Ten Years of Breeding to International Pedigree Jersey Bulls

A Report to the Royal Jersey Agricultural and Horticultural Society

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May 2018

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Conclusions

This first report has tried to describe the pattern and degree of uptake of imported semen since 2008. It has documented the changes in milk production per cow and in their conformation and reproductive performance. The actual changes have almost all been favourable and the genetic trends strongly positive. While there was considerable opposition to importing back in 2003, the farming community is now almost entirely convinced that it has been the correct decision. The previous fears expressed by members of the public and some farmers included importing non-Jersey genes, destroying breed purity, and bringing in new diseases. These have not been realised. It is probably too soon to draw firm conclusions on any changes in health and fitness traits in the cattle, but no serious concerns have been raised. While annual milk yield per cow has increased considerably, this has not produced an unsaleable surplus at the Dairy. The extra supply was limited by a managed reduction in the number of milking cows, but the development of profitable export markets has absorbed the considerable expansion in total volume.

It is hoped that this short report will provide sufficient background for all stakeholders as the author proceeds to consult more widely. The results of these discussions will lead to his proposals for 'A breeding plan for the Island Jersey herd – 2018-2028' in Report 2. The target completion date is 31 August 2018.

Acknowledgements

Many of the figures for the current report were produced by Henry Richardson, Senior Data Analyst, and his colleagues at the National Bovine Data Centre, based upon data supplied by AHDB-Dairy. The underlying numbers and equivalent information for other type traits are now lodged with the RJA&HS office and are available on request. Jersey Dairy supplied some industry statistics.

Other data, and much information, were willingly supplied by staff of the RJA&HS. David Hambrook has managed and facilitated this fascinating development since before the first semen was imported. It has been a pleasure to work with such a competent professional over the past five months, and I look forward to our further collaboration as we evolve a plan for the next decade.

Schedule of Acronyms and Definitions

AHDB-Dairy	Agriculture and Horticulture Development Board. One of the divisions of the statutory levy board funded by GB dairy farmers and others in the supply chain to help them be competitive
AJCA	American Jersey Cattle Association. The breed society in the USA
BVD	Bovine Viral Diarrhoea
CHeCS	Cattle Health Certification Standards. A self-regulatory body for cattle health schemes in the British Isles
CI	Calving Interval. Number of days between successive calvings
CIS	The Cattle Information Service. Provides a herd management system developed by Holstein UK. Linked to the National Bovine Data Centre (formerly known as the Centre for Dairy Information)
DIY(AI)	Do-it-yourself Artificial Insemination. Farmers inseminate their own cattle using frozen semen stored in on-farm flasks. This replaced a previous service using professional inseminators
DNA	Deoxyribonucleic acid. A thread-like chain of nucleotides carrying the genetic instructions used in the growth and reproduction of living organisms. There are billions of nucleotides strung together along the chromosomes. A gene is a sequence of DNA which codes for a molecule that has a function. Genes may exist in two or more forms called alleles. A haplotype is a group of alleles inherited together from a single parent. JH1 and JH2 are two haplotypes associated with lowered fertility in carriers. The sum of all the genes in an individual (affecting a specific trait) is its genotype for that trait. Its total array of genetic material is its genome
EBL	Enzootic Bovine Leucosis
EBV	Estimated Breeding Value. Twice the amount by which an individual's progeny (from random mates) are expected to differ from the population average
EU	European Union
EGENES	EGENES-SRUC. A department of the Scottish Rural College in Edinburgh which provides genetic evaluations for UK dairy cattle on behalf of AHDB-Dairy
FI	Fertility Index. A complex prediction of an individual's ability to produce daughters with above average reproduction derived from several measured traits
HUK	Holstein UK. The breed society for the Holstein breed
IBR	Infectious Bovine Rhinotracheitis

JBPS	Jersey Bull Proving Scheme. An improvement programme conducted on the Island between 1988 and 2008 based upon identifying ('proving') superior sires through an initial sample of their daughters
JCMS	Jersey Cattle Movement Service. Run by RJA&HS since 2003 to maintain a database on the location of all animals throughout their lives, compliant with EU regulations
JHMS	Jersey Herd Management System. The Island-specific system provided today by CIS/NBDC and controlled by JIG
JIG	Jersey Island Genetics. Established by RHA&HS in 1994 to handle the marketing of cattle and genetics exported from the Island. From 2008 it also took on the role of controlling and organising the import and distribution of frozen semen. JIG also oversees the management of the cattle health scheme
JMMB	Jersey Milk Marketing Board. This farmer cooperative was established in 1954. It is now responsible for the collection processing and marketing of all milk produced in the Island. Its commercial activities are vested in Jersey Dairy, which has had modern facilities on the RJA&HS site since 2010
LEAF	Linking Environment and Farming. The leading UK charity delivering more sustainable food and farming. It has recently merged with FACE (Farming and Countryside Education). LEAF awards its marque to farm businesses which meet its standards of sustainable practice
NBDC	National Bovine Data Centre. Previously known as the Centre for Dairy Information. Provides analysis of data for the improvement of UK dairy production to guide breeders to make informed decisions
NMR	National Milk Records. Another provider of milk recording and herd management services, used by RJA&HS until the change in 2008 to CIS
£PLI	Profitable Lifetime Index. A genetic index which predicts the additional profit margin which any daughter of the individual cow (or bull) is expected to create over her lifetime, compared with daughters from an average cow or bull
PTA	Predicted Transmitting Ability. The amount by which an individual's progeny (from random mates) are expected to differ from the population average. It is thus one half of the Breeding Value
RJA&HS	Royal Jersey Agricultural and Horticultural Society. Formed in 1833 when it immediately adopted rules for the improvement of cattle breeding. It established the Herd Book in 1866
SRUC	Scottish Rural College. Its EGENES department has a contract with AHDB to provide genetic evaluations for UK dairy cattle based upon production type and pedigree data supplied by the recording companies (e.g. CIS)
SCC	Somatic Cell Count. The total number of cells per ml in milk. These are primarily leukocytes (white blood cells) produced by the immune system to fight inflammation in the udder or mastitis. Hence SCC is used as a measure of milk hygiene

SNP (pronounced SNIP)	Single Nucleotide Polymorphism. A fragment of DNA which has been identified by analysis to exist in more than one form between individuals. Genomic analysis seeks to identify associations between these forms and traits of interest to the breeder. Once established, then the analysis of DNA from a tissue (blood, semen, hair follicle) can give direct insight into an individual's breeding value, independent of any performance data from itself or its relatives
TB	Bovine Tuberculosis
US	United States of America
USDA	US Department of Agriculture. Corresponds to the agricultural sections of the UK's Department for Environment, Food, and Rural Affairs

1. Background

This first report will look backwards over the years from 2008 until now. Its main purpose is to set the stage for the second report 'A Breeding Plan for the island Herd, 2018-2028'.

At the outset it may be useful to recap briefly on developments on the Island which led up to the historic decision to allow semen imports in 2008.

During 2001, some 59 herds produced over 18 million litres of milk, much more than can be consumed on the Island. A significant volume was exported, but these markets were lost in 2001 and 2002 which forced a sudden and drastic contraction. This was achieved in part by encouraging entire herds to cease production. In early 2003 the conclusions from two external reviews of the sector were accepted by the Jersey Milk Marketing Board (JMMB) and built into the new business plans of Jersey Dairy. Following these, the Council of RJA&HS asked the author to make recommendations on the future genetic management of the Island herd; including whether it should remain closed to imports. That report was presented in July 2003.

It confirmed the existence of improved strains of the breed, particularly in North America and Denmark. Their much larger populations, and their earlier adoption of science-based improvement programmes, had produced superior production and efficiency – a fact well known to several Island breeders who had already visited those countries!

The 2003 study reviewed efforts made within the Island since 1988 and noted the deficiencies of the Jersey Bull Proving Scheme (JBPS). This was a classic progeny testing programme, conducted with only modest support within a small total population. Even an improved version could not expect to make up the performance lag behind the other available strains.

Objections to importation included the risk of introducing genes from other breeds and thus damaging the Island brand; of bringing new diseases into the Island; and of destroying a unique situation of carefully recorded breed purity. The report considered these risks, but strongly recommended importation while proposing methods to avoid them. It also dismissed the argument that higher-yielding cows would be of no value where total milk was already in surplus. There were many other traits which breeders wanted to improve, and in any case, higher yields per cow could lead to keeping fewer total cows while still providing Jersey Dairy's needs.

RJA&HS Council accepted the main recommendations over importation, but the membership, including some herdowners, rejected them in October 2003. Over the next five years, the JBPS became even less effective as the States of Jersey cut the subsidies. Participation was reduced, making it more difficult to generate accurate daughter proofs.

Meanwhile, the Council continued to push for importation, joined by the JMMB's revised plan for Jersey Dairy, and the majority of milk producers. Finally, a States of Jersey Scrutiny Panel reviewed the subject in public hearings, and recommended in favour. These combined forces led to a States vote in July 2008 to change the law and allow semen imports.

2. Implementation of Recommendations from Section 2 of the 2003 Bichard Report

2.1

The main recommendation (2003/2.9) was that all herds should be permitted to import frozen semen from high-reliability proven sires, chosen to meet their own improvement goals. Jersey Island Genetics (JIG) had originally been established (by RJA&HS) in 1994 to handle the marketing of cattle and genetics **exported** from the Island, with the help of States funding. In 2008 it added to this role the reverse function of controlling and organising the **import** of frozen semen.

David Hambrook has worked closely with herdowners to identify suitable bulls in USA, Canada, Denmark, UK, and Australia. Details are circulated to all herds twice a year. Owners then make their choices and their orders are aggregated, placed, and arranged by JIG. The semen is imported (mainly from UK companies with access to international supplies), and bulk-stored in new modern facilities at the RJA&HS. Parcels of semen are delivered to herds as required, with JIG staff taking responsibility for this, for maintaining the on-farm liquid nitrogen tanks, and for ordering the necessary equipment and supplies.

2.2

Naturally, all imports must conform to the Island's strict EU-compliant health regulations. JIG has ensured that all semen sources have provided the necessary documentation.

2.3

It was an essential condition that breed purity should continue to be maintained. RJA&HS Council approved an amended set of Rules of the Jersey Herd Book in January 2008. These stipulated that bulls not born in the Island, and licenced for use through imported semen, must be at least seven-generation purebred and registered Jersey animals, recorded in a recognised Jersey herdbook or other official registry, and have no known ancestors of any other breed. JIG has endeavoured to conform to these rules in two ways: first, by requesting evidence from the sources of bulls that the seven generation checks have been satisfied; and second, by confirming that a DNA sample has been submitted, and that no evidence has been found of genetic material originating from outside the breed. No such test can provide absolute proof, but the probability of wrongly approving an individual is extremely small.

