Guernsey Genetics
How are we doing and how do we compare?

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Introduction

In order to answer the question "How are we doing?" we first should establish what it is we are trying to achieve. This will vary from country to country, or even farm to farm, but is likely to be a mixture of several important traits.

Desirable genetic progress therefore begins with the basics, and requires a well-defined breeding goal. Modern breeding goals are typically much broader than was previously the case, and are made up of a combination of production, health, fertility, longevity and conformation traits. The results of changes in breeding goals in recent years are now becoming visible on farms and are an important reminder of the power of genetics. This impact is also seen in traits of which the heritability we can detect is low (e.g. fertility). The importance of including all relevant trait information should therefore not be under estimated, as ignoring any of these will inevitably lead to disappointing outcomes.

What drives genetic gain?

Once the breeding goal is clear, genetic gain is subsequently determined by a combination of the variation within the population under selection, selection intensity, accuracy and generation interval.

<u>Variation</u>

As the biological genetic variation is (largely) out of the breeders control, the implication of this for a breeding programme is to maximised the number of animals that are under consideration for selection, by seeking genetic material internationally, rather than on a local basis. Through the male side, Interbull already provides the service to compare daughter proven bulls internationally. For females and young sires, a sharing of genetic information between the breeding populations will be beneficial. In order to maintain genetic variation, especially within a population that is getting smaller, inbreeding should be minimised (see later section of this paper).

<u>Selection intensity</u>

By only using the very best international males and females for selection (as determined by the breeding goal), maximum progress can be achieved. The use of reproductive techniques such as MOET and IVF can assist in maximising selection intensity, but clearly this comes at a cost.

