effects. However this may have been due in part to the confounding of rearing and seasonal effects, the earlier born recipient reared lambs having access to better quality pasture over the later part of the growth period (40-70 days) than the own genotype-reared lambs. This is supported by the greater-drop (13%) in growth rates which occurred for the own genotype-reared lambs compared with the recipient reared animals.

The wide range in growth rates observed make partitioning of maternal effects difficult as the original design assumed that artificial rearing on ad libitum milk would have resulted in optimal "maternal" conditions for the expression of lamb growth. The lower growth rates attained by artificial rearing may have been associated with behavioural problems but also it seems likely that low concentrations of dry matter may have contributed to this as very high fluid intakes were recorded (Table 1) with low efficiency of gain.

Whatever the cause of these depressed growth rates, the relative growth rates of the genotypes remain consistent and the data suggest that direct genetic makeup of the lamb contributes somewhat more than 50% of the differences between selection lines as originally suggested by Yates and Pattie (1970).

CONCLUSION

The relative contribution of ewe and lamb effects to birth weight and pre-weaning growth rate differences between divergent weaning weight selection lines have been examined. Direct lamb effects are the predominating influence on birth weight while for preweaning growth rate direct lamb effects appear to explain somewhat more than 50% of the differences between lines. Further studies of these lines, including partial or complete diallel crosses, should allow the more accurate quantification of maternal effects on these two "growth" traits.

REFERENCES