SUMMARY AND CONCLUSION

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Data of this study were collected from three dairy herds allocated at El-Gimmiza, El-Serw and Sids experimental stations. These stations belong to the Animal Production Reseasrch Institute, Agriculture Research Center, Ministry of Agriculture, Egypt. Three up-grading trials were carried out in these stations. Animals of Friesian trial (El-Gimmiza station) involved Friesian, Domiati and their crosses; those of Shorthorn trial (El-Serw station) included dairy Shorthorn, Domiati and their crosses and those of Jersey trial (Sids station) were Jersy, Domiati and their crosses. These three up-grading trials were used to quantify the heterotic components of direct additive effect (G^I), maternal additive effect (G^M), direct heterosis (H^I), maternal heterosis (H^M), direct recombination effect (R^I) and maternal recombiantion effect (R^M) for milk production traits and reproductive intervals in these trials. Records were collected over a period of 26 consecutive years started from 1950. Data of each crossbreeding trial were analysed separately using mixed model procedure. The traits included were initial 90-day milk yield (M90), 305-day milk yield (M305), total milk yield (TMY), lactation period (LP), dry period (DP), calving interval (CI), 305-day milk yield divided by calving interval (MCI1), total milk yield divided by calving interval (MCI2) and age at first (AC1) and second (AC2) calving. Results obtained could be summarized as follow:

I. Breed group means

In the three trials, breed group effects were mostly significant ($P<0.05$ or $P<0.01$ or $P<0.001$) and formed the most important source of variation in each separate lactation and across all lactations.

In separate lactations and in all lactations of Friesian trial, means of M90, M305, TMY, MCI1 and MCI2 generally increased with the increase of the proportion of Friesian blood from 1/2 to 15/16F. Means for lengths of LP and CI increased with the increase of Friesian blood, while inconsistent trend was found with DP. Age at first (AC1) and second (AC2) calving increased with the increase of proportion of Friesian blood from 1/2 to 7/8.

In separate lactations and across all lactations of Shorthorn trial, least-squares means for M90, M305, TMY, LP, MCI1 and MCI2 generally decreased with the increase of proportion of Shorthorn (S) blood from 1/2S to 7/8S and increased thereafter (i.e. for 15/16S). Least-squares means for CI increased with the increase of the proportion of Shorthorn blood from 1/2S to 7/8S while indefinite trend was observed for DP.

In Jersey trial, least squares means of most traits in separate lactations showed that no clear trend was detected with the increase of the proportion of Jersey blood (J) in the different genetic groups. Across all lactations, means of M305, TMY, MCI1 and MCI2 decreased with the increase of the proportion of Jersey blood from 1/2J to 15/16J. Means of different genetic groups for LP were approximately the same for all genetic groups, while means for DP showing a decreasing trend as the proportion of Jersey blood increase. For CI, no clear trend was observed.

The inter-se mating of 3/4F1/4D, 7/8F1/8D, 3/4S1/4D and 7/8S1/8D produced cows with better performance than the other grades. Sometimes, these grades of inter-se mating had superior (or approached) performance when compared to the exotic paternal purebreds (Friesian and Shorthorn). Breed-groups means, however, reveal that breed groups of Friesian trial ranked first for milk yield traits, then followed by those of Shorthorn trial and Jersey trial.

II. Direct (G^I) and maternal additive (G^M) effects

For milk production traits, foreign breeds (Friesian, Shorthorn and Jersey) always surpassed Domiati breed in their direct (G^I) and maternal (G^M) additive effects. For most traits, estimates of G^I and G^M in Friesian trial were higher than those of G^I and G^M in Jersey and Shorthorn trials. For DP, Friesian breed showed the lowest G^I and G^M, followed by Shorthorn and Jersey. Also, Friesian trial showed higher G^I and G^M for CI compared with Shorthorn and Jersey breeds. Among the three foreign breeds, Friesian recorded the lowest G^I and G^M for AC1 and AC2 than Jersey and Shorthorn.

III. Individual (H^I) and maternal (H^M) heterosis

In the three trials, direct heterotic superiority (H^I) of crossbred cows over their purebred parents are evidenced. In most milk production traits, Jersey trial showed higher estimates and percentage of H^I than Friesian and Shorthorn trials. Positive estimates of H^I for milk production traits ranged from 1.2 to 13.3% in Friesian trial, 1.0 to 26% in Shorthorn trial and 0.3 to 47.4% in Jersey trial.

Results of heterotic maternity (H^M) obtained in the three trials show that Friesian maternity for milk production and reproductive intervals ranked first, followed by maternities of Shorthorn and Jersey in a descending order. Estimates of H^M ranged from 3.7 to 23.3% in Friesian trial, 1.8 to 20.1% in Shorthorn trial and 5.0 to 43.5 in Jersey trial.

Estimates of H^M for most milk production traits (M90, M305, TMY, LP, MCI1 and MCI2) in up-grades of Friesian trial were generally higher than in up-grades of Shorthorn and Jersey trials. Also, Friesians and their up-grades recorded higher H^M for LP along with favorable lower H^M for DP. Estimates of H^M in the three up-grading trials for CI were positive and unfavorable, where significant heterotic maternity ($P<0.01$) was observed in Friesian trial only. Friesians and their up-grades recorded the lowest H^M for AC1 and AC2 than the other up-grades in the two trials.

