Change in the conformation of Irish Holstein-Friesian dairy cows over the past decade

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Executive Summary

- The object of this study was to quantify how the conformation of a sample of the Irish Holstein-Friesian population has changed over the past decade from 1995 to 2005

- The data consisted information on 17 type traits on 47,953 Holstein-Friesian cows from 1,960 herds

- Linear models were used to estimate annual least squares means for each of the type traits separately. Further analyses estimated the linear regression coefficient simultaneous with the other fixed effects in the model

- Over the past decade Irish Holstein-Friesian cows have become taller with no obvious trend in chest width, body depth or rump dimensions

- Udders have become deeper and more strongly attached and supported

- Teat length has not changed but the distance between teats, viewed from the side, has increased although distance between teats viewed from the rear has not changed significantly

- There has been no significant change in any of the legs related traits, most likely an artefact of their intermediate optima

- Animals have become more docile and faster milking over the past decade

Introduction

Net profit is dictated by the ability to efficiently utilise grass availability. Cow maintenance is a major energy cost and is associated with live-weight (Jarriage, 1989; NRC 2001). Labour also constitutes a major input cost and in dairy farms milking requires the majority of labour (O'Brien et al. 2004). Furthermore, most housing cubicles and milking parlours are old and were built on cow dimensions of several decades ago.

However, genetic selection in Ireland over the past decades has predominantly been on milk production, with the associated genetic correlations with type traits (Berry et al., 2004) implying a correlated response in animal size/dimensions and mammary system. For example, if selection was practiced for milk production alone animals would be expected to be grow taller, wider and deeper over time (Berry et al., 2004). This may have repercussions for cow comfort or injury in existing cubicles and milking parlours subsequently leading to increased incidence of lameness and leg damage (DEFRA/ADAS, 2002). Furthermore, Change in cow size may also affect maintenance energy cost. Additionally, changes in the physical characteristics of the mammary system, such as teat placement, if not addressed may increase milking time or mammary infection as well as potentially rendering these animals unsuitable for automatic milking systems.

Temperament as a management trait, has increasingly become a concern for breeders, as production life is a large contributor to the profitability of a dairy farm, and farmers are more likely to cull cows if they are very nervous during the milking procedure (Berry et al 2005a; König. et al. 2006).

The object of the report was to quantify how the conformation of a sample of the Irish Holstein-Friesian population has changed over the past decade from 1995 to 2005.

Materials and methods

Cow identification number, herd, and calving month for cows with information on type traits as well the year of inspection, age of inspection, and lactation stage at inspection were extracted from the Irish Cattle Breeding Federation database. A total of 57,592 records were available for inclusion in the analysis. A description of the linear type traits recorded is summarised in Table 1.

Table 1. *Description of linear type traits as well as their corresponding means, standard deviation in the current sample population (n = 47,953).*

Trait	Score		Mean	Std. deviation
	1	9		
Stature	130cm	154cm	5.6	1.56
Chest width	Narrow	Wide	4.9	1.46
Body depth	Shallow	Deep	5.6	1.28
Angularity	Coarse	Sharp	5.8	1.31
Rump angle	High pins	Low pins	4.1	1.19
Rump width	Narrow	Wide	5.1	1.33
Fore-udder attachment	Loose	Tight	5.4	1.45
Rear-udder height	Very low	Very high	5.7	1.45
Udder support	Broken	Strong	5.9	1.30
Udder depth	Below hocks	Above hocks	5.6	1.32
Teat position rear view	Wide	Close	4.5	1.43
Teat position side view	Close	Apart	5.5	1.27
Teat length	Short	Long	4.6	1.27
Rear legs side view	Straight	Sickled	5.4	1.14
Foot angle	Low	Steep	5.2	1.25
Temperament	Nervous	Quiet	5.7	1.42
Ease of milking	Slow	Fast	5.5	1.48

Data editing

Following preliminary analysis of the frequency distribution of data records only type trait data scored on first lactation animals calving between 1995 and 2005, inclusive were retained. Furthermore, only herd-years that had least three type trait records were retained; a total of 50,270 remained. Additionally, the first record in time scored on each animal was retained for analysis. The final data set consisted 47,953 cows from 1,960 herds. A frequency distribution of the annual number of records included in the analyses is illustrated in Figure 1; the lower level of recording in the years 2000 and 2001 was due to the outbreak of Foot and Mouth disease and it effects on farm-to-farm movement.