There was an early event which emphasised the importance of this second check, when the dam of a US bull used on the Island was later confirmed to have genes from the Red Holstein breed. The few Island-registered progeny were immediately de-registered from the Island herdbook, and treated as beef crossbreds.

Nevertheless, this example has consequences which will need to be addressed in Report 2. The American Jersey Cattle Association (AJCA) has retained thousands of descendants of that bull's dam within its herdbook, though prefixed in a way which makes them identifiable. Such 'grading-up' is commonly allowed in other herdbooks of all species, but not, so far, within the RJA&HS.

2.4

Recommendation 2003/2.10 was that several precautionary measures should be implemented before any imports. An adequate semen bank from Island-born bulls should be retained. This should allow pre-importation bloodlines to continue to be used, and/or to be reintroduced in the future should this be thought useful. JIG arranged for some 40K straws from 480 bulls to be kept in two sets in the Trinity facilities. In addition, 25 straws from each of 50 bulls, stratified across the previous five decades, have been sent for long-term storage in a secure USDA facility in USA.

2.5

It was advised that a DNA bank should be created for future research, based on blood samples from pre-importation cows. This has not been done. The semen banks do, of course, contain tissue from which DNA could be extracted, and there are still females alive which contain no imported blood. Around 49 such heifers were registered in 2017 (out of a total of 681), but their numbers will continue to decrease.

2.6

The third precautionary measure, which was recommended to be implemented before the first semen imports were allowed, was to add a comprehensive health monitoring programme to the existing schemes for milk recording and herd management. Producers and veterinarians would be required to provide the data, including all treatments and interventions for disease, foot problems, dates and reasons for culling or death. The purpose is in part to give early warning of any problems arising from the use of imported semen. But the main reason would be to provide data to enable more accurate genetic selection for 'functional traits', herd life, and improved health.

The Scandinavian countries have long implemented such comprehensive health recording in all their breeds. As a consequence, they have earned international recognition for progress made in many traits often dismissed as of low heritability (except in the Holstein where breeders have continued to use imported sires from other countries).

JIG oversees the management of an Island-wide cattle health scheme. Of the three statutorily tested diseases, TB and Brucella '*test free*', and one last clear screen for EBL secures official '*freedom from*' status for this disease. The Island secured CHeCS accredited status for the three important cattle diseases, BVD, IBR and Leptospirosis in 2012, following which Jersey now holds OIE '*freedom from*' status for IBR. In addition, milk samples are submitted at least annually and screened for Johnes disease. Nevertheless, this scheme still falls short of the comprehensive recording which has been routinely implemented so successfully in Scandinavia for many years – and which has produced such valuable results.

2.7

Other recommendations (2003/2.11, 2.12, 2.13) concerned the continued provision of inseminator services, facilities for local collection and freezing, and a back-up semen store to guard against interruption of imports by a disease emergency in UK.

The previous inseminator service has been satisfactorily replaced by farm staff becoming proficient in DIY. The limited calls for local semen processing (and embryo transfer) have been accommodated by bringing in specialist technical help as needed, using new lab facilities at the Society.

JIG has decided not to keep an insurance supply of imported semen for use if supplies from UK are interrupted. The assumption is that if imports via UK were blocked by disease restrictions, then supplies from US and Canadian bulls could be routed via other European ports of entry. Small stocks do exist on most farms, and around 1450 unsold units (representing six months usage) are currently in the central store, left over from previous purchases.

2.8

Finally, it was recommended (2003/2.16) that consideration should be given to the use of beef semen, from colour marking breeds, but with a prohibition on breeding from any crossbred offspring. Aberdeen Angus semen was indeed imported and used from the outset in 2008. The extent to which this new freedom has been utilised is summarised later.

3. Continuing Development of the Dairy Industry

Before assessing the impact of using imported semen in the 10 years since 2008, it is worth outlining a few other changes both on dairy farms and the services they employ.

3.1

By the time the 2003 policy reviews were being implemented, both the number of herds and the total number of cows were much reduced from the peaks at the turn of the century. In 2003, some 3600 cows were in 35 herds. But in the next five years, before semen was imported, these figures declined even further to some 3050 cows in 30 herds. By 2016, the remaining 21 herds contained 2731 cows, an average herd size of 130. The forecast is for a continuing managed reduction toward 15 or so professional dairy units with enlarged modern facilities.

The JMMB licences individual farms to deliver specified volumes of milk in each seasonal period at the current price. Excess deliveries are heavily penalised on price. These annual 'quotas' may be increased to compensate for other herds ceasing production, or to fulfil new export contracts. Such increases are awarded among those farmers who apply by an independent panel who consider a wide range of factors. This system of supply management presently includes an element of compensation to those herds which announce their intention to cease production well in advance.

3.2

The provision of services to this changing production sector has also increased in important ways over a period when the States has reduced both its direct involvement and level of support. As a result, both RJA&HS and the JMMB have taken on more responsibilities.

JIG controls the Jersey Herd Management System and in 2008 it changed the service provider from National Milk Records (NMR) to Cattle Information Services (CIS) the herd management and milk recording system provider linked to the Centre for Dairy Information. CDI has recently rebranded as the National Bovine Data Centre (NBDC). An Island-specific system was developed, compatible with others used in UK, including by UK Jerseys. RJA&HS staff record milk yields, normally once a month, morning and afternoon, and take milk samples.

The Agricultural Department of RJA&HS controls the herdbook function, and also the Jersey Cattle Movement Service (JCMS). This was formed in 2003 to maintain a database compliant with EU regulations. The pedigree data system was upgraded in 2008 to accommodate Jersey animals born outside the Island, and their Island-born offspring. Whilst the majority of herds use the comprehensive herd management software package supplied through CIS, JIG staff record milk yields on a monthly basis. In support of Jersey Dairy and the Environment Department's obligations to record data, the farms utilise various contract options, from an independent recorder taking individual cow samples over both a PM and AM milking (full recording), through to factoring (AM one month, PM the next), through to two of the smaller herds using a DIY programme.

Classifiers employed by Holstein UK (HUK) visit the Island every five months (hence two or three visits per year) and carry out phenotypic scoring on all milking heifers. These data are used, together with production and reproduction records, by the genetic statisticians in EGENES, a specialist unit within the Scottish Rural College (SRUC), to compute Estimated Breeding Values (EBVs) for all animals. Updated values are published three times a year by AHDB-Dairy. All phenotypic and production data for the UK and Island Jersey populations are evaluated as a single merged population with the same index parameters before the two Societies receive their respective data back following the evaluation processes. Some farms also make use of the Triple A assessment system and use the scores made by an independent assessor to plan their matings.

RJA&HS took over insemination services from the States in 2003, but by April 2015 all farms had changed to DIY insemination, with some of the very small producers supported by neighbouring farmers or vets.

Two private veterinary practices provide health advice, vaccinations and pregnancy checks. Some farms routinely utilise specialist hoof trimming contractors, and several use technical nutritional advice and products from two UK-based feed compounders. Farm management advice and production costings may be undertaken by the UK Kite Consultancy whose staff arrange visits and run training meetings. All farms will soon have to be accredited within the LEAF system (Linking Environment and Farming) in order to provide evidence that food has been produced sustainably with care for the environment.

4. Uptake of International Genetics

The RJA&HS staff threw themselves behind the campaign to change the law on importation. But when the debate had been won, they allowed individual herd owners to make their own decisions on whether and how much to use the imported semen. Naturally, there was considerable pent-up demand from some farmers, many of whom had worked continuously from the Society's unsuccessful vote in October 2003 to the favourable States vote in July 2008.

Of the 30 herds which were active when the first semen became available, 21 are still present today. Eight of these, now containing more than half of all cows, used almost 100% imported semen as soon as it was permitted. The remainder were more cautious. Three resisted until new management took over, and then changed completely. Six have still only used the new bulls sparingly or ventured into using local-born sons sired by imported semen. One large and two small herds have not changed at all.

Overall the uptake was rapid, as illustrated by the percentage of registered heifers sired by imported semen in the calendar years 2008 to 2010 and shown in Table 4.1.

Table 4.1 The percentages of registered heifers sired by imported semen.

Year	%
2008	0
2009	39 (part year)
2010	64

After this, some herds started to make use of Island-born bulls which were the products of the first imported semen, and then later those having inherited international genes from their dams. The uptake of these several sources of international genes, as evaluated by the percentages of total heifer registrations has continued to increase (Table 4.2). Some 92% of the 2017-born cohort were sired by bulls containing at least some imported blood.

While this table summarises the figures over all 10 years, the successive annual figures have of course been available in each year's Annual Reports. Society staff have constantly monitored these developments in the Island herd and set them out clearly.

Bulls born in USA and Canada were the most popular choice from the outset, and have continued to this day, siring 56% of the 2017-born heifers. Danish bulls have been next, at 12% of that cohort, with those from UK third, providing 5% in 2017. Locally-bred bulls containing some imported genes, when once they become available, have not gained a major role, siring only around 20% of recent heifer crops.