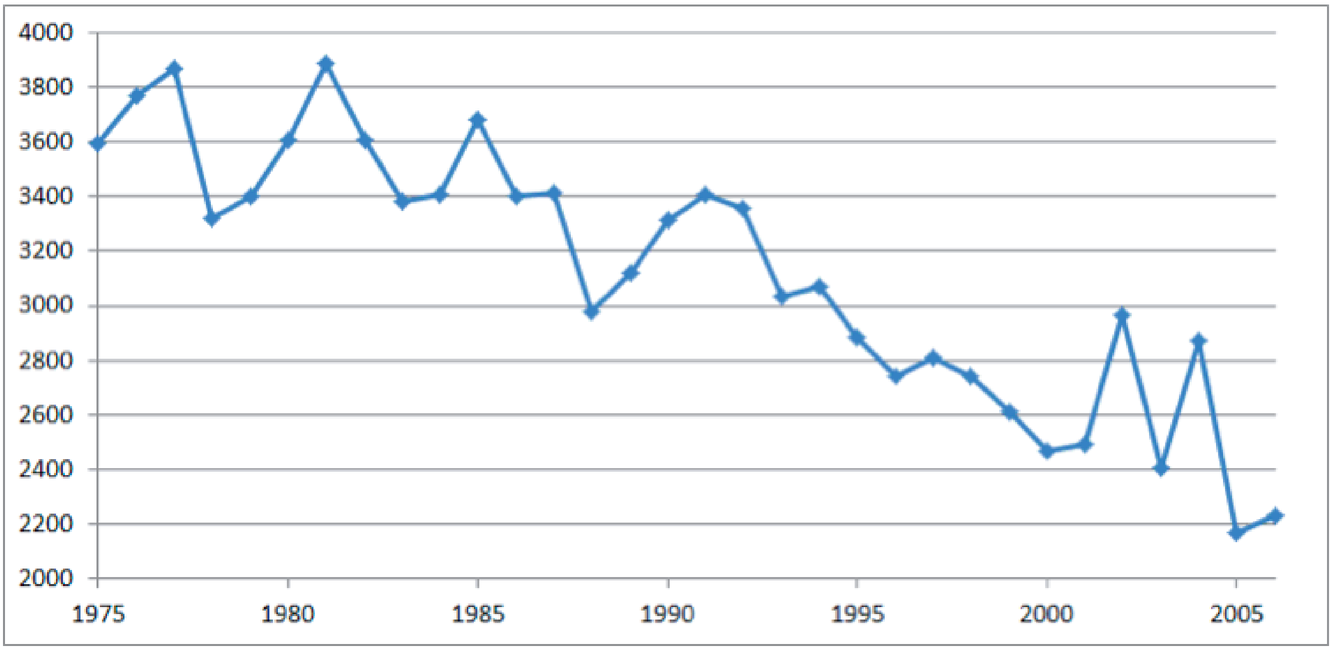
<u>Accuracy</u>

Selection should always be done on the most accurate assessment of genetic potential. This means that genetic indexes should take priority over phenotypic records, as these phenotypes can be biased by environmental circumstances. Accuracy of indexes can be further enhanced with high participation in national data recording. In addition reliability can also increase with the use of genomics (see later section)

Generation interval

By mating the very best bulls to the very best cow, and repeating this process with the next generation as soon as possible, the progress can be maximised. In practice this means that the younger generation of males and females should also be considered for the breeding programme and should not be ignored in preference of the older cow or bull. Of course, younger animals typically have lower reliability indexes, and so a balance between risk and reward has to be struck.