A second data set was created containing only the 57 herds that had type trait information for each of the 11 years of the present study. A total of 8,842 cows were included in this analysis.

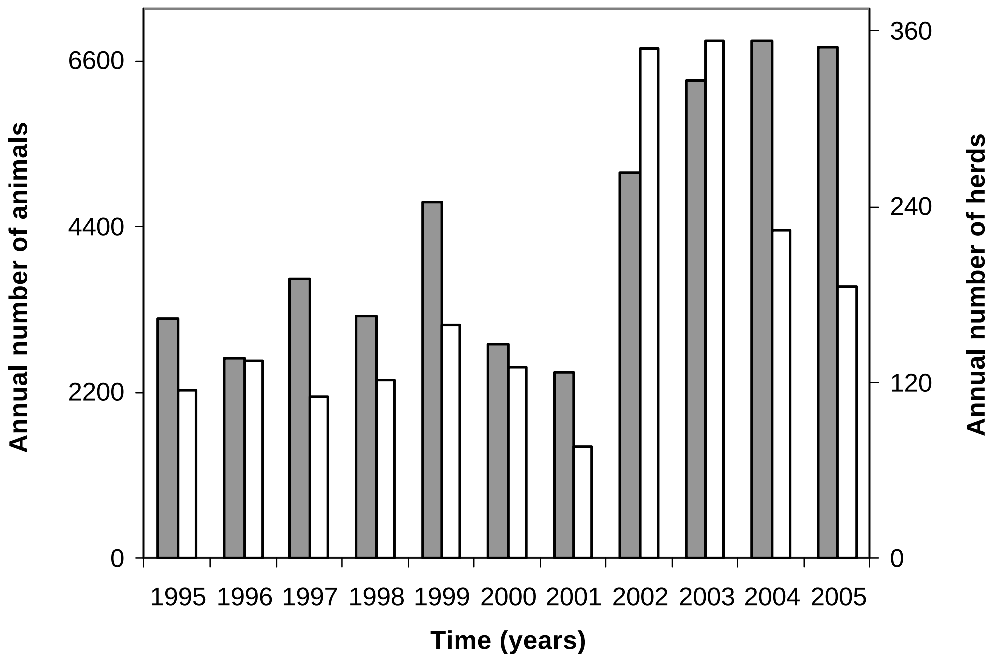

Figure 1. *Frequency distribution of the annual number of animals (shaded bars) and herds (unshaded bars) from 1995 to 2005.*

Data analysis

The data were analysed using the following linear multiple regression model in ASREML (Gilmour et al., 2006):

$$Y = \mu + \text{Herd} + \sum_{i=1}^{2} Age + \text{Stage} + \text{Month} + \text{Year} + e$$

Y= observation for each type trait,

μ=overall mean,

Herd= fixed effect of herd,

$\sum_{i=1}^{2} Age$ = quadratic regression on the age of inspection,

Stage= continuous effect of lactation stage,

Month= continuous effect of calving month,

Year= fixed effect of year of inspection,

e= random residual term.

Year was included as a continuous variable in the model. However, a significant linear regression coefficient on year may be an artefact of the large dataset size. Hence, in a separate series of analyses, year was included in the model as a factor with 11 levels. The least squares means were extracted from the analysis and a linear regression line fitted in PROC REG (SAS, 2005) through the resultant least squares means. This approach was undertaken to place equal emphasis on each year, irrespective of the number of animals recorded within year.