Table 4.2. Numbers of registered heifers sired by different types of bulls by years

Origin of bulls siring registered heifers 2008-2017									
	Island	**USA/ Canada**	**Denmark**	**UK/ Ireland**	**Australia**	**All or part overseas**	**100% Island**	**All types**	**% from sires with imported blood**
Year	**Breed code**					**Breed code**			
	74 (<100%)	**76**	**66**	**04**	**68**		**74**		
2008							917	917	0
2009		273	93			366	574	940	39
2010		423	116	7		546	308	854	64
2011	47	430	118	18		613	254	867	71
2012	187	349	85	32		653	196	849	77
2013	173	366	91	37		667	150	817	82
2014	122	414	122	39		697	140	837	83
2015	161	387	137	45	8	738	96	834	88
2016	174	379	88	42		683	101	784	87
2017	126	381	84	36		627	54	681	92
All years	**990**	**3402**	**934**	**256**	**8**	**5590**	**2790**	**8380**	**67**
%	12	40	11	3	-	67	33	100	

Figure 5.1 Average penetration of international genes into the Island heifers

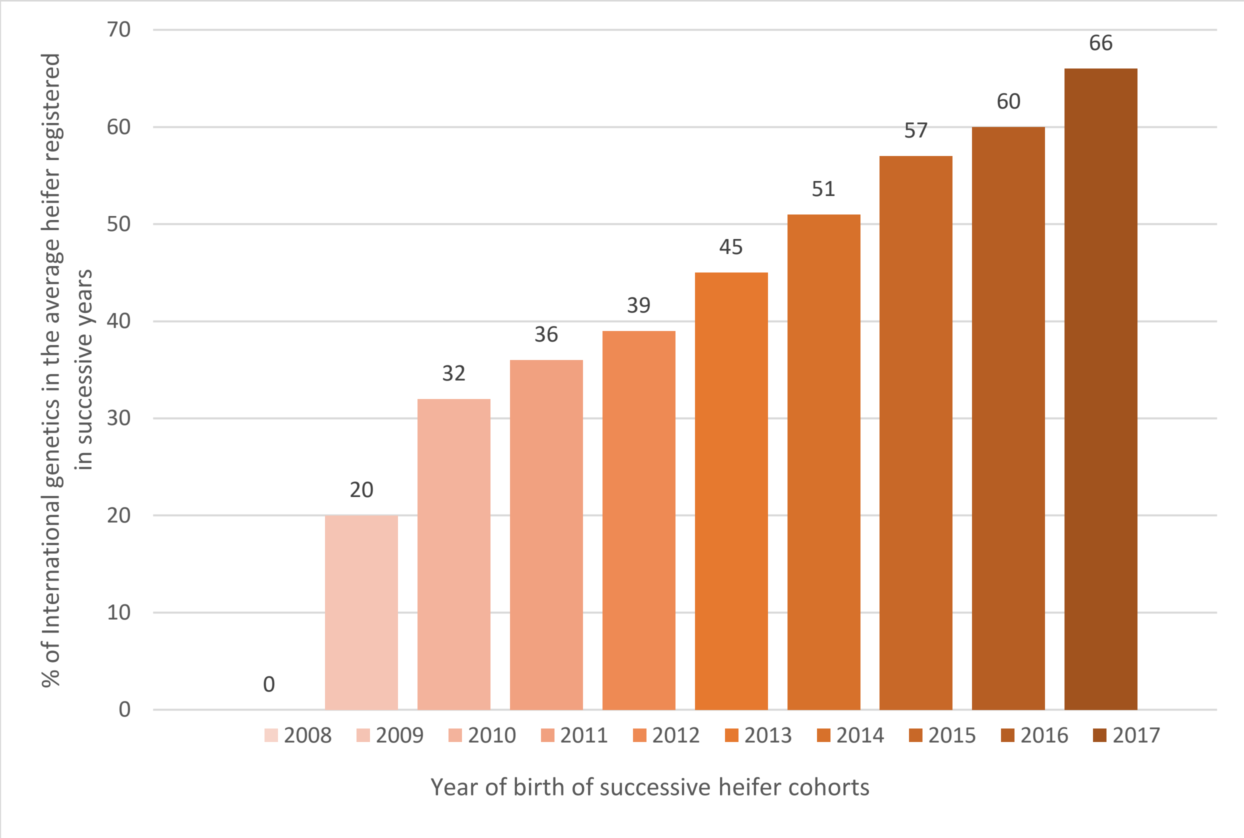
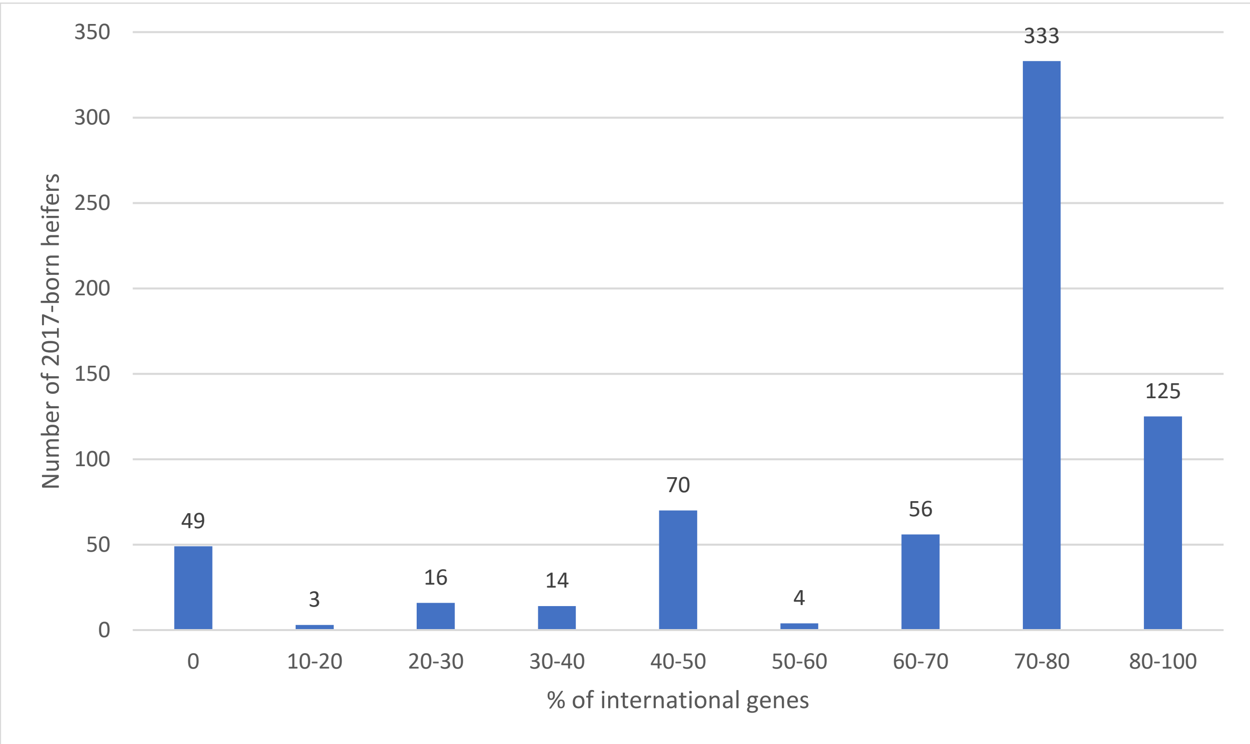


Figure 5.2 Variation among 2017-born heifers in their % of international genetics



5. Penetration of International Genetics

5.1

It is not possible to assess the degree to which the Island herd has absorbed this imported genetic material just from a knowledge of the sires used each year. For this it is necessary to use the detailed pedigree records. (Even these assume that maternal genes and paternal-derived genes continue to be passed down in equal proportions each generation.) Using the predicted percentages of imported material in each registered heifer, Figure 5.1 shows how the average has increased in successive calf crops, reaching 66% in 2017.

Of course, there is wide variability among these heifers (Figure 5.2) with 49 animals (7%) still having no imported genes, while 125 (19%) had more than 80%. Almost half of all the heifers (333) appear to be the results of two cycles of imported semen (0→50%→75%), and the 125 would be from three generations (→82.5%). If herds continue to rely heavily on overseas-born bulls, then the average percentage will slowly build up towards 100% over many years. The arguments for and against allowing this to happen will be considered in Report 2.

5.2

These figures all relate to the annual calf registrations. Since these animals will only start milking around two years of age, and then remain in the herd for several lactations, the proportion of imported genes in the Island's milking herd will lag quite a long way behind. Using the historic proportions of each parity group (or birth year) in the herd (from the 2014 recording year), it can be estimated that during 2018 the average percentage in the milking herd will be around 47%. To the extent that some herds have been bringing in heifer replacements faster than normal, then it seems likely that this percentage may already have passed 50%.

5.3

When stating that the average percentage of imported genes in the 2017-born crop has risen to 66%, it is NOT correct to say that only 34% of the pre-2009 Island genes remain in these heifers, or that two thirds of the Island's heritage has been lost.

Island cattle were sent overseas for at least 150 years. They carried with them samples of all or most of the original genes which often occurred in two or more forms (alleles or haplotypes). Their new owners then selected males and females to continue and expand their herds within herdbook structures. They tried to shift the frequency of those alleles which affected production or type traits by favouring 'bloodlines' which pleased them. As a result, some alleles might have become fixed (100%) and others eliminated (0%).

Natural mutation might introduce new forms or reintroduce lost ones. A few of these mutants which were found to be advantageous (or linked on the chromosomes to other genes which were) will have become established. But not many – since new mutants are overwhelmingly harmful for survival.

As a result, the imported semen from carefully chosen bulls, conforming to strict purity checks, will mainly contain the same alleles that had originally left the Island; though a proportion will have changed frequencies. We actually have evidence for this from the DNA analyses done in the USA on the semen samples sent over to form the semen bank. These showed just how similar the Island and US sub-populations still are, compared SNP (Single Nucleotide Polymorphism) by SNP across thousands of positions along the chromosomes.

Two new harmful haplotypes which have become established in the North American cattle strain (both lowering fertility) were first recognised in 2012. Since then, and where tested for these haplotypes, the RJA&HS and JIG are careful to ensure herd owners have all the information available to decide whether to use such bulls. It was discussed whether to reject such identified bulls, but as a good number of the heavily used bulls in the 2008 to 2012 importations were haplotype carriers, this was considered to have as many negatives as positives and would have been a case of trying to 'shut the door after the horse had bolted'. In addition, and at that time, it was not known at what level the Island population was already affected. Ad-hoc screening of the pre-2008 local population since would indicate that Jersey Haplotype 1 (JH1), the more prevalent haplotype, was not present on the island before 2008. The lower incidence haplotype JH2 does appear in profiled stock with no international genetics in the pedigree. With this information to hand very little semen from international JH1 carrier bulls is now ordered.

Thus the 'new' or 'international' genes are overwhelmingly the Island ones which have been away 'on holiday', though returning with some important changes of frequency. Overseas breeders have been able to use their greater scale, earlier access to scientific procedures, and different market conditions to make genetic changes which have been welcomed by most of the Island's farmers.

6. Concentration of Bloodlines

In some other countries, where an existing population has been 'refreshed' or 'improved' by importing stock from a related population, there has been a danger of subsequent inbreeding. This can happen if only a few live males are imported, because of cost or health constraints, and are then used widely. This should not be a problem in Jersey because semen has so far been brought in, in restricted amounts, from at least 172 international bulls from a variety of different strains. These have sired registered heifers, with an average of 27 per bull. (This number may increase further as the newer imports continue to be used.) The most popular few have left quite large daughter groups. Seven North American bulls and one Danish have each left more than 100, with two siring more than 250. By contrast, 367 Island-born bulls averaged some 10 daughters per sire, with only four leaving more than 50.