An analysis on the age of sires of the bulls in the analysis is showing that these are getting younger, and age of MGS is showing a similar picture. In recent years, the age of the sire was around 2200 days (equivalent to 6.01 years), compared to 3800 days in the ‘70s (equivalent to over 10 years of



age). This is a positive trend and show the Guernsey breeds health attitude towards using the younger generation of bulls in the breeding programmes.

What direction is the breed heading?

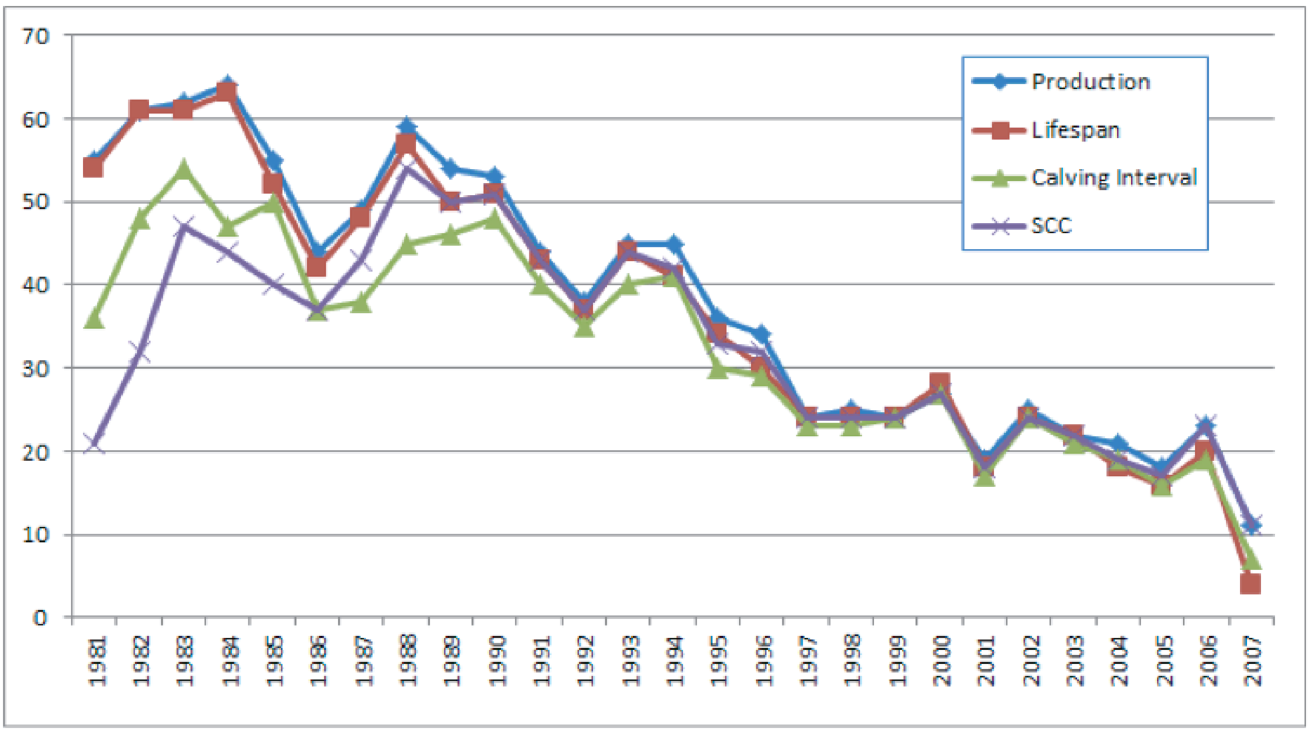
In this paper we will look at the direction the breed is heading based on genetic indexes, as these provide a more accurate picture than phenotypic data. The reason for this is because on-farm environmental factors (such as age at calving, housing system, feeding regime etc.) can influence the phenotypic performance we see on farm, and may bias the true genetic potential that breeders are trying to identify. Analysis of phenotypic data, although of interest, is for this reason far less informative to breeders than the information we can extract from genetic indexes, which have been corrected for these environmental effects.

