

Associations between age at first calving, liveweight at first calving and milk production in Holstein-Friesian dairy cows

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Introduction Current recommendations are that Holstein-Friesian dairy heifers should calve at 2 years of age at a target liveweight (LW) of 550 kg. There is, however, some evidence to suggest that the effects of a younger age at first calving (AFC) on milk performance can be offset by a heavier LW at calving (Dobos *et al.*, 2001). Nonetheless, most studies only report the associations between either AFC (Berry and Cromie, 2009) or LW at calving (Cowan *et al.*, 1974) and milk performance. The objective of this study was to quantify the association between both AFC and LW at first calving and first lactation milk production in spring-calving Irish Holstein-Friesian dairy cows.

Materials and methods Milk performance data from 485 spring-calving, Holstein-Friesian dairy heifers, calving for the first time between 20 and 28 months of age, over a five year period (2003 to 2008) were obtained from three research herds at Moorepark Dairy Production Research Center. LW at first calving was assumed to be the first recorded LW between days 1 to 14 post-calving. Predicted transmitting ability (PTA) for carcass weight for each animal was obtained from the May 2009 national domestic genetic evaluation run. PTA for carcass weight is based on the carcass weight of male animals aged between 300 and 1,200 days at slaughter and female animals aged between 300 and 875 days at slaughter. A multiple regression model was developed with LW at first calving as the dependant variable and both PTA for carcass weight and days post calving to first LW recording included as independent variables. The residuals from the model were added to the intercept to generate an adjusted LW at first calving which was used in all subsequent analyses. Logistic regression was used to quantify the association between both AFC and LW at first calving and survival to second lactation; animals culled because of poor genetic merit or surplus to requirements were excluded from this analysis. A fixed effects linear model was used to quantify the associations between both AFC and LW at first calving and first parity milk performance; lactation yield was based on the actual lactation length for each animal and not standardised to 305-days. Fixed effects adjusted for in the model were experimental treatment and year of calving. AFC and LW at first calving were included in all models as continuous variables and non-linear associations with survival and performance were also investigated.

Results Mean (standard deviation) AFC and LW at first calving among the 485 animals was 726 days (29.7 days) and 546 kg (45.6 kg), respectively. The correlation between AFC and LW at first calving was 0.29; however, no collinearity existed between the two variables. AFC was not associated with survival to second lactation but LW at first calving was non-linearly associated with survival to second lactation ($\text{Logit}\{P=\text{survived}|LW\} = 0.0035*LW - 0.0001*LW^2$). AFC was non-linearly associated with all traits with the exception of milk fat percent. Yield was positively associated with AFC to an AFC between 677 and 704 days after which a negative association existed. No non-linear associations were observed between LW at first calving and performance and LW was not associated with milk dry matter content. Increased LW was associated with increased yield. With the exception of milk fat and milk protein percent, LW explained more of the variation in performance than AFC.

Table 1 Linear and quadratic regression coefficients of milk production on AFC and LW at first calving as well as partial coefficient of determination (R^2).

	Intercept ¹ (se)	Age at first calving (days)			LW at first calving (kg)	
		Linear (se)	Quadratic (se)	R^2	Linear (se)	R^2
AFC (days)	725 (1.7)				0.22 (0.028) ^{***}	0.10
LW at first calving (kg)	549 (2.6)	0.53 (0.07) ^{***}		0.11		
Milk yield (kg)	5020 (40.8)	89.6 (37.5) [*]	-0.066 (0.026) [*]	0.02	4.6 (0.8) ^{***}	0.06
Fat yield (kg)	201.8 (1.7)	5.35 (1.57) ^{***}	-0.004 (0.001) ^{***}	0.04	0.18 (0.03) ^{***}	0.06
Protein yield (kg)	170.2 (1.4)	4.85 (1.25) ^{***}	-0.004 (0.001) ^{***}	0.05	0.15 (0.03) ^{***}	0.06
Milk solids yield (kg)	372.0 (2.9)	10.20 (2.70) ^{***}	-0.007 (0.002) ^{***}	0.05	0.33 (0.05) ^{***}	0.06
Fat percent (%*1000)	4.11 (0.02)	1.51 (0.68) [*]		0.01	-0.189 (0.430) ^{NS}	0.00
Protein percent (%*1000)	3.45 (0.01)	31.11 (10.21) ^{**}	-0.022 (0.007) ^{**}	0.03	-0.007 (0.204) ^{NS}	0.00

¹ Intercept represents the average across all treatments and years and the average adjusted liveweight of 546 kg and average AFC of 726 days. ^{***} $P < 0.001$; ^{**} $P < 0.01$; ^{*} $P < 0.05$; NS non-significance

Conclusions Both AFC and LW at first calving were associated with milk, fat and protein yield but only AFC was associated with milk dry matter content; most of the associations involving AFC were non-linear. The results indicate that optimum AFC is between 22 and 23 months of age, in addition it is clear that animals also need to attain their respective pre-calving target weight to ensure that production performance is maximised.

References

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