The 22 imported bulls who left more than 50 daughters contributed 30% of all registered heifers during the period, and also 30% of the registered bull calves. Clearly, there is potential for incurring future inbreeding to the most popular bulls, particularly if they are already related. This subject will be addressed further in Report 2.

7. Use of Beef Breed Semen

There have always been a few purebred Jersey calves designated as 'Jersey Beef' when registered as calves. They were destined to be reared for veal, or to heavier weights, and made a small contribution to the local beef supply alongside culled cows. Table 7.1 shows the numbers of crossbred calves (sired mainly by Aberdeen Angus) which have to some extent replaced these purebreds.

Table 7.1 Numbers of crossbred beef calves registered each year

Year of birth	Jersey x beef calves
2009	23
2010	123
2011	156
2012	205
2013	177
2014	163
2015	160
2016	183
2017	164

8. Performance Trends from the Island Herd

8.1

Performance data from all Island herds are received by the National Bovine Data Centre (NBDC, formerly CDI) and processed. Figures 8.1a and b, 8.2, and 8.3 show the trends in average performance for milk yield and components, somatic cell count (SCC), and calving interval (CI). The data are set out in table form for both the Island and UK Jerseys in Appendix Table 1 and Table 2.

Milk yield per cow had been fairly constant over the 10 years before the first heifers sired by imported semen joined the milking herd. Between the 2010 and 2017 recording years the average has increased annually by some 2.5%, or around 20% in total. Milk composition has changed rather little, with fat increasing by 0.1% and protein decreasing by the same amount.

Somatic Cell counts had already been reduced before importation but have since made impressive progress down by a further 25%. Calving interval has however remained relatively stable over the past 10 years after a previous increase of almost 20 days.

8.2

While these actual (phenotypic) performance levels are fundamental determinants of profitability on individual farms, and affect Jersey Dairy's efficiency, they are influenced by many factors other than the genotypes of the cattle. Management decisions by individual farmers concerning feeding levels, culling policies, heat detection and insemination practices, hygiene levels, and forage quality caused by weather conditions, all play their parts. In order to investigate the specific effects of the imported semen, it is the underlying genetic trends which must be calculated. Fortunately, these can now be estimated.

Farmers have become familiar with the use of Estimated Breeding Values (EBVs) supplied to them through AHDB-Dairy. Sometimes these are expressed as Predicted Transmitting Abilities (PTAs), which are the amount by which an individual's progeny are predicted to perform above or below the average. The PTA is equal to half of the EBV. In a well-recorded, pedigreed population, all animals can be given an EBV from birth. At that stage it can only be estimated as the average of its two parents' values. As a heifer grows, calves, and enters the adult herd, it provides data on its own milk and reproduction traits. These figures are incorporated into a revised and more accurate EBV. This process continues throughout its life (and indeed afterwards) as more data accumulate from its own performance and from all of its relatives. Similarly, bull calves start life with a parental average EBV, and while this is updated as they age, it only really becomes more accurate when it has daughters in milk. Revised EBVs are published three times a year and are used by the owners to help decide which heifers (or bulls) to rear, which to retain, and which matings to arrange. (The use of DNA information, to supplement or replace actual performance records for the purposes of estimating breeding values will be considered in Report 2.)

If these EBVs are averaged, say for all heifers registered in a year, and compared with the mean of the previous year's group, then the difference can give a measure of the annual genetic change in the population. Fortunately, NBDC staff, using results from AHDB, are now able to calculate trends for all recorded traits. They do however restrict publication for some. Where the statistics cannot be calculated with a sufficiently high degree of reliability, then their policy is not to publish in case misleading conclusions are encouraged.

Figure 8.1a

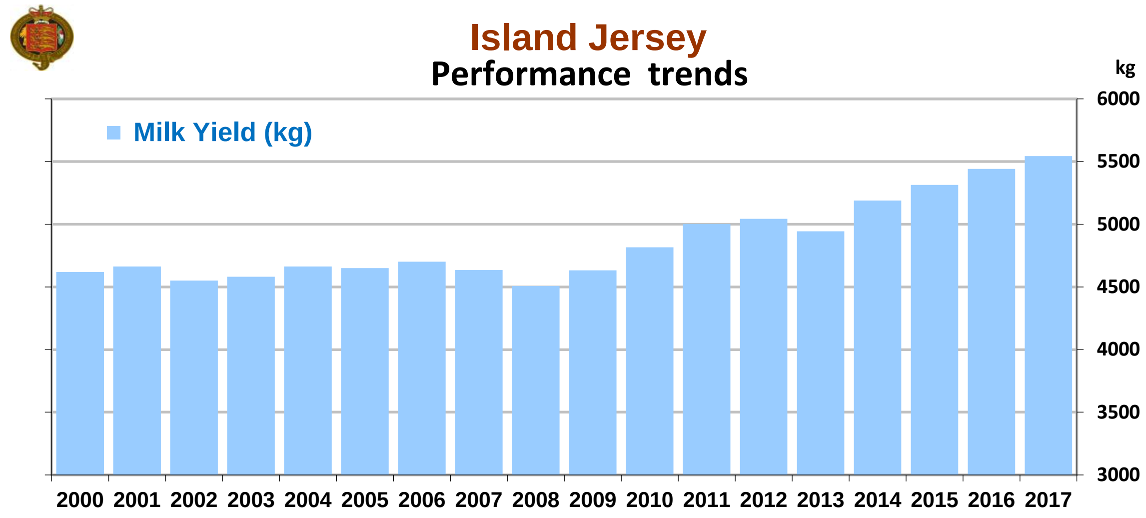


Figure 8.1b

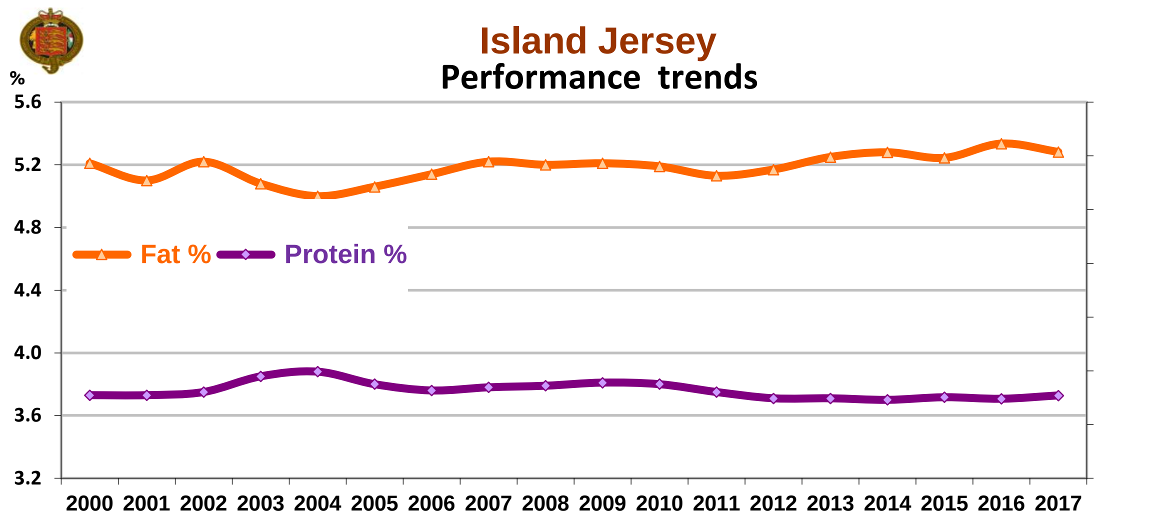


Figure 8.2

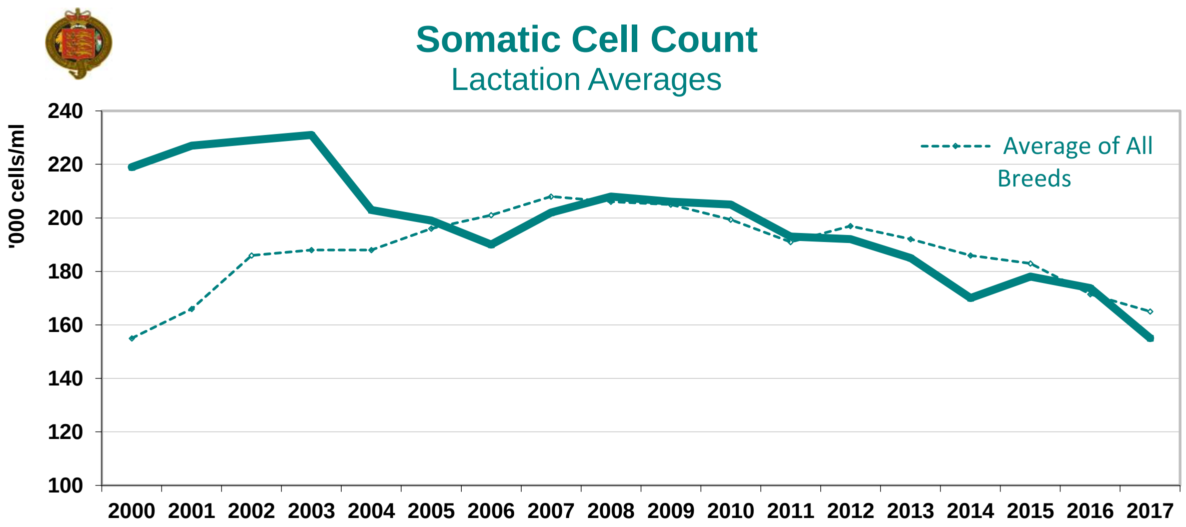
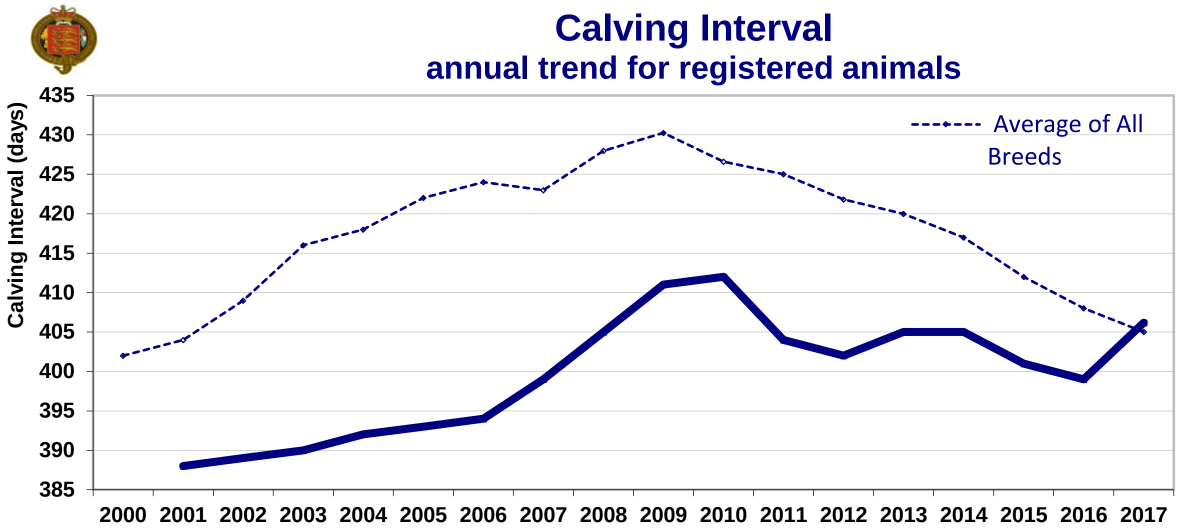