Typically the majority of genetic change is driven by the sires available to the breeding programme. Therefore in this paper the genetic indexes used are those taken from daughter proven bulls participating in the April 2013 Interbull release. The results presented are all expressed on a UK genetic base and scale.

We will have a look at genetic trends for the production traits (milk, fat, protein), udder health (Somatic cell count), daughter fertility (Calving Interval), Longevity and a selection of conformation traits.

It should be noted that number of Guernsey proven bulls in most years is relatively small, in particular in the very last year (2007) the average is based on a low number and therefore the data shown for 2007 should be regarded as preliminary (figure 1). What is also clear from Figure 1 is that the number of bulls being progeny tested is showing a continuing downward trend.

Figure 1: Number of bulls with genetic index by Year of birth



Figures 2 to 5 give the genetic trends for bull with daughter proofs in interbull for the various traits.

Figure 2 below shows that the Lifespan index is showing a small positive trend over time. Lifespan in the UK is expressed as a Predicted Transmitting Ability (PTA) on a number of calving's scale. Over the last 27 years the average genetic merit of bulls has improved around 0.25 points, equivalent to an increase of around 75 days in milk.

Figure 2: Lifespan genetic trend by year of birth

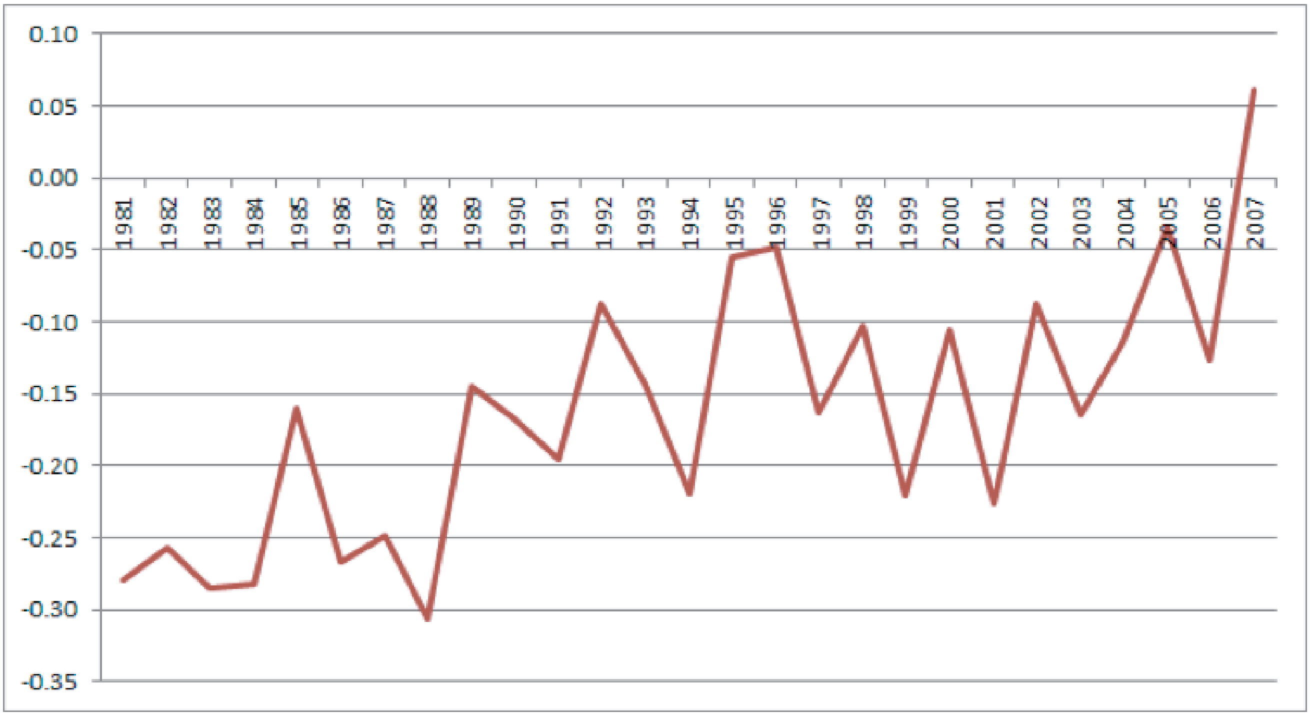
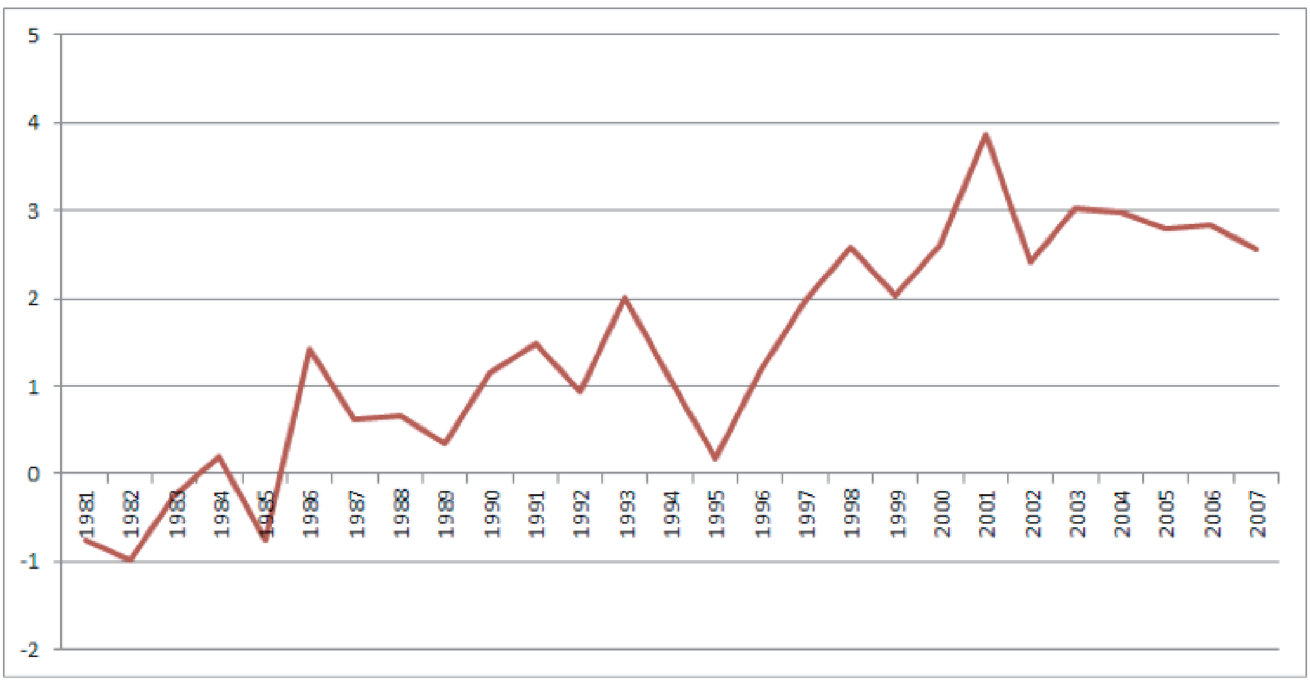


