INTERRELATIONSHIPS BETWEEN PRODUCTIVITY AND FERTILITY IN DAIRY COWS

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SUMMARY

Eighty eight Friesian cows and heifers were fed one of four complete diets based on maize silage and containing increasing levels of grain (from 0 to 500 g DM/kg diet DM), in two trials. Days from calving to first observed oestrus and to conception were recorded as were yields of milk and milk fat and live weight changes during early lactation. In the second trial, complete lactation data were recorded on all 46 animals.

Animals fed diets high in grain were more productive but required more inseminations per conception. Non-pregnant animals produced over 3 l/day more milk during early lactation and over 900 1 more milk (or 40 kg more milk fat) over the complete lactation than did pregnant animals.

INTRODUCTION

The management of high yielding dairy cows must consider reproduction as well as nutrition, disease and milk harvesting. From surveys in the U.K., Esslemont (1979) concluded that maximum annual milk yields came from herds with calving intervals ranging from 330 to 360 days. However in intensively managed dairy herds, the mammary gland takes priority over the reproductive system. A 35 year survey in the U.S. clearly showed the negative association between milk yield and conception rate in lactating cows (Butler and Smith 1979).

The threshold of herd productivity above which fertility is likely to be adversely affected would vary with the genetic makeup of the cow population. Esslemont (1979) cites Israeli studies suggesting this to be 8500 l/cow whereas he suggests a more realistic level in Europe is 7000 l/cow. In feedlot trials at Kyabram, Moran and Trigg (1989) and Moran (unpublished data) recorded lactation yields of up to 7600 l fat corrected milk (FCM) or 350 kg milk fat per cow. Fertility observations made on these animals and their interrelationships with productivity are reported below.

MATERIALS AND METHODS

The Kyabram Friesian herd were upgraded over the last 20 years from a Jersey base and would be typical of many dairy herds in Victoria. Friesian heifers (in their first lactation) and cows (in their second or later lactations) were fed ad libitum in two trials on complete diets based on maize silage, lucerne hay, cottonseed meal, urea and minerals with increasing levels of grain (a mixture of rolled wheat and whole oats) in two trials during 1983 and 1984. Four diets were fed in each trial with grain levels increasing from 0 to 162 to 325 to 487 g DM/kg diet DM in Trial 1 and from 0 to 164 to 332 to 502 g DM/kg diet DM in Trial 2; these were designated Diets A, B, C and D with increasing grain level. Trial 1 involved 24 heifers and 18 cows fed from 45 to 101 days post-partum during autumn. Trial 2 involved 12 heifers and 34 cows fed from 48 to 146 days post-partum (early lactation) and for their complete lactation commencing in spring. Full details of diets, research methodology, together with dietary effects of production are presented by Moran and Trigg (1989).

All 88 animals were artificially inseminated on the first heat after calving. The interval between calving and first observed oestrus was recorded-together with the number of inseminations per successful conception. For the 67 animals

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that conceived within 180 days post-partum, the time interval between first
observed oestrus and conception was recorded.

The data were analyzed using the GENSTAT statistical package (Numerical
Algorithms Group 1983). Three sets of analyses were conducted using linear
models which included the following factors:

\[ TR, \text{ trial, two levels for Trial 1 and 2.} \]
\[ PA, \text{ parity, two levels for heifers and cows.} \]
\[ PR, \text{ pregnancy status, two levels for pregnant and non-pregnant.} \]

The following continuous variables were also simultaneously regressed:

\[ GR, \text{ grain content (\%)}. \]
\[ FY, \text{ milk fat yield during early lactation (kg/day)}. \]
\[ LWC, \text{ live weight change during early lactation (kg/day)}. \]
\[ BCC, \text{ body condition score change in Trial 2 (units/14 weeks)}. \]

The first analysis of fertility data was the following model:

\[ Y = a + b \cdot TR + c \cdot PA + d \cdot PR + e \cdot FY + g \cdot LWC \]

where \( Y \) was either time interval between calving and first observed oestrus or
between first observed oestrus and conception (days).

The second analysis of production data was the following model:

\[ Y = a + b \cdot TR + c \cdot PA + d \cdot PR + e \cdot GR + f \cdot GR^2 + g \cdot LWC + h \cdot LWC \times PA \]

where \( Y \) was either yield of FCM or milk fat during early lactation (kg/day).

The third analysis of production data in Trial 2 was the following:

\[ Y = a + b \cdot PA + c \cdot PR + d \cdot GR + e \cdot GR^2 + f \cdot LWC + g \cdot LWC \times PA + h \cdot BCC \]

where \( Y \) was either yield of FCM or milk fat over the complete lactation (kg).

For the three analyses, the partial regression coefficients (and standard
errors) of levels of each factor and of each continuous variable were
calculated. The significance of including factors and variables in consecutive
order was determined by changes in the residual mean square in the
corresponding analyses of variance. The final models only contained
statistically significant (\( P < 0.05 \)) partial regression coefficients.

RESULTS

The two time intervals in the first model had normal distributions thus
validating the least squares analyses carried out in the linear model. With
the exception of \( TR \), there were no significant effects of factors or variables
on either days from calving to first oestrus or days from first oestrus to
conception; average values (and standard errors) for Trials 1 v 2 were 30(\pm 3)
v 42 (\pm 3) days and 50 (\pm 5) v 77 (\pm 4) days respectively.