Results and Discussion

A significant ($P<0.001$) linear trend in each of the 17 type traits analysed existed across all years of the study within the entire data set (Table 2) and within the data set of only common herds (Table 3). Nonetheless, the more conservative approach of fitting a linear regression through the least squares means revealed a significant ($P<0.05$) trend in only nine of the type traits including: stature (Figure 2A), angularity (Figure 2B), fore-udder attachment (Figure 3A), rear-udder height, udder support, udder-depth (entire dataset only; Figure 3B), teat position side view, temperament (Figure 4A) and ease of milking (Figure 4B). The least squares means were generally higher in the 57 herds that have been measuring type traits for at least the past 11 years that in the entire dataset. Herds included in the entire dataset were present for at least 5 years out of the 11 included in the study.

Table 2. *Least squares means for each of the type traits in the first year (1995) and last year (2005) of study using the entire dataset. Also included in the regression coefficient (b) and associated F-statistic on year when estimated simultaneously in the model and the significance of the linear regression when fitted through the least squares means.*

	Mean		b(*100)	F-statistic of regression coefficient	Significance of regression through least squares means
	1995	2005			P-value
Stature	4.8	5.6	6.92	836	0.014
Chest width	5.0	4.9	-1.33	22	0.692
Body depth	5.8	5.5	-1.37	34	0.765
Angularity	5.1	5.4	4.50	355	0.002
Rump angle	4.2	4.1	-1.28	28	0.670
Rump width	5.2	5.5	1.11	19	0.457
Fore-udder attachment	4.7	5.2	5.77	432	<0.001
Rear-udder height	5.0	5.6	7.51	102	<0.001
Udder support	5.7	5.8	5.05	399	0.008
Udder depth	5.7	5.5	-4.76	363	0.030
Teat position rear view	4.3	3.8	-4.32	240	0.227
Teat position side view	5.0	5.3	4.44	340	0.013
Teat length	4.3	4.1	-1.85	52	0.101
Rear legs side view	5.4	5.5	1.91	70	0.139
Foot angle	4.6	4.7	1.25	25	0.362
Temperament	4.1	6.4	21.99	7775	<0.001
Ease of milking	3.7	6.1	22.45	7316	0.002

Body related traits

An average annual incremental increase of 0.05 to 0.07 in mean stature score over the past decade manifests itself as animals increasing by 0.5 to 0.7 of a score (scale 1-9) over the past decade. An increase in cow height is expected following selection for milk production alone (Berry et al., 2004), which was the predominant breeding objective based on the relative breeding index in Ireland up to the year 2000. This corroborates previous studies (Berry et al., 2005b) that reported a significant effect of origin of germplasm on mature cow height with animals of North American ancestry (predominantly Holstein) being significantly taller than animals of New Zealand ancestry (predominantly Friesian). In 2005 mean stature score in the dataset of all herds was 5.6, implying that if breeding strategies are to remain unchanged, stature will score 6.3 on the type trait scale by 2015. This may have repercussion for optimal cubicle and milk parlour design. Nonetheless, body depth or chest width has, on average, not changed significantly over the past decade when placing equal weight on the annual least squares means and fitting a linear regression through them.

Table 3. *Least squares means for each of the type traits in the first year (1995) and last year (2005) of study using the dataset with only the 57 herds common across all years. Also included in the regression coefficient (b) and associated F-statistic on year when estimated simultaneously in the model and the significance of the linear regression when fitted through the least squares means.*

	Mean		b (*100)	F-statistic of regression coefficient	Significance of regression through least squares means
	1995	2005			P-value
Stature	5.8	6.6	4.91	162	0.036
Chest width	4.9	4.9	-0.10	0	0.989
Body depth	5.9	5.7	-0.78	4	0.783
Angularity	5.8	6.2	4.69	157	0.001
Rump angle	4.2	4.0	-1.05	8	0.625
Rump width	4.9	5.4	2.57	39	0.112
Fore-udder attachment	5.3	5.9	6.79	254	<0.001
Rear-udder height	5.9	6.4	7.76	376	<0.001
Udder support	5.9	6.1	5.63	198	0.005
Udder depth	5.9	5.8	-4.76	144	0.091
Teat position rear view	4.8	4.5	-2.76	41	0.322
Teat position side view	5.4	5.7	5.28	189	0.004
Teat length	4.6	4.5	-1.10	7	0.325
Rear legs side view	4.9	5.4	1.50	16	0.241
Foot angle	5.1	5.2	2.71	45	0.278
Temperament	3.7	6.1	24.76	3938	0.001
Ease of milking	3.6	5.9	25.37	3423	0.003