Figure 3 below shows the genetic trend for daughter fertility, expressed as calving interval PTAs. An increase in calving interval shown, means that daughter fertility on Guernsey bulls is gradually getting worse. Although latter years appear to show a levelling, there is no strong indication of an improvement yet, also bearing in mind that the 2007 average is as yet based on incomplete data.

Figure 3: Calving interval trend by year of birth



Somatic Cell Count genetic trends are given in figure 4 below. The UK index is expressed on a percentage scale, indicating that lower values equate to a percentage reduction in SCC and are therefore favourable. The graph clearly shows that the sires are improving for this trait since the late ‘90s when information on SCC became available as a genetic index to breeders.

Figure 4: Somatic Cell Count genetic trend by year of birth

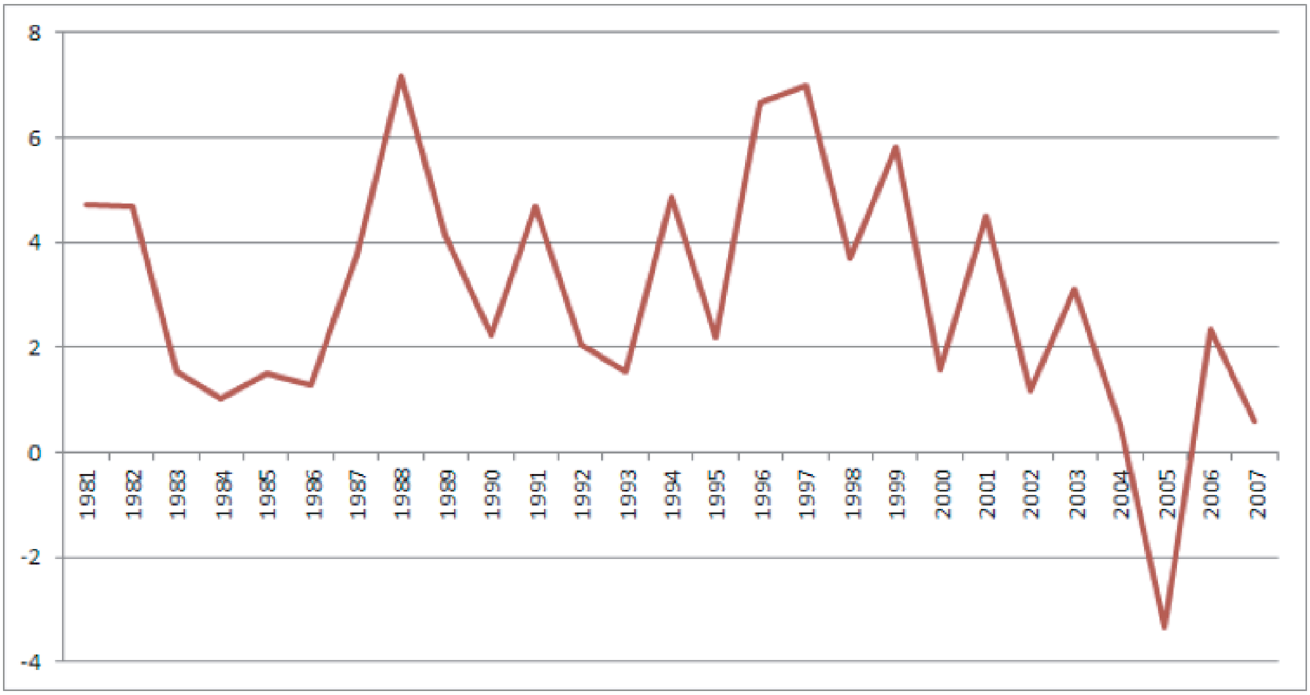


Figure 5 below shows genetic trends for the production traits, and not surprisingly all three traits show a strong improvement in the 80’s and 90’s. However, in the most recent years this improvement seems to have stabilised, perhaps as a result of the broadening of selection traits. The most recent year only has 11 bulls in the mean so far, and so this dip in trend is likely affected by incomplete data.

Finally, figure 6 gives the genetic trends for a selection of conformation traits. The graph shows a steady improvement in overall Feet and Legs and Udder composite index, but also shows that both Stature and Angularity continue to increase, with perhaps an indication that this may have slowed down in recent years. For future selection is would be wise to guard against further increases in stature and angularity as these may go against the desire for efficient and easy to manage cows.

So how does the breed compare?

In order for the breed to protect its future among the major dairy breeds it has to be aware of the genetic changes happening in other breeds’ genetics also.

For all traits, the Holstein breeds is making most change year on year, which is not surprising given size of the population. Large numbers of animals to work with globally, combined with high selection intensities and a reducing generation interval, all lead to changes in the Holstein breed typically being 2 to 3 times faster than those observed in other breeds.