Figure 8.3



9. Genetic Trends from the Island Herd

9.1

Figures 9.1 to 9.3 show the genetic trends in milk yield and components. These are based first on the PTAs of milking females, but also have a second line calculated from the PTAs of their sires. In most improvement programmes the major selection pressure is applied through the choice of bulls, and their genetic advantage is then passed into the herds through their daughters. This is well illustrated in these graphs. As superior international sires became available from 2008 the lines separate. The sires can clearly be seen to be pulling the cow population upward with an inevitable time lag.

The genetic increase in annual milk yield from the heifers born in 2008 to those in 2017 is already over 300 litres, and the sire line shows that breeders are continuing to find bulls with even higher potential. Since these heifers take time to move through the several age groups in the milking herd, there is clearly a promise of continuing increase in actual (phenotypic) yields per cow on the farms. What is more, the genetic trends in both fat and protein % are positive, with increases of 0.1 to 0.15% over these 10 years.

9.2

For somatic cell count, there is no published genetic trend line based on the cow genotypes. The sire line (Figure 9.4) suggests that before 2012/13 there had been a tendency for breeders to use bulls which were poorer than average, but that there has subsequently been a considerable improvement. The Danish population has a good reputation for this trait, and breeders have consistently sired around 10% of their replacements by such bulls.

The two measures of genetic trends in fertility related traits, Calving Interval, and Fertility Index, based only on sire data (Figures 9.5 and 9.6) both reveal unfavourable trends. These traits must surely be given more attention in future sire selection. There is ample evidence of how the Holstein breeders in the UK have improved reproductive traits in their cattle since health and fitness traits have been given greater weight in bull evaluations.

Figure 9.1

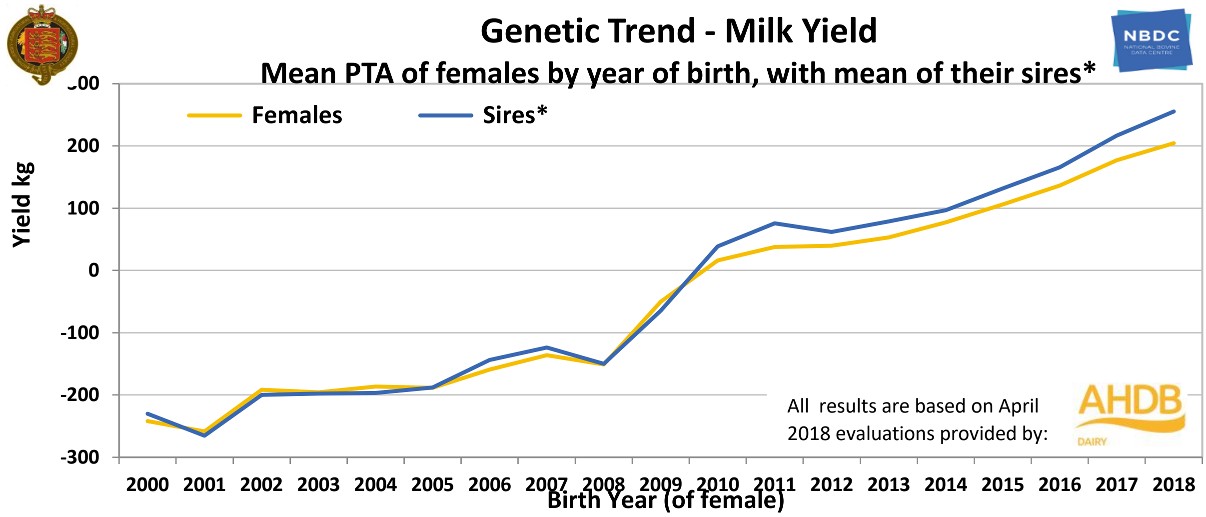


Figure 9.2

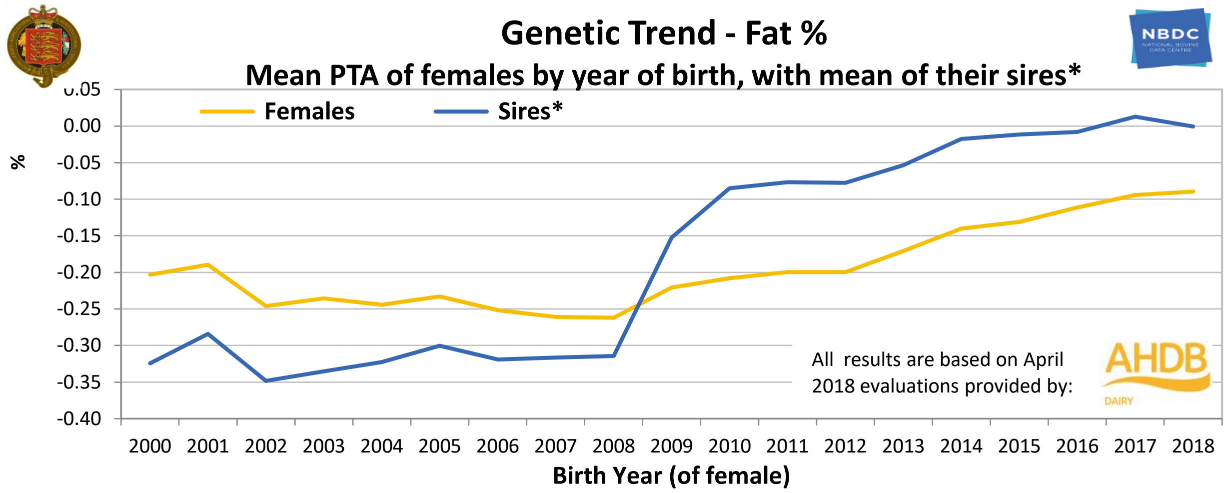
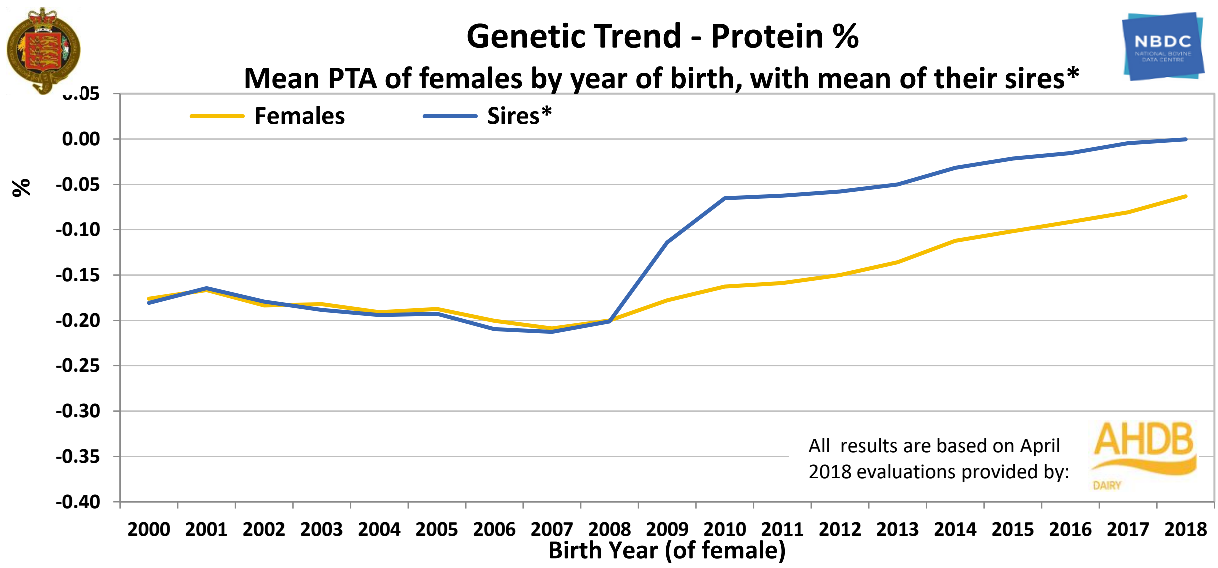


Figure 9.3



(*Sire averages are weighted according to the number of daughters)

