Are High Pins Related to Poor Fertility?

E. Wall [a,*], I. S. M. White [b], M. P. Coffey [a] and S. Brotherstone [b]

[a] *Sustainable Livestock Systems, SAC, Bush Estate, Penicuik, Midlothian, EH26 0PH, UK*

[b] *ICAPB, School of Biological Sciences, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JT, UK*

Introduction

There is anecdotal evidence amongst farmers, breeders and vets that suggests the decline in fertility seen in recent years can be partially attributed to rump angle, suggesting that animals with higher pins have poorer fertility (Veepro Magazine, 1995). This argument is based on the fact that high pins cause the vaginal canal to sit at an angle as opposed to lying flat. This will impact on areas such as reproduction, pregnancy and parturition. It is suggested that an upward angle, the reproductive tract is more prone to infection from external foreign agents as the vagina is unable to drain effectively (Astiz *et al.,* 2002). The angle of the vaginal canal may also cause difficulties during parturition as the natural path of exit is a slightly downward facing angle and higher pins may not drop enough as the cow prepares to calf to facilitate an easy calving. Farmers and breeders also believe that poor legs and feet will also have a negative impact on fertility as the cow will not clearly display one of the signs of oestrus, mounting and standing to service (Van Eerdenburg *et al.,* 2002). It is important to state that these are anecdotal reasons put forward to back up the presumption that high pins and poor legs results in poor fertility.

Research in the UK has recently led to the development of a Fertility Index for dairy cattle to address the decline in fertility (Wall *et al.,* 2003). After examining national data it was decided that fertility proofs would be based on calving interval (CI) and non-return rate after 56 days (NR56) predicted transmitting abilities (PTA) weighted by their relative economic weights (independent of culling). There was an unfavourable genetic correlation between the fertility traits and milk yield and body condition score (BCS). Results are encouraging and have led to a Fertility Index that will help to improve national dairy cow fertility.

Some type traits have also been shown to be correlated to health (Rogers *et al.,* 1998), longevity and fertility (Pryce *et al.,* 2000) traits but not necessarily rump traits. Interestingly Veepro Magazine (1995) showed that there was an intermediate optimum for rump angle with relation to culling rates, with animals of rump angle score 3-7 having lower culling rates than either extreme.

Very few studies have shown a significant relationship between aspects of fertility and rump traits. Rump angle and width have been shown to have an unfavourable correlation with calving ease (e.g., Cue *et al.,* 1990) of the order of 0.3 - 0.5. Van Dorp *et al.* (1998) found that pin set and pin width had a genetic correlation with incidence of retained placenta with this less likely to happen in cows with wider pins (-0.11) and a downward slope from hooks to pins (0.38). Larroque *et al.* (1999) showed that post-partum fertility (trait measuring the success/failure of AI) was unfavourably correlated with higher pins (0.16). Royal *et al.* (2002) found an inferred genetic correlation of – 0.25 between rump width and commencement of luteal activity. Other studies have found little or no relationship between rump traits and fertility in terms of cyclicity (Pryce *et al.,* 2000), ability to hold to service and overall profit (Pérez-Cabal & Alenda, 2002).

The purpose of this study was to investigate the popular belief that high rump angle equates to poor fertility. Some other type traits (udder traits and composite traits) were studied to see if they had potential to add additional information in calculating fertility PTAs in the UK.

Materials and Methods

Information on rump angle (RA) and rump width (RW) for first lactation animals were extracted from the Holstein UK database. A preliminary analysis in which the correlation between fertility and type PTAs were calculated, indicated that rear udder height (RUH) and udder support (US) PTAs were correlated with fertility PTAs with higher and more defined central ligaments resulting in shorter calving and first service intervals. The composite trait PTAs of mammary system (MAM) and legs and feet (L&F) were favourably correlated with fertility PTAs. Descriptions of the scales for these 6 chosen traits are given in Table 1. All traits are adjusted for recording officer before use in genetic evaluations by scaling records so that individual field officer standard deviations were equal to the mean standard deviation of all field officers (Brotherstone, 1994).

A number of direct fertility traits were defined using information on inseminations and calvings from national milk recording databases, including: (i) calving interval, CI, (ii) number of days to first insemination, DFS, and, (iii) a binary trait measuring a return to service within 56 days of first insemination, NR56. Complete cow pedigree information was extracted from the Holstein UK database. Records for first lactation Holstein-Friesian animals with at least three tests were taken from 1997 until the end of 2003. General validation and editing rules were applied to these data as described in Wall *et al.* (2003). Bulls with more than 5 and less than 300 daughters were included in the analysis. There had to be at least 5 cows in each herd-year-season. This resulted in a dataset of just over 29,000 records for parameter estimation with an average age of 27.9 months. These animals were in 5,118 herd-year-season of type classification and 2,181 herd-year-seasons of calving. There were 57,530 animals in the pedigree file for these cows.

