EFFECT OF AGE AT TEST, STAGE OF LACTATION AND GESTATION ON MILK YIELD IN DAIRY BREEDS AND IMPLICATIONS FOR GENETIC EVALUATION

M. Haile-Mariam\textsuperscript{1}, L. Jones\textsuperscript{2} and K. Beard\textsuperscript{2}

\textsuperscript{1}ILFR, The University of Melbourne, 3010; \textsuperscript{2}DPI and ADHIS, Attwood, Vic 3049

SUMMARY
Test day milk yield of Holstein-Friesian (HF), Jersey (J), Red breeds, HF-J crosses and Guernsey were analysed to determine if correction for stage of gestation on milk yield is necessary. The effect of stage of gestation on milk yield is least in the smaller dairy breeds compared to the larger breeds such as HF. Results suggest that uniform correction factors for age at test, stage of gestation and lactation may not be appropriate to all the breeds. The Red breeds in particular were the least persistent, the most affected by stage of gestation and the lowest producers when they are young relative to their mature milk yield.

Keywords: stage of gestation, stage of lactation, milk yield, dairy breeds

INTRODUCTION
Genetic evaluation for milk yield traits in Australia is a two-step procedure. In the first step test-day milk yields are adjusted for difference in age at test, stage of lactation and herd-test-day effect. This is used to calculate test-day deviations for each cow which are then combined into a ‘lactation’ milk yield record which is analysed using an animal model (Jones and Goddard, 1990). Currently the same correction factors for stage of lactation are used for all breeds whereas different correction factors for age at test are used for the three main dairy breeds (Jersey, Holstein-Friesian and their crosses) to reflect difference in the rate of maturity. Currently there is no adjustment for stage of gestation. The objective is to assess if correction for stage of gestation is necessary when undertaking genetic evaluation for milk yield. The second objective is to determine if breed-specific correction factors should be applied for age at test, stage of lactation and gestation.

MATERIALS AND METHODS
Test day milk yield, calving and pedigree data of cows that calved between 1990 and 2002 were extracted from the ADHIS database. The average lactation length of the breeds varied from 302 in Jersey (J) to 309 days in Holstein-Friesian (HF). Test day data of cows sired by AI bulls were used for this study. In the case of HF, large herds with over 1000 test records were considered whereas all the available data were used in the other breeds. Tests before day 6 and after day 305 were excluded. The data structure and average test-day milk yield and covariates by breed is shown in Table 1.
Table 1. Structure of data for the different dairy breeds (standard deviations in parentheses)

<table>
<thead>
<tr>
<th>Breeds</th>
<th>No. cows</th>
<th>No. tests</th>
<th>Milk litres/day</th>
<th>Age at test (days)</th>
<th>Days in milk</th>
<th>Day of gestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF</td>
<td>83283</td>
<td>2960566</td>
<td>21.7(6.7)</td>
<td>1794(754)</td>
<td>149(83)</td>
<td>72(70)</td>
</tr>
<tr>
<td>Jersey</td>
<td>67543</td>
<td>1225836</td>
<td>15.0(5.3)</td>
<td>1417(536)</td>
<td>148(82)</td>
<td>72(69)</td>
</tr>
<tr>
<td>Red breed</td>
<td>19769</td>
<td>313285</td>
<td>17.5(6.8)</td>
<td>1655(667)</td>
<td>150(82)</td>
<td>70(68)</td>
</tr>
<tr>
<td>JxHF</td>
<td>39874</td>
<td>692986</td>
<td>18.5(6.7)</td>
<td>1720(736)</td>
<td>147(82)</td>
<td>72(68)</td>
</tr>
<tr>
<td>Guernsey</td>
<td>3804</td>
<td>52709</td>
<td>15.8(5.9)</td>
<td>1720(697)</td>
<td>151(83)</td>
<td>69(68)</td>
</tr>
</tbody>
</table>

Firstly, the HF data were analysed to determine if correction for stage of gestation is appropriate. This involved a two-step procedure similar to the current practice of ADHIS. In the first step test-day milk yields were analysed by fitting a random effect of cow, a fixed effect of age at test, herd test-day and days in milk to obtain solutions for cows. Test records of cows were considered as repeated observations. The solution for cows where days of gestation was fitted as a covariate was considered as a separate trait from the one where it is ignored. In the second step solutions for each cow were analysed in a bi-variate sire and animal models. The models fitted included sire or animal with all known relationships as random and herd-year-season of calving as fixed effect. From this analysis heritability, correlations between the traits (milk yield accounting for gestation stage and ignoring it) and breeding values were estimated. Secondly, to determine if different correction factors are appropriate for days in milk, age at test and stage of gestation, test-day data of the five breeds of cattle were analysed fitting these effects as covariates. In addition the fixed effect of year-season of calving and herd-test day and the random effect of cow and sire were fitted. Test-day yield of first parity HF cows were also used to see if stage of lactation is affected by calving season and State where the herd is located. Test-day yields within parity and parities within cow were considered as repeated records. All data were analysed using ASREML (Gilmour et al. 2000).