The annual increase in angularity is most likely an artefact of the upgrading of the traditional British Friesian herd to Holstein. Holsteins have traditionally been aggressively selected for high milk output compounded by conscious selection for more sharp animals (i.e., high angularity). The association between body condition score and fertility and health has been well documented at the phenotypic (Roche et al., 2006; Berry et al., 2007; Buckley et al., 2003) and genetic level (Berry et al., 2004; Berry et al., 2003; Cassandro et al 1999). The phenotypic and genetic correlations between body condition score and angularity in Ireland are -0.61 and -0.84, respectively (Berry et al., 2004) implying that body condition score and angularity are similar but opposite traits. The increase in angularity observed in the present study is therefore a likely contributor to the deterioration of the fertility (Mee et al. 1999; Evans et al., 2006) and health status (Berry et al., 2006) of the Irish dairy herd over the past decade.

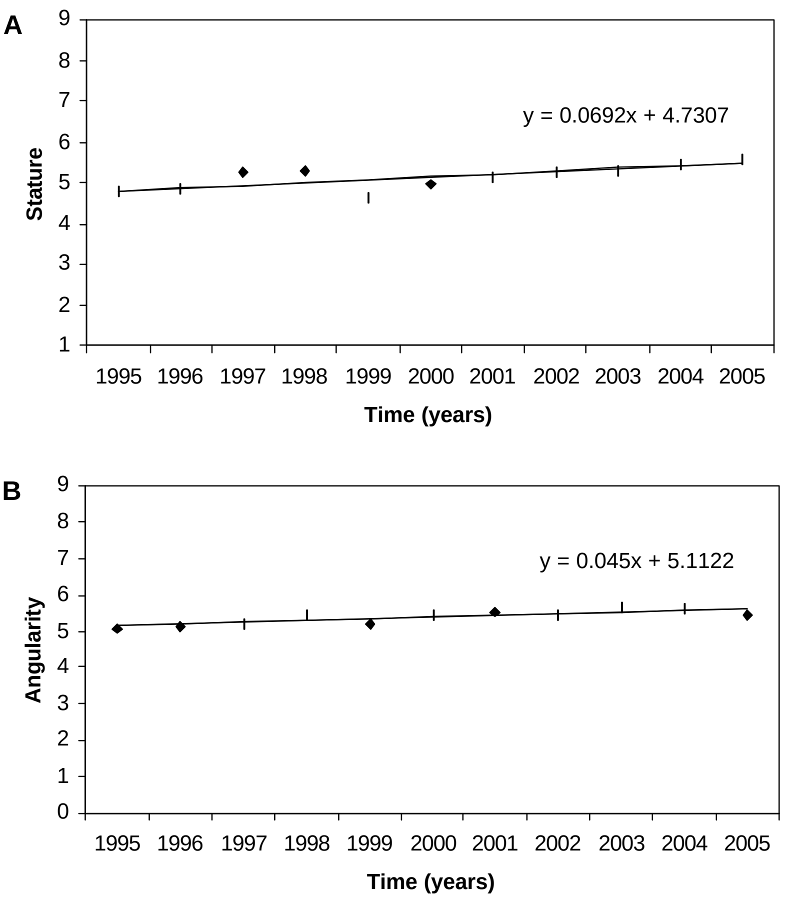

Figure 2.A-B. *Change in cow stature (A) and angularity (B) from 1995 to 2005, with regression line fitted through least square means.*

No significant linear change in rump angle or rump width has occurred over the past decade when taking the more conservative approach of fitting a linear regression through the least squares means. This is most likely due to an intermediate score being optimum for these traits.

Udder conformation

Udder traits have an important influence on involuntary culling decisions, mainly because of their influence on susceptibility to injuries and infections (Weigel et al. 1998). Udder depth is the most important type trait with regard to functional longevity (Caraviello et al 2004); cows with deeper udders tend to have higher levels of somatic cells (Rodgers et al 1991). Udder depth and teat position side view type traits exhibit an intermediate optimum as it relates to production life (Sewalem et al 2004). Fore-udder attachment, rear-udder height, and udder support showed a clear linear relationship with production life (Sewalem et al 2004).