The data were analysed using residual maximum likelihood (REML) analyses to estimate the variance components. Quatro-variate analyses were run for CI, DFS, NR56 and each of the type traits (RA, RW, RUH, US, MAMM, L&F) in turn. Additional analyses were run between the type traits to complete the variance covariance matrix. A linear model was fitted that included animal as a random effect, herd-year-season, month of calving, age at calving and days in milk at type classification as a linear and quadratic regression coefficient.

The variance covariance matrices from these multiple quatro-variate analyses were then combined to generate a full variance covariance matrix using ASREML. We have 9 (t) traits.

(i) For each subset of 4 (s) traits the covariance matrix (C) and the Cholesky root (upper triangular U such that C = U'U) was calculated. Dummy datasets were created (s×t or 4×9) consisting of columns of U (multiplied by √s) for the 4 traits and missing values for the remaining 5 (t – s) traits.

(ii) The dummy data sets are concatenated into one data set (sum(s) × t) and analysed as sum(s) values of t traits. Ensure mean values are not fitted.

Results and Discussion

Table 1 provides a summary of the data and descriptive statistics for all traits used for parameter estimation. The average CI was just under 400 days (87 days to first service) with 36% of the cows returning to service within 56 days. Heritability estimates were low for all fertility traits (CI = 0.039, DFS = 0.050, NR56 = 0.011). The heritability estimates for fertility traits were similar to earlier estimates in the UK (Pryce *et al.,* 2000, Royal *et al.,* 2002) and elsewhere (Veerkamp *et al.,* 2001). The most recent estimates of heritability for fertility in the UK was a study of Wall *et al.* (2003) which used a similar dataset and estimated the heritability of CI, DFS and NR56 as 0.035, 0.039 and 0.018 respectively. The estimate of heritability for DFS was higher with this analysis and statistically different from the previous analysis ($p > 0.05$). This may be attributed to the use of an animal model with this study whereas the study of Wall *et al.* (2003) used a sire model.

The heritability estimates were moderate for the linear type (RA = 0.27, RW = 0.22, RUH, 0.21, US = 0.15) and composite (MAM = 0.27, L&F = 0.15) traits. The heritability estimates for the linear type traits were similar to those reported, using UK data, by Brotherstone (1994, sire model) but lower for all linear type traits than those reported by Pryce *et al.* (2000, animal model). The heritabilities for the composite traits (L&F and MAM) were similar to those previously calculated in the UK (Brotherstone, pers comm).

Table 2 shows that the correlation of CI with DFS was strong and favourable (0.82) and were of similar magnitude to other studies (de Jong, 1997). The correlation of CI with NR56 was -0.21 and the correlation of DFS with NR56 was 0.24 suggesting that animals that return to service will have a longer CI but a shorter DFS. Both are of a similar magnitude to those reported by other studies (Roxström *et al.,* 2001) but not significantly different from zero.

The majority of studies (e.g., Pryce *et al.,* 2000; Royal *et al.,* 2002) that have examined the relationship between type traits and fertility have found that the linear traits associated were body size (body depth, angularity and stature) have been genetically correlated with CI. However, the majority of the correlations between the selected type traits in this study and fertility were not significantly different from zero. However, there were some significant genetic correlations seen. CI was genetically correlated with RA (-0.16), suggesting animals with high pins would have a longer calving interval. This would seem to back-up the farmer and vet anecdotal evidence that high pins result in poorer fertility. However, there was no significant relationship between RA and the two components of CI, namely DFS and NR56. The analysis of UK data conducted by Pryce *et al.* (2000) found no correlation between any of the type traits studied and CI. Royal *et al.* (2002) found an inferred genetic correlation between RW and commencement of luteal activity (CLA, correlated to CI) of – 0.25 but only a low correlation between CLA with RA and US.

The relationship between fertility traits and RA was further examined by fitting RA (adjusted for the effects in the model described earlier) as a linear and quadratic effects in the model for each trait. This was to examine the direct relationship between fertility with RA and study the possibility of an intermediate optimum of RA. Examining the direct effect of RA on fertility also helps to further understand the validity of the argument that high pins results in poor fertility. These results showed that there was no significant linear or quadratic relationship between change in RA and any of the fertility traits and therefore no evidence of a direct relationship between high pins and poor fertility.

MAM and US was shown to be genetically correlated with CI with a strong udder and excellent mammary system resulting in a longer calving interval. This may be considered counter-intuitive as one may think that animals with good udders are in good health and therefore have less fertility problems. However, a good mammary system is favourably correlated with higher 305 day milk yields (0.14, Brotherstone pers comm) thereby increasing CI. Therefore, the relationship between good udders and fertility could be being mediated through the unfavourably relationship of milk yield and fertility.

L&F was favourably correlated to NR56, suggesting that animals with good L&F score would be less likely to return to service. The study of Haile-Mariam *et al.* (2004) also found an unfavourable relationship between the linear trait foot angle and fertility traits. These results do concur with farmer and vet based stories that lame animals have poor conception rates due to the inability to display full signs of oestrus, especially when cows are kept indoors (concrete flooring).