IV. Individual (R^I) and maternal (R^M) recombination effect

Estimates of R^I and R^M for milk production traits were positive and significant and indicating that crossbred dams mothered heifers with higher milking ability than did purebred Friesian dams where both groups were mated to the same purebred Friesian bulls. Insignificant negative estimates of R^I for DP were observed, while insignificant positive estimates were recorded for CI, AC1 and AC2.

V. Genetic evaluation of each up-graded group relative to purebreds

(i) Additive effect

(1) For the three milk production traits (M305, TMY and LP) in the three trials, estimates of G^I and G^M for each breed-group were in favour of the foreign breed, i.e. Friesian, Shorthorn and Jersey. Also, estimates of G^I and G^M increased with the increase of foreign blood from 1/2 to 15/16, i.e. breed group with blood proportion of 15/16 Friesian or Shorthorn or Jersey recorded the highest estimates of G^I and G^M relative to the proportion of 1/2 or 3/4 or 7/8. Percentages of additive effect relative to least-square mean of the trait (i.e. G^I/LSM or G^M/LSM) were high and increased with the increase of foreign blood from 1/2 to 15/16.

In Freisian and Shorthorn trials, inter-se mating groups of $(3/4E1/4D)^2$ and $(7/8E1/8D)^2$ showed higher estimates of G^I and G^M than those of their corresponding breed groups of 3/4E1/4D and 7/8E1/8D. The inter-se matings in Shorthorn trial only had higher estimates of G^I and G^M than for all other breed groups in this trial.

(ii) Heterotic effect

For both estimates of $H^I + H^M$ (i.e. total heterosis), the estimates in Friesian, Shorthorn and Jersey trials respectively averaged 8.6, 6.7 and 17.9% for 1/2E, 8.9, 6.7 and 8.4% for 3/4E, 4.0, 1.2 and 4.5% for 7/8E and 3.6, 1.6 and 2.1% for 15/16E. Estimates or percentages of heterosis (H^I or H^M or both together) decreased with the increase of the proportion of foreign blood from 1/2 to 15/16 in Friesian trial, 1/2 to 7/8 in Shorthorn trial and 1/2 to 15/16 in Jersey trial. A breed group with blood proportion of 3/4F in Friesian trial, $(3/4S1/4D)^2$ in Shorthorn trial and 1/2J in Jersey trial recorded the highest total heterotic superiority, while 15/16F in Friesian trial, 7/8S in Shorthorn trial and 15/16J in Jersey trial recorded the lowest total heterotic superiority. Also, inter-se mating groups of $(3/4E1/4D)^2$ and $(7/8E1/8D)^2$ recorded higher heterortic superiority than groups of 3/4E1/4D and 7/8E1/8D, respectively. In the meantime, inter-se mating group of $(3/4E1/4D)^2$ showed higher heterosis than group of $(7/8E1/8D)^2$.

For estimates of total heterosis (i.e. H^I+H^M) relative to total additive (i.e. G^I+G^M), the estimates in Friesian, Shorthorn and Jersey trials respectively averaged 14.9, 30.1 and 35.2% for blood proportion of 1/2E, 15.7, 25.1 and 18.9% for 3/4E, 6.3, 4.7 and 9.0% for 7/8E and 5.1, 4.7 and 3.8% for 15/16E.

(iii) Recombination effect

For the three milk production traits (M305, TMY and LP), estimates of R^I for inter-se mating groups of $(3/4E1/4D)^2$ and $(7/8E1/8D)^2$ in Friesian and Shorthorn trials were higher than those estimates of H^I. R^I and R^M for milk traits in these two crossbreeding trials decreased with the increase of foreign blood from 3/4F or 3/4S to 7/8F and 7/8S. Therefore, inter-se mating groups of $(7/8E1/8D)^2$ showed lower recombination effect than groups of $(3/4E1/4D)^2$.

Percentages of recombination effect relative to additive effect (i.e. R^I/G^I or R^M/G^M or both R^I+R^M relative to G^I+G^M) were positive and higher in groups of 3/4E1/4D than in groups of 7/8E1/8D. In dairy industry, such favorable recombination effect in groups of 3/4E1/4D and 7/8E1/8D for milk traits indicate that epistatic recombination losses in these inter-se mating groups were negligible and therefore there is a potential advantage to use crossbred cows or dams including foreign blood (Friesian or Shorthorn) to develop parental strains to be used in crossbreeding stratification systems in Egypt.

VI. Methodology comparison of breed-group models with regression models

The comparisons between the two analyses suggest that the additional genetic effects (e.g. nonlinear effects of additive x dominance and linkage) did not significantly reduce the error variance. For most traits in the first four lactations and all lactations, insignificant differences between the two analyses were observed, indicating that additive x dominance and linkage (i.e. non-linear effects) were not important in the two up-grading trials (F and S trials). Consequently, the amount of heterosis estimated for these different traits were basically due to dominance. Also, the present results reveal that prediction of different up-grades between Domiati and each of Friesian or Shorthorn or Jersey are similar and using any simple analysis of breed-group model or regression-analysis model is quite efficient, i.e. both analyses gave the same accuracy in estimating genetic components.