Figure 5: Milk, Fat and Protein genetic trends by year of birth

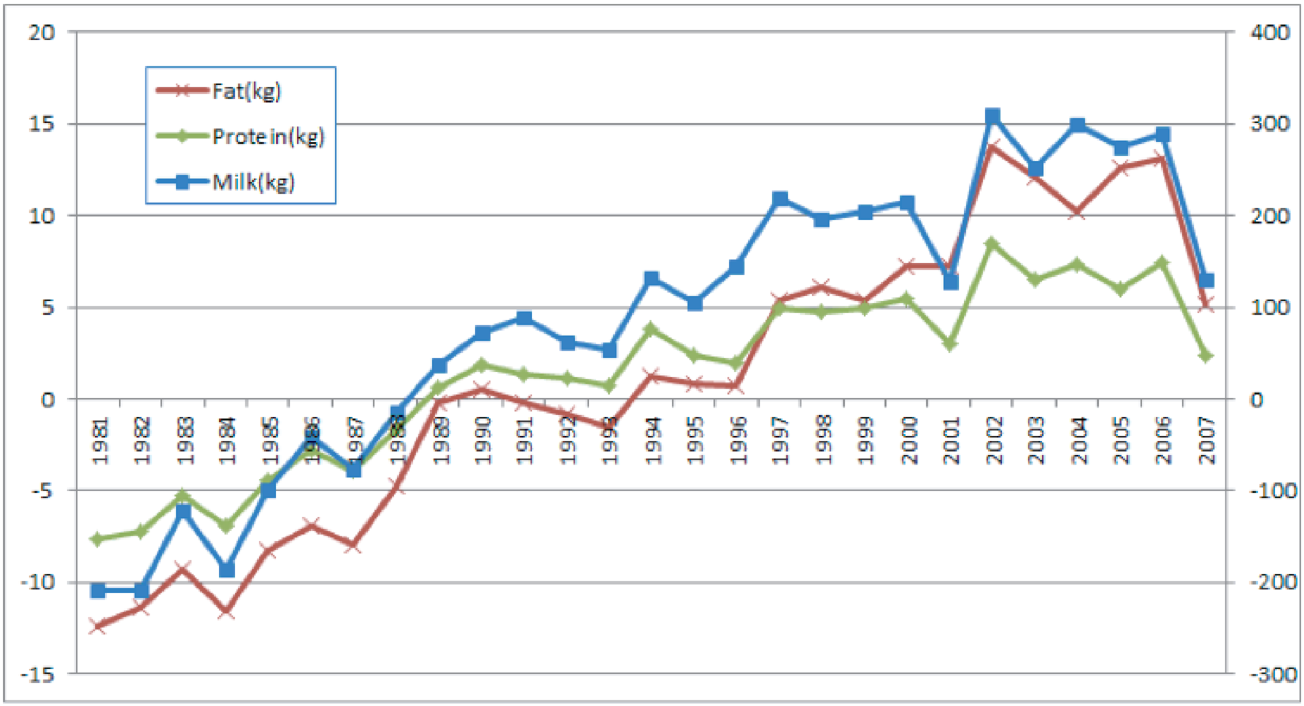
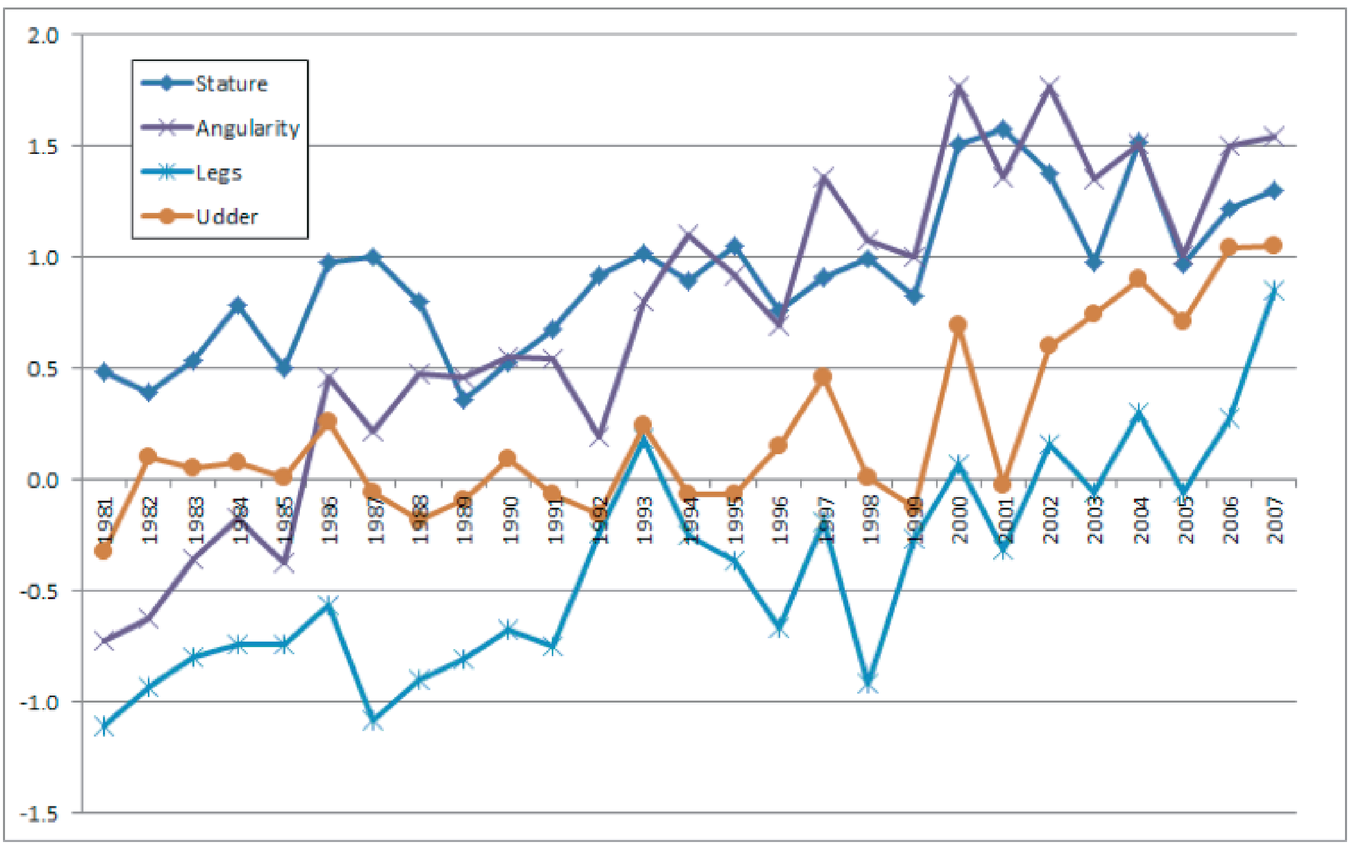