Figure 9.4

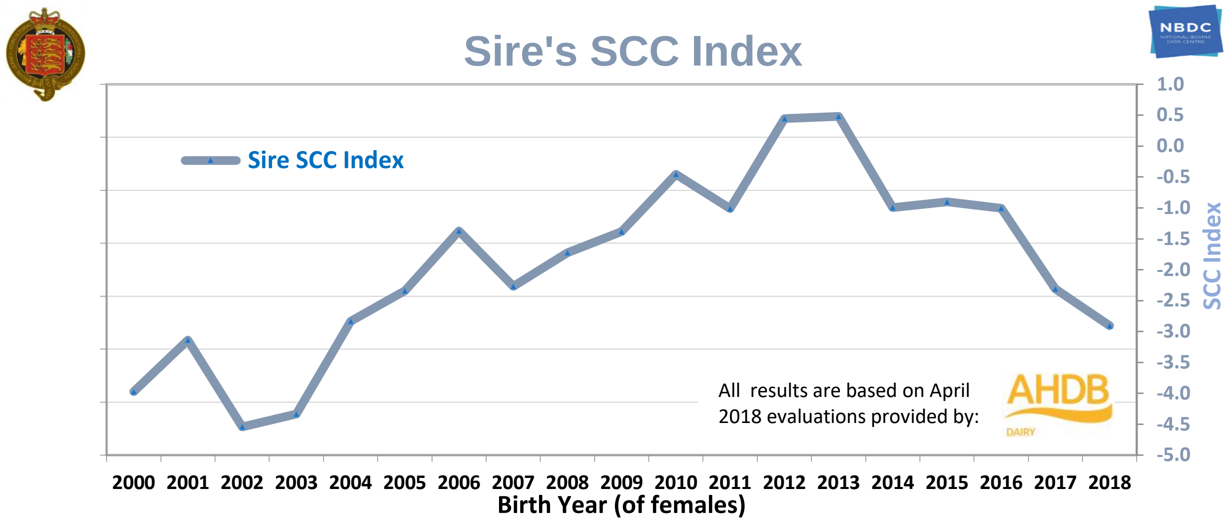


Figure 9.5

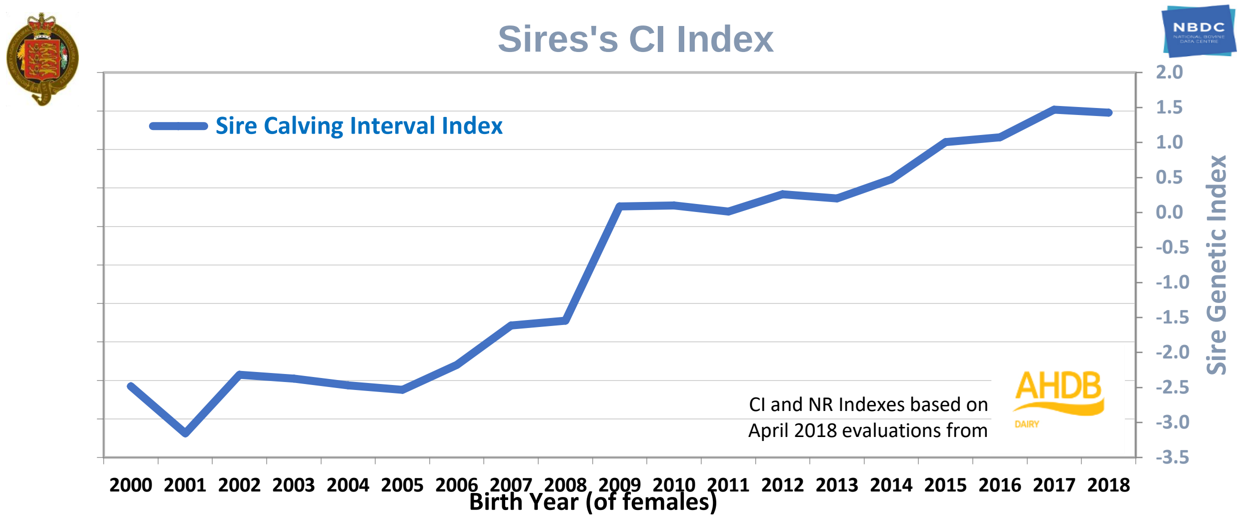
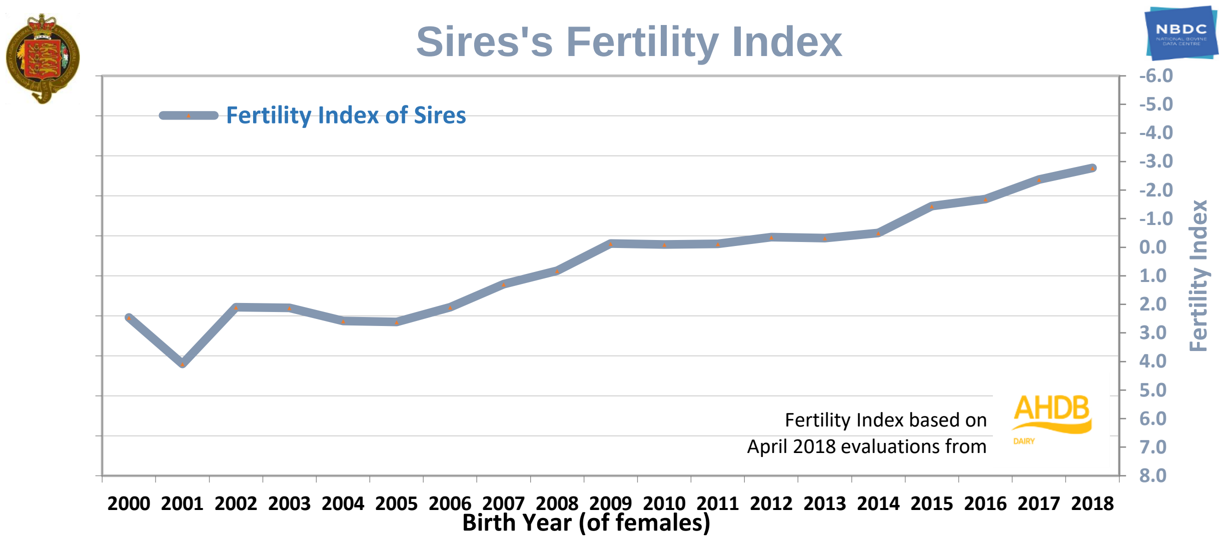


Figure 9.6



(Sire averages are weighted according to the number of daughters)

10. Type Traits

Many different type traits are scored by the visiting classifiers from Holstein UK. Only a few of these are considered here. Figures 10.1 to 10.11 all attempt to show the actual assessed (phenotypic) changes in successive annual cohorts of heifers recorded during their first lactations compared with the genetic trends in their sires' PTAs. Care is needed in drawing conclusions from the linear assessments as some traits may be more affected by subjective scoring. Traditionally the Island cattle have been more similar phenotypically within the wider British Jersey population. The different UK classifiers see all the Island cattle together, every five months, and may have been less able to use the full scale. Scores for the 2015 and later cohorts may be less accurate because only a proportion of them had been assessed by April 2018.

Overall, the heifer scores are fairly stable or slightly favourable, while virtually all the genetic trends from sires are quite strongly positive since the time when importations were permitted. This is shown again in Figure 10.12 where the heifers' genetic trend is plotted, calculated until 2015 from their own evaluations. These statistics confirm the conclusions from breeders' observations from their own cattle.

Figure 10.1

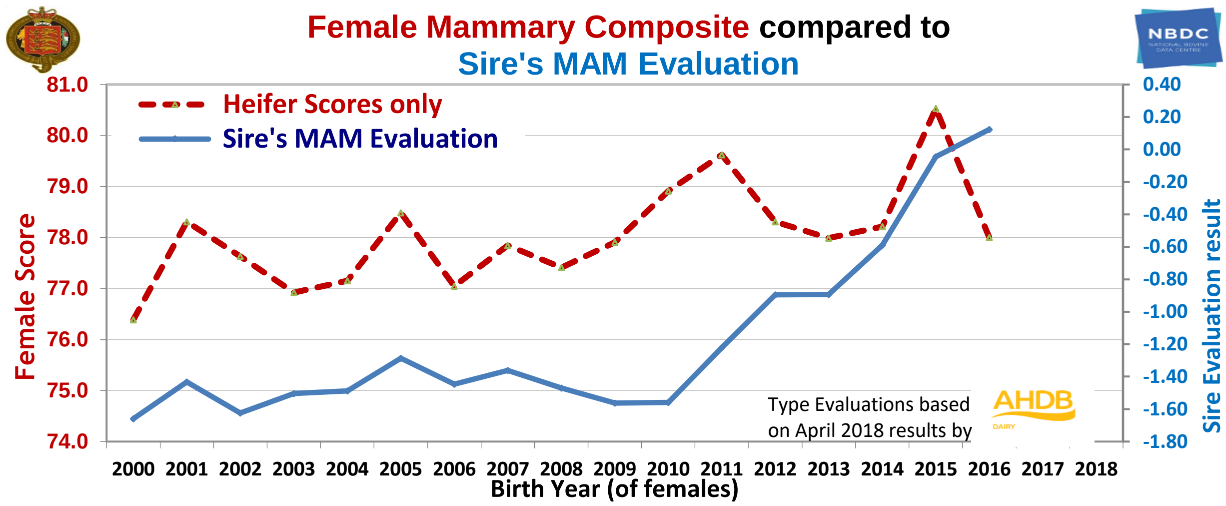
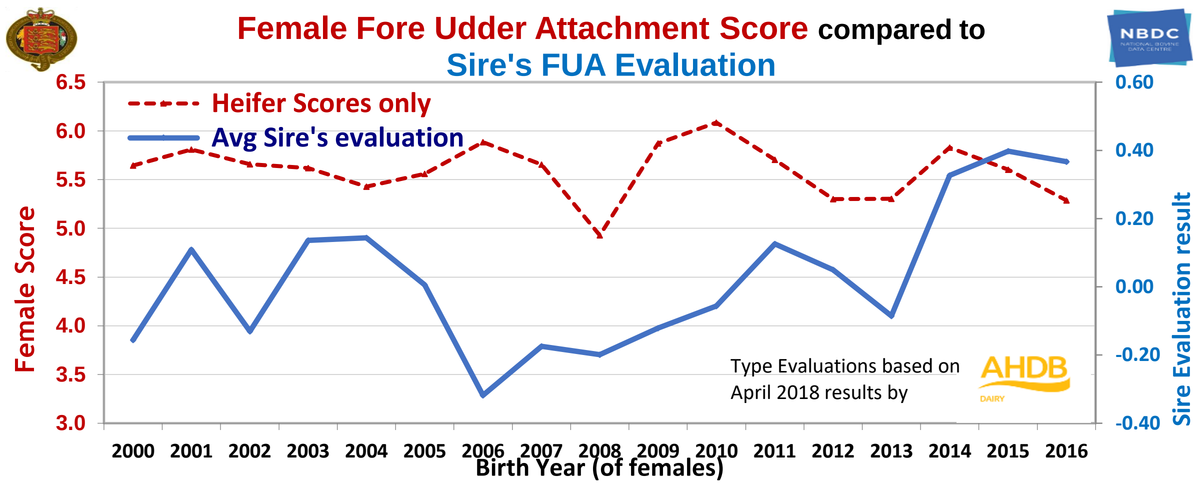


Figure 10.2



(Sire averages are weighted according to the number of daughters)