An interesting aside from this study in the use of ASREML to combine the var/cov matrices from many sub-analyses. This method seems to work well, with either an R or G matrix.

The results of this study are interesting as many of the previous studies have shown fertility to be negatively correlated to body linear traits only, suggesting that bigger and thinner cows will have poorer fertility (e.g. Pryce *et al.,* 2000). Many studies have described the relationship between cows producing this higher milk yield from her own body reserves resulting in poorer fertility and longevity (Collard *et al.,* 2000). These studies suggest that body traits that are displayed when the cow is in negative energy balance are related to health and fertility as her body reserves are diverted from these functions to producing milk. However, this study may be some potential in using some composite traits to help predict fertility PTAs. The study of Gutiérrez *et al.* (2002) found that udder development was unfavourably correlated with age at first calving in beef cattle. Age at first calving is an estimate of the maturity of the cow when she is first mated. Further studies may show that the relationship we see between CI and US could be partially explained by the maturity at first mating of the cow.

This study has shown that there is little evidence of a direct relationship between high pins (and other linear type traits) and fertility in UK dairy cows. This challenges the anecdotal evidence from the farming sector of the poorer fertility (both cyclicity and conception) that is seen in cows with higher pins and poor legs and feet. It is important to point out that this study is based on first lactation cows only – the major reason for involuntary culling in the 1st lactation is poor fertility. It could be that farmers and vets opinion are being driven by what they are seeing in later life. Further analysis to disentangle how changes in type traits (rump and body traits) time and fertility is necessary to fully understand what is driving the belief that animals with high pins will have poorer fertility.

Acknowledgements

The authors would like to acknowledge the funding of the UK Department for Environment, Food & Rural Affairs, National Milk Records, Cattle Information Services, Genus, Cogent, Holstein UK, and Dartington Cattle Breeding Trust through the LINK Sustainable Livestock Production Programme. SAC receives financial support from the Scottish Executive Environment & Rural Affairs Department.

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Table 1. Mean, standard deviation (sd), range (min & max), numbers of records and heritabilities ($h^2 \pm$ s.e.) of the traits in the analysis.

	Type Trait Score							
	1	**9**	**Min**	**Max**	**Mean**	**sd**	**No.**	**h^2**
Calving Interval (days) (CI)			300	600	399.6	56.2	21901	0.041±0.0069
Days to first insemination (DFS)			1	200	86.9	31.4	27949	0.050±0.0068
Non return rate (NR56)			0	1	0.64	0.48	27900	0.014±0.0040
Rump angle (RA)	High	Low	0.01	9.95	4.2	1.3	29212	0.280±0.0163
Rump width (RW)	Narrow	Wide	0.04	9.74	5.3	1.4	29212	0.223±0.0150
Rear udder height (RUH)	Low	High	0.04	9.89	5.7	1.4	29212	0.218±0.0126
Udder support (US)	Broken	Strong	0.09	9.97	5.8	1.4	29212	0.159±0.0115
	50	**100**						
Legs & Feet (L&F)	Poor	Excellent	63.49	92.28	78.45	5.19	29212	0.147±0.0073
Mammary system (MAM)	Poor	Excellent	63.95	92.48	78.62	5.39	29212	0.275±0.0363

Table 2. Estimates of genetic standard deviations (diagonal), genetic correlations (below diagonal) and residual .correlation (above diagonal) for CI, DFS, NR56, RA, RW, RUH, US, L&F and MAM.

	CI	**DFS**	**NR56**	**RA**	**RW**	**RUH**	**US**	**L&F**	**MAM**
CI	**10.9394**	0.4451	-0.3058	-0.0293	-0.0024	0.0219	0.0309	0.0037	0.0369
DFS	0.8209	**6.2073**	0.0127	-0.0055	-0.0186	0.0292	0.0262	-0.0062	0.0219
NR56	-0.2103	0.2382	**0.0548**	0.0146	-0.0068	0.0033	-0.0074	-0.0091	-0.0043
RA	-0.1556	0.0925	-0.0069	**0.6599**	0.0261	-0.0643	-0.0356	-0.0167	-0.0753
RW	-0.0109	-0.0482	-0.0624	0.0100	**0.5848**	0.1116	0.0390	0.0843	0.1216
RUH	0.0945	0.0456	-0.0913	-0.0770	0.1670	**0.6000**	0.4140	0.1992	0.6184
US	0.2458	0.1295	-0.0922	-0.0325	0.0345	0.6566	**0.4950**	0.1608	0.5294
L&F	-0.0101	-0.1229	-0.2048	-0.0986	0.1132	0.3568	0.3761	**1.7833**	0.2967
MAM	0.1421	0.0751	-0.1341	-0.0702	0.1129	0.7422	0.7656	0.4591	**2.5756**