Figure 6: Selected conformation genetic trends by year of birth.



However, in comparison to the other non-Holstein dairy breed trends, the Guernsey breed is makes similar progress in Lifespan and SCC. For daughter fertility however, this is not the case, and the Guernsey breed is lagging behind the others.

Impact of Genomics

The availability of low cost, high density genotyping since 2008 has seen a rapid uptake in many of the dairy cattle breeding programmes. In order to interpret the genotype obtained, the technology is reliant on the availability of large number of daughter proven bulls with genetic indexes in order to establish a reliable reference population for calibrating the genetic marker effects (Single Nucleotide Polymorphisms; SNPs). This has meant that numerically larger dairy populations have had a distinct advantage in capturing its full potential, and have implemented and embedded the technology into their breed improvement programmes in record time.

Despite efforts to ‘translate’ the SNP marker effects from one breed to another, results have so far been disappointing at best. This is an important limitation, and puts the numerically smaller dairy breeds, such as the Guernsey, at a significant disadvantage. Research efforts continue in this field, and the Guernsey breeds participation in genomic project such as Gene2Farm is encouraging.

However, we should not dismiss the potential of establishing a within breed genomic evaluation. Whereas a few years ago the cost of genotyping may have been prohibitive; today with the rapid reduction of cost there may yet be opportunities. Even on relatively small numbers of bulls, implementation may be achievable. For example, North America recently launched genomic evaluations for the Ayrshire breed based on just over 600 daughter proven bulls with genotypes. With the knowledge that Interbull data show over 1000 Guernsey bulls with production daughter proofs, it indicates that there is potential. This does rely on a global united effort of the world Guernsey population to provide enough genomic data to realise genomic evaluations. Finding DNA (semen) on these bulls may be very challenging, but should not be dismissed as impossible without further investigation.

The accuracy of genomic evaluations with a limited number of bulls is never-the-less going to be lower than those with many 1000’s of bulls, but despite this, based on previous experience the genomic evaluations should be an improvement over simple parent averages, and therefore will aid the genetic progress of the breed.

Summary

The presented genetic trends of bulls provide a sense of direction for the breed and reveal some interesting and also somewhat worrying insight.

Genetic progress for production is levelling off, but this is offset with improvements in longevity and SCC. However, worryingly the decline in fertility does not yet seem to be halted and this should be a priority trait for the breed going forward.

In addition, the number of bulls tested each year is declining, which not only impacts the intensity with which selection can be applied in proven bulls, but also has implications for the potential to deteriorate inbreeding.

A quick analysis of inbreeding levels of these bulls shows that their inbreeding percentage continues to increase at a linear rate. This is reflected by national cow statistics that also show this increase in inbreeding. This should be addressed by the bull breeders, as this increase, in combination with reducing population size, is not sustainable in the long term.

Open sharing of genetic data on all elite males and females and an alignment of breeding priorities will further assist the genetic progress the breed may be able to achieve.

Finally, the global Guernsey federation should continue to pool resources in order to evaluate if a genomic bull reference population could be established, which would pave the way for implementation of genomic evaluations.

Your breed - Your choice - Your future !