Figure 10.3

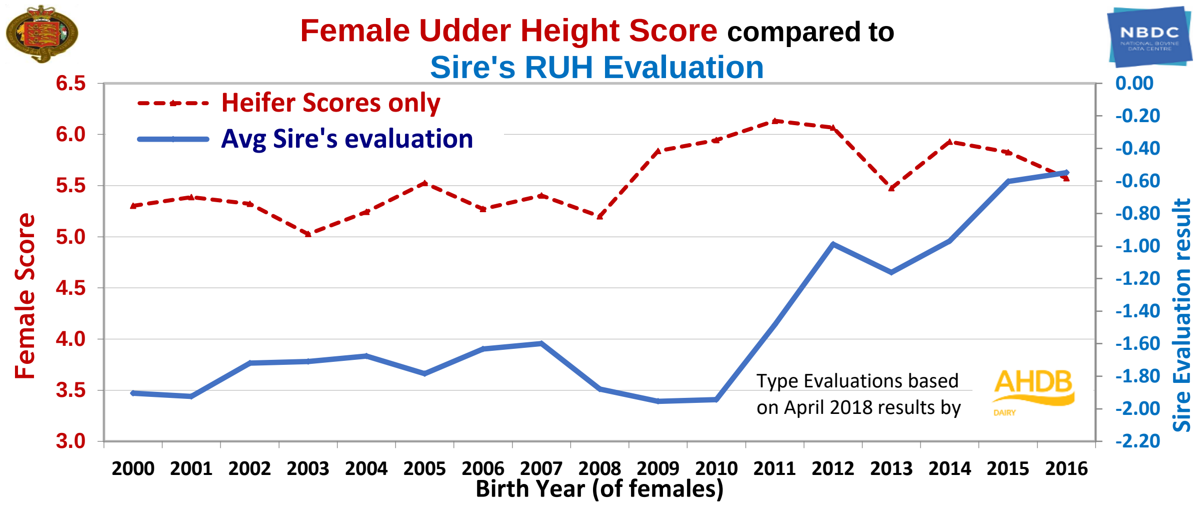


Figure 10.4

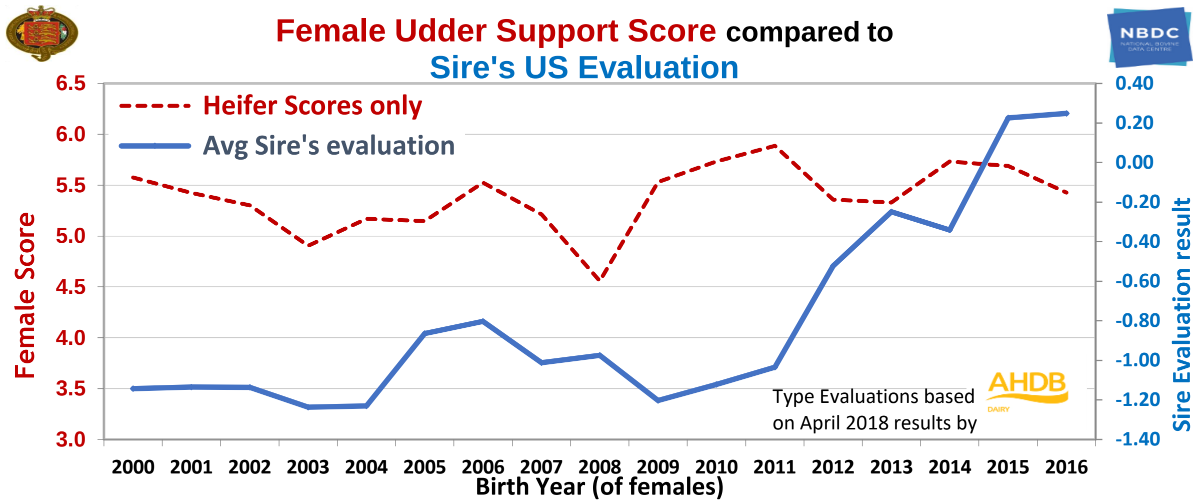
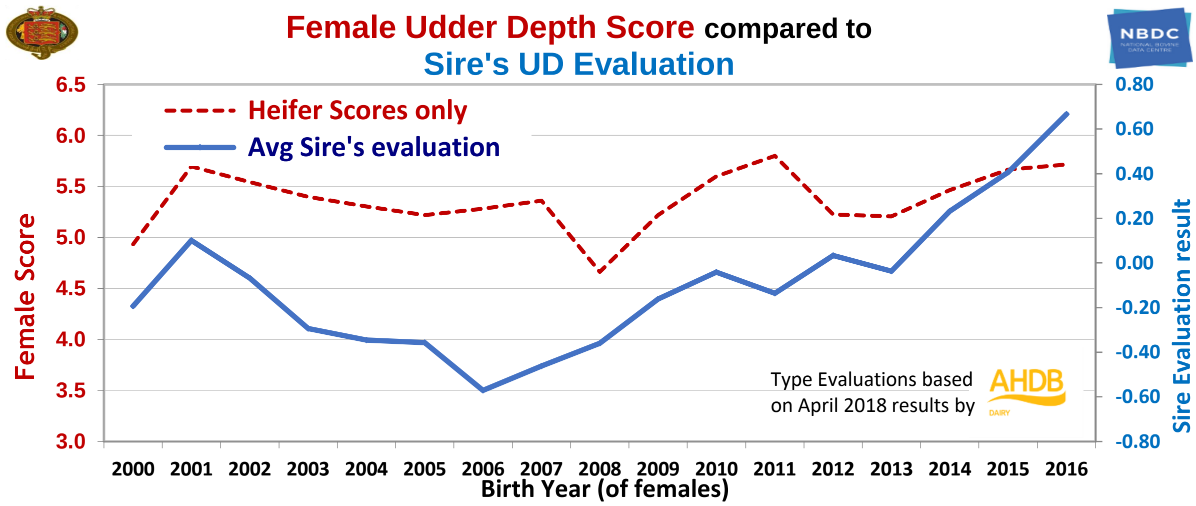


Figure 10.5



(Sire averages are weighted according to the number of daughters)

Figure 10.6

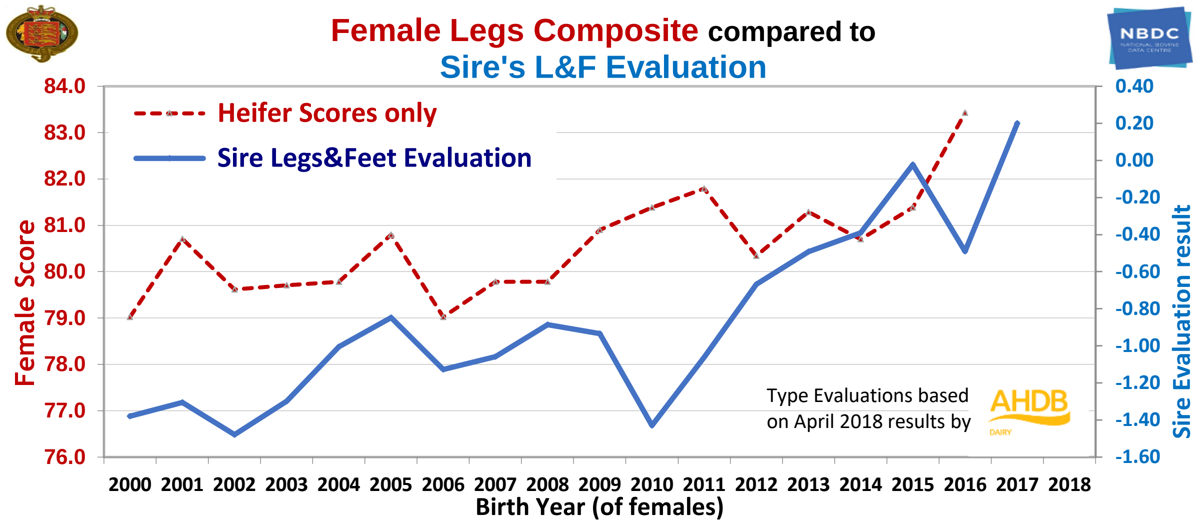


Figure 10.7

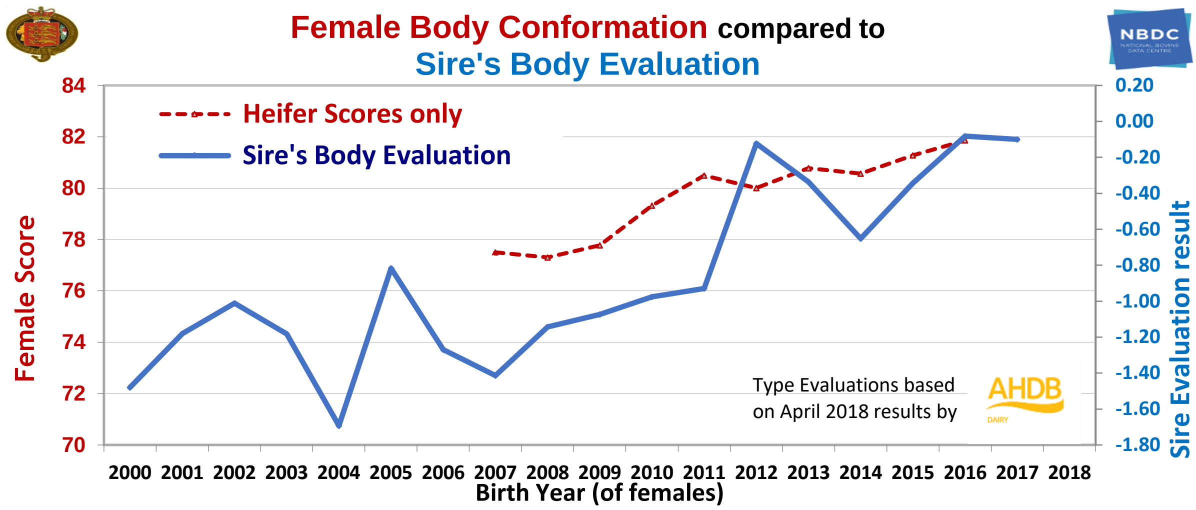
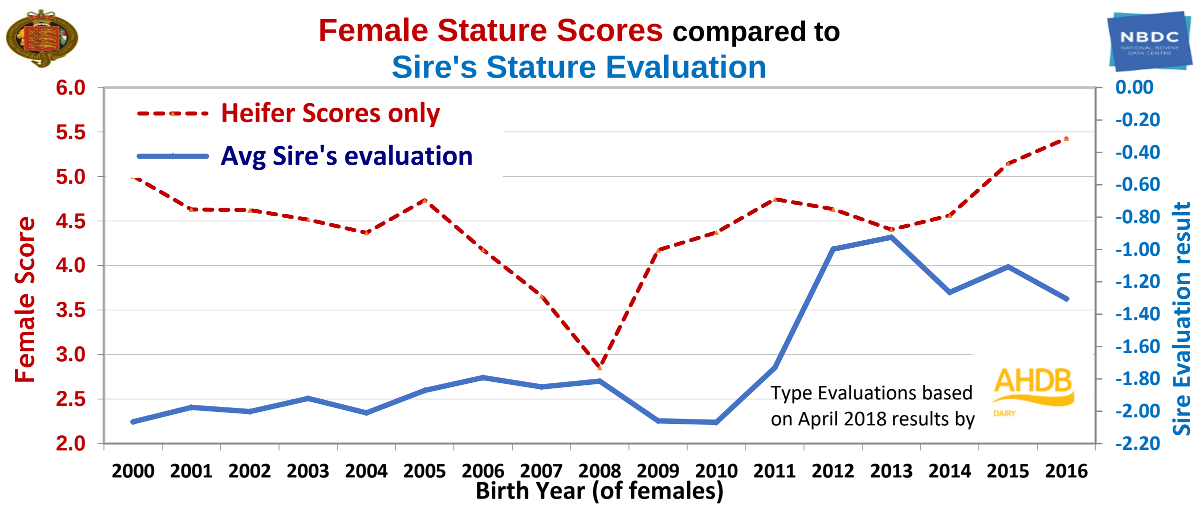