Animals fed Diets C and D produced more milk fat during early lactation than
those fed Diets A and B (0.90 v 0.79 kg/day) but required more inseminations
per conception (1.9 v 1.3); both these differences were statistically
significant (\( P < 0.05 \)). It is of interest to note that of the seven-cows
producing more than 290 kg milk fat for their entire lactation, five failed to
conceive within 180 days post-partum.
The linear models for production during early lactation contained significant coefficients as follows:

**FCM yield:** \[ Y = 19.8 - 4.2(\pm 0.9) \text{ PA} + 0.30(\pm 0.07) \text{ GR} - 0.004(\pm 0.001) \text{ GR}^2 + 3.1(\pm 1.0) \text{ PR} - 4.6(\pm 1.8) \text{ LWC} \]
\[ r^2 = 0.48 \text{ r.s.d.} = 3.6 \]

**Milk fat yield:** \[ Y = 0.83 - 0.17(\pm 0.04) \text{ PA} + 0.014(\pm 0.003) \text{ GR} - 0.0002(\pm 0.0001) \text{ GR}^2 + 0.13(\pm 0.04) \text{ PR} - 0.25(\pm 0.08) \text{ LWC} \]
\[ r^2 = 0.47 \text{ r.s.d.} = 0.16 \]

The linear models for production over complete lactations contained significant coefficients as follows:

**FCM yield:** \[ Y = 4983 - 714(\pm 320) \text{ PA} + 21(\pm 7) \text{ GR} + 913(\pm 340) \text{ PR} \]
\[ r^2 = 0.27 \text{ r.s.d.} = 951 \]

**Milk fat yield:** \[ Y = 212 - 27(\pm 14) \text{ PA} + 0.9(\pm 0.3) \text{ GR} + 39(\pm 15) \text{ PR} \]
\[ r^2 = 0.25 \text{ r.s.d.} = 42 \]

Table 1 presents the yields of cows and heifers in different physiological status when fed the same diet (containing 240 g grain DM/kg diet DM) and with the same live weight gain during early lactation (0.19 kg/day). Non-pregnant cows produced 14% and non-pregnant heifers produced 17% more FCM and milk fat during early lactation than their pregnant counterparts while corresponding values for complete lactation were 17% and 19% respectively. All these differences were statistically significant (P<0.05).

<table>
<thead>
<tr>
<th>Yield of</th>
<th>FCM</th>
<th>Milk fat</th>
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<tbody>
<tr>
<td></td>
<td>Pregnant</td>
<td>Non-pregnant</td>
</tr>
<tr>
<td><strong>Early lactation (kg/day)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow</td>
<td>22.3(0.6)</td>
<td>25.4(0.9)</td>
</tr>
<tr>
<td>Heifer</td>
<td>18.2(0.7)</td>
<td>21.3(1.0)</td>
</tr>
<tr>
<td><strong>Complete lactation (kg)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow</td>
<td>5504(177)</td>
<td>6417(316)</td>
</tr>
<tr>
<td>Heifer</td>
<td>4790(287)</td>
<td>5703(379)</td>
</tr>
</tbody>
</table>

Table 1 Predicted yields of fat corrected milk (FCM) and milk fat (with standard errors) in cows and heifers of different pregnancy status during early or complete lactations.
DISCUSSION

Although productivity did not differ between trials, animals took longer to cycle and conceive in Trial 2. Calving intervals averaged 11.9 months in Trial 1 and 13.3 months in Trial 2. The lack of effect of milk fat yield on days to first heat is in agreement with Butler and Smith (1989) who noted the correlation between milk yield and days to first ovulation to be significant only after 40 days when most cows would have already ovulated. However they did conclude that high milk yields impair conception rates through delays or failure of early resumption of ovulation in the post-partum period.

Production had an adverse effect on fertility (or vice versa) in that pregnant animals produced significantly less milk and milk fat and that high yielding cows had lower conception rates at six months post-partum. herd fertility is influenced by current nutrition, cow condition, milk yield potential, current milk yield and live weight change. Because of these complex interrelationships, Esslemont (1979) noted that in only half of the studies cited, was there a significant association between yield and fertility. Furthermore, many of these interactions would have a threshold effect, hence multiple regression analyses, which assume linear responses, would underestimate their predictive values. For example, Ducker et al. (1985) reported conception rates in heifers to fall from 0.64 to 0.28 once they produced more than 20 1 milk/day.

In a subsequent trial involving 24 lot fed cows yielding between 4200 and 7650 kg FCM (Moran unpublished data), of the five cows yielding more than 7000 kg FCM, or 320 kg milk milk fat, three failed to conceive within six months post-partum. Moate and Harris (1983) surveyed 1200 cows in Victoria, finding conception rates to first services decreasing from 0.58 to 0.48 once their early lactation milk fat yields exceeded 1 kg/day. On the other hand, Fulkerson (1985) surveyed 2800 cows in Tasmania finding that less cows returned to service within 21 days as milk fat production increased up to 1 kg/day; above 1 kg/day, there was a decline in fertility. Clearly these cows were underfed in early lactation to such an extent that production and reproduction were both sub-optimal.

Once feeding management during early lactation is improved sufficiently for milk fat yields to approach 1 kg/day, it would appear that greater attention should be placed on reproductive management. If such animals fail to conceive, nutritional demands later in lactation will be reduced as foetal development will not take place. In this study non-pregnant animals were found produce up to 900 1 more FCM or 40 kg more milk fat over a complete lactation than their pregnant herd mates.

REFERENCES