There has been a significant trend over the past decade in Irish dairy cows towards tighter fore udder attachments, deeper udders but with stronger support (i.e., more pronounced central ligament). This is concurrent with increase in the distance between the teats when viewed from the side, despite its intermediate optimum. This may have repercussion for the suitability of animals, long term, to automatic milking. However, there has been no significant trend in the teat position viewed from the rear or in teat length.

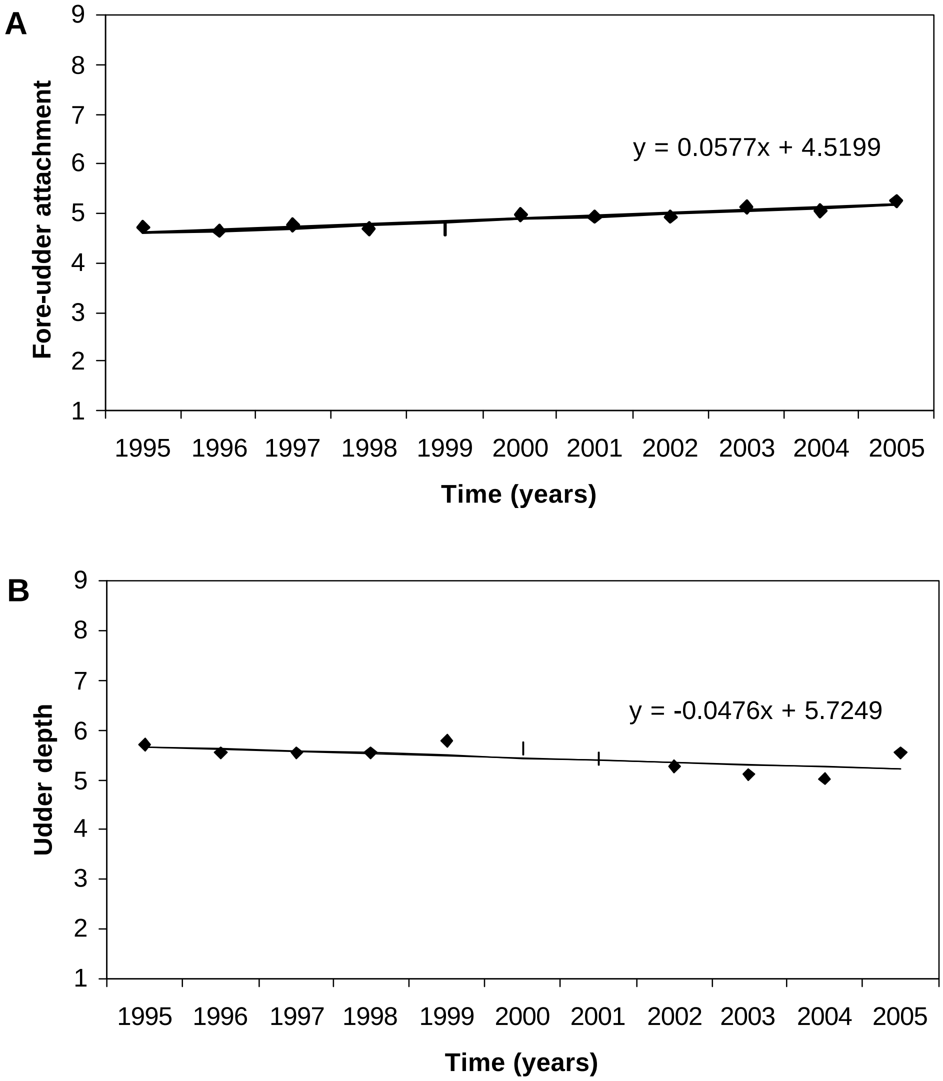

Figure 3.A-B. *Change in cow fore-udder attachment (A) and udder depth (B) from 1995 to 2005, with regression line fitted through least square means.*

Feet and legs

There has been no significant linear trend in either foot angle or rear legs side view both of which have intermediate optima.

