

50 years and counting: the longest running genetic selection experiment



The Challenge

Genetic improvement plays a key role in the advancement of livestock production, bringing permanent, cumulative and long-term benefits to the sector that complement the more immediate short-term benefits achieved by introducing improved on-farm management practices. Individual animal traits are improved by selectively breeding superior animals to parent the next generation. Animal trait dynamics are complex and the interplay between production and fitness has caused issues in the latter when attempting to unilaterally improve animal production. The Langhill experiment set out to address this, while also examining the interaction of livestock with the environment.

The Research

This is the longest running genetic selection trial worldwide. The Langhill cow herd was established in 1973 and was designed to accommodate two equally sized genetic selection lines (ca. 100 cows each) that included a Control line consisting of daughters of sires of average genetic merit available in the UK and a Select line sired by high genetic merit bulls for milk component (fat and protein) yield. All animals have been closely monitored on the farm and individual data recorded on a continuous basis. The objective was to examine the impact of selecting for increased milk component yield on overall cow performance. In 1988 two production system groups (high versus low input) were introduced to the design, which evolved over time to reflect changing practices with regards to animal feeding and grazing. Cows from the two genetic lines are equally divided into the two production system groups in a design that allows the study of the interaction between animal genetics and environment. A multitude of scientific research studies have been conducted over the past decades using the unique data generated on the farm.



The Results

By design, results of the selection experiment partly reflect progress achieved in the UK dairy cattle population via sire selection. This is exemplified by the increase in milk fat and protein yield observed in the Control line (Figure 1) accompanied with a steadiness in animal health and reproduction (Figures 2–4). Expectedly, the Select line has a higher production by 20–25% due to the additional emphasis placed on milk fat and protein yield. Results also demonstrate the possibility to continue increasing milk production while controlling disease, as manifested by a reduction in milk somatic cell count (a mastitis indication) and number of distinct disease episodes (Figures 2 and 3) in the Select line, whose profile is now similar to that of the Control line as far as animal health and reproduction are concerned.

These results pertain to the past 16 years, which coincide with a gradually balanced emphasis being placed on animal production and fitness traits in the UK breeding programme (<https://ahdb.org.uk/dairy>), and include cumulative benefits achieved in the previous time period.

The Impact

Nearly 50 years of uninterrupted recording and close monitoring of the Langhill cows have generated a trove of unique data that underpin scientific research on multiple topics. The density and uniqueness of data have enabled the derivation of valuable phenotypes reflecting animal biology and the identification of genes associated with the expression of these phenotypes. Collective outcomes from past and ongoing research are shedding light on the impact of genetic selection on key animal functions associated with health, reproductive performance, feed intake, body energy, immune profile, and greenhouse gas emissions. Results inform optimal breeding programmes and strategies for the long-term benefit and sustainability of the dairy sector nationally and globally.

The Future

A two-fold challenge is expected to dictate the farm's future direction: (i) the need to expand breeding goals to improve new animal functions such as those related with feed efficiency and environmental impact; (ii) the continuous reshaping of the dairy industry manifested in the ever-evolving interplay among farmers, breeders, societies and private companies. Ownership and possession of relevant information will determine the success of all involved. This presents the opportunity to capitalise on the unique database and recording system and consolidate the farm's role as a source of rich high-quality novel phenotypes for cutting-edge research. Further focus on automated recording devices will enhance the feasibility of routine precision phenotyping. The unique experimental design may also be used to derive and analyse phenotypes in "specialist" environments, for example reflecting the grazing practices and forage intake in the two cow production systems in place.

In conclusion, new challenges and opportunities shape the future environment of the dairy sector, warranting solid data and management practices for the farm to remain in pace with the external developments and ensure continuing success over the next 50 years and beyond.

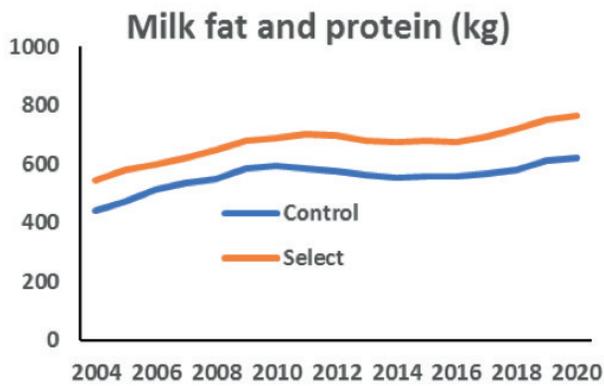


Figure 1. Cumulative lactation milk fat and protein yield (kg) per calendar year in the Control and Select genetic lines

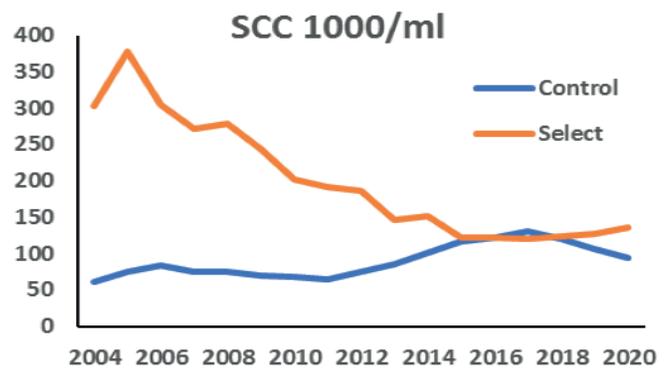


Figure 2. Average milk somatic cell count (SCC; 1,000/ml) per calendar year in the Control and Select genetic lines

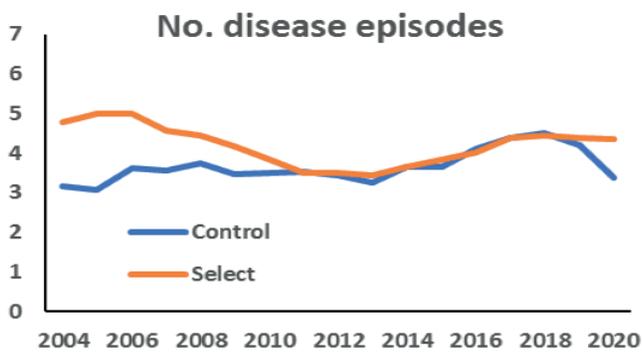


Figure 3. Number of disease episodes (mastitis, reproductive, lameness) per calendar year in the Control and Select genetic lines

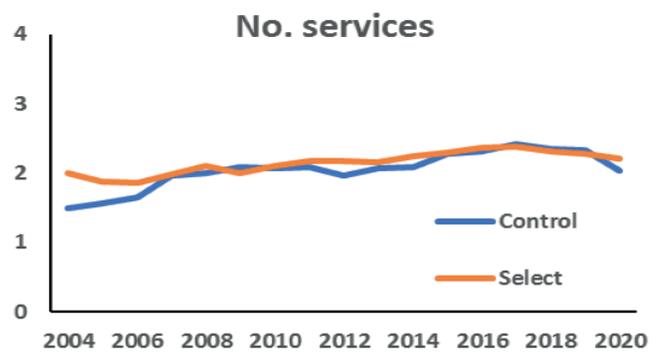


Figure 4. Number of services required per conception per calendar year in the Control and Select genetic lines



Additional Information:

Publications:

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