Figure 10.8



(Sire averages are weighted according to the number of daughters)

Figure 10.9

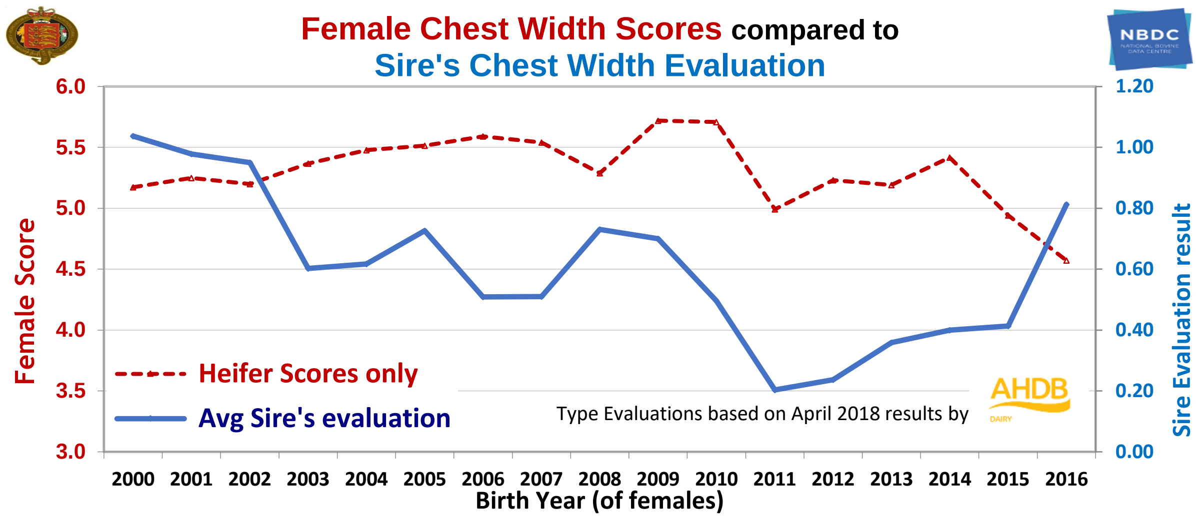


Figure 10.10

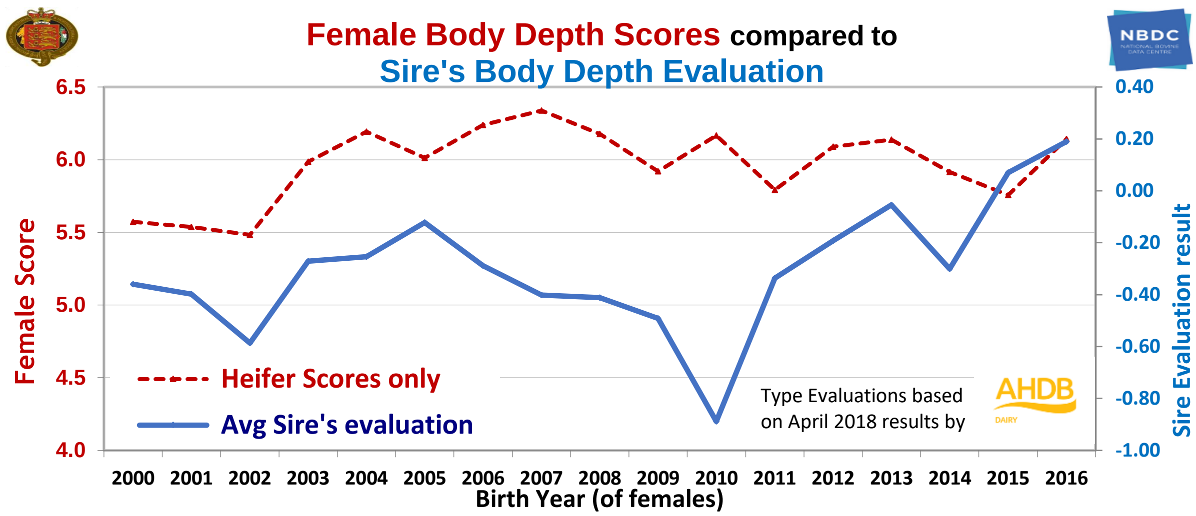
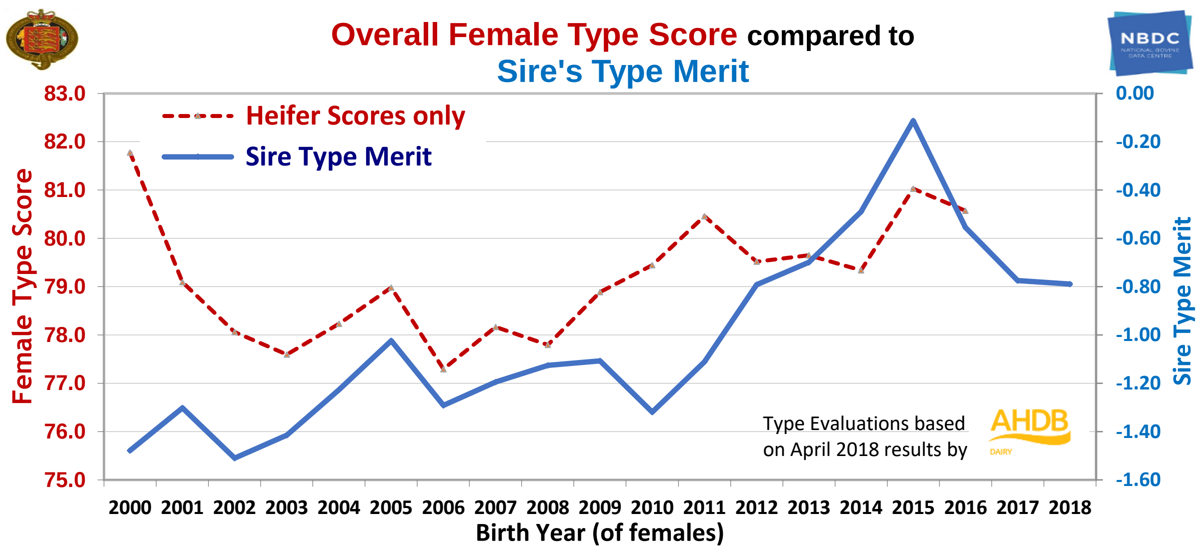
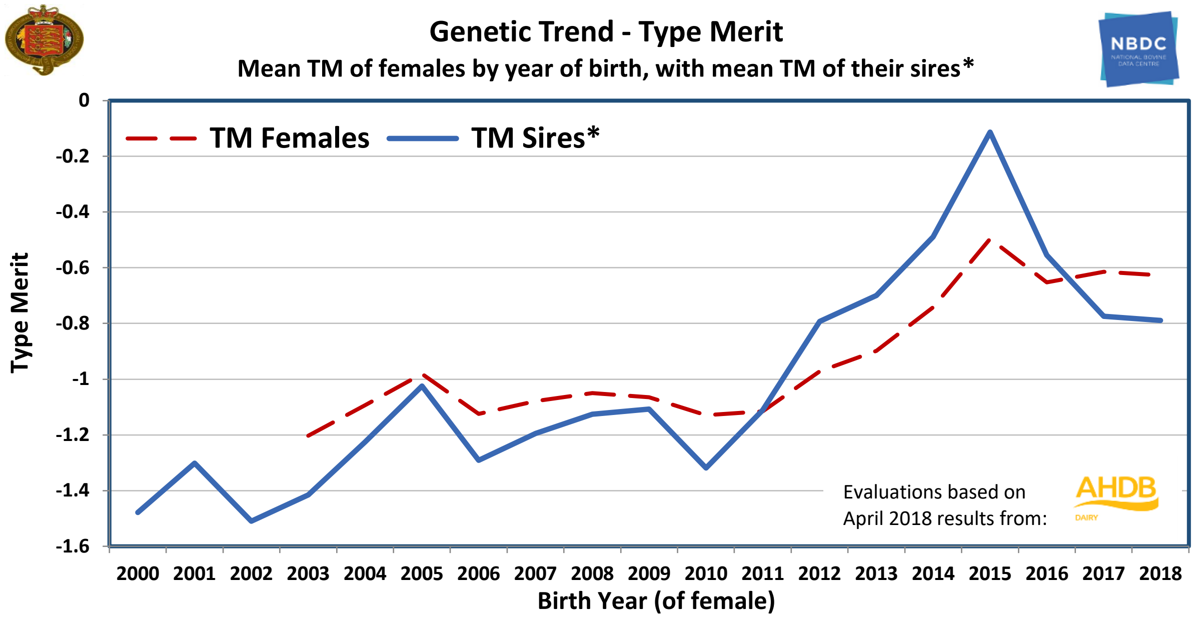


Figure 10.11



(Sire averages are weighted according to the number of daughters)

Figure 10.12



(*Sire averages are weighted according to the number of daughters)

11. Overall Improvement

Figure 