Management traits

The inevitable desire to increase labour efficiently, as well as the increasing use of automated milking machines, and increased concern on health and safety demands docility. Berry et al. (2005a) reported an increased likelihood of voluntary culling in temperamental, slow milking cows in New Zealand. Based on the results from the present study animals in Ireland have become more docile and faster milking over the past decade. This corroborates previous studies suggesting positive genetic correlations between milk yield and good temperament (Visscher and Goddard 1995). Nonetheless fast milking is associated with increased leakage and somatic cell counts (Luttinen and Juga, 1997), but at the same time very low milking speed may also have negative effects on udder health, caused by longer/more mechanical stress during milking and incomplete milked out udders.

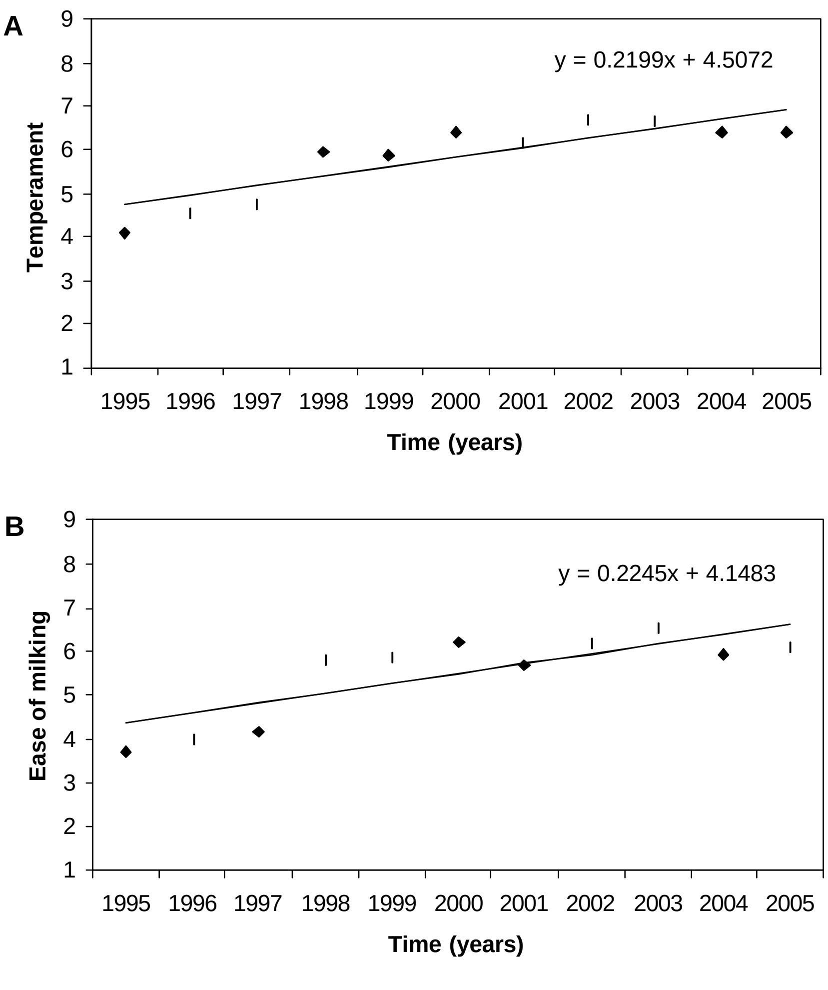

Figure 4.A-B. *Change in cow temperament (A) and ease of milking (B) from 1995 to 2005, with regression line fitted through least square means.*

Conclusions

The sample of Irish Holstein-Friesians included in the present study suggests that animals are getting taller, with deeper, more strongly supported and attached udders. Animals have also tended to become more docile and faster milking. One could argue that the sample chosen is somewhat biased in that it only includes animals with type measurements which were predominantly pedigree registered. Although true, the current GENE Ireland progeny testing program is sourcing bulls from predominantly Irish pedigree registered dams hence the trend in the national population is expected to follow, albeit with a time lag, the trend in the sample population included in the present study.

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