RESULTS AND DISCUSSION

When stage of gestation was accounted for by fitting it as a covariate the heritability of milk yield from sire and animal model analysis was 0.31 and 0.43, respectively. The parameter estimates did not change when stage of gestation is not fitted. The estimate from sire model analysis in the current study is in agreement with estimates reported by Haile-Mariam et al. (2003). Similarly the environmental and genetic correlations between the two traits was above 0.99 both from the sire and animal model analyses. However, the breeding value of eight sires out of the top ten changed ranks by at least one when stage of gestation was included compared to ignoring it. Correction for stage of gestation is recommended since the value of a bull’s semen and its degree of use will be greatly influenced on whether he ranks first or second among his cohorts.
Figure 1 shows the effect of days in milk on daily milk yield of different breeds. Guernseys are not shown in the figures because effects were similar to Jersey and their numbers were small. Peak daily milk yield was reached at 33 days of milk in Guernsey and Jersey and at 34 days of milk in the other breeds. The daily milk yield of Red breeds was the least persistent whereas HF, Jersey and Guernsey have similar persistency level. At the end of lactation (305 days) the daily yield of HF, Jersey, Reds, crosses and Guernseys was 75, 76, 66, 72 and 72% of their yield at 150 days, respectively. Compared to the lactation curve of HF cows reported by Beard (1983) lactations of cows in the current study appear to be more persistent. The difference between States and season of calving (four seasons) in the lactation curve was small. The difference between parities was relatively large and as expected first parity cows showed more persistency than multiparous cows. However, the reliability of parity record of cows needs to be improved before parity-specific correction factors can be used.

The effect of days in gestation on daily milk yield is shown in Figure 2. Milk yield of Jersey is the least affected while milk yield of Red breeds is the most affected. The figure illustrates that daily milk yield starts to show some decline at about 100 days of gestation in all breeds except in Jersey. At 250 days of gestation HF, Jersey, Red breeds, HF-J crosses, and Guernseys were producing 69, 83, 66, 72, and 77%, respectively, compared to non-pregnant cows. These results are in general agreement with
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Sharma et al. (1990) and Bormann et al. (2001) who reported that the effect of days of gestation on milk yield is lower in Jersey than in HF cows. Although Coulon et al. (1995) did not notice differences between breeds, they reported that the effect of stage of gestation on milk yield is higher in high yielding cows compared to low producers. The difference in the effect of stage of gestation on milk yield between breeds may be related to the difference in size of foetus, foetal membranes, uterus and mammary gland (Bauman and Currie 1980).

The effect of age at test on daily milk yield is illustrated in Figure 3. Compared to seven-year old cows, two-year old HF, Jersey, Red breeds and HF-J crosses were producing 68, 77, 61 and 70%, respectively. Jersey and Red cows appeared to reach their maximum yield at about 4 years of age whereas HF and crosses attained their maximum yield about 2 years later. Figure 3 also shows that the daily milk yield of the Red breeds was the lowest in young cows and reached its maximum in 4-year olds and then declined slightly. This inconsistency is perhaps a reflection of the fact that the data on this breed are composed of 45% Illawarra, 26% Ayrshire and 29% the Australian Red.

The effect of days dry on milk yield as well as previous days open was examined in HF data. The effect of days dry showed that cows, which had about 65 days of dry period, had the maximum daily milk yield. Daily milk yield increased with the increase in the number of previous days open which is in agreement with observation of Bormann et al. (2001) working in the USA.

The effect of stage of gestation on milk yield is least in the smaller dairy breeds compared to the large breeds such as HF. The Red breeds in particular were the least persistent, the most affected by stage of gestation and the lowest producers when they were young relative to their mature production. This may be related in part to the selection history of the breeds. Difference in management level may also have contributed to these differences. The results suggest that uniform correction factors for age at test, stage of gestation and lactation may not be appropriate to all the breeds.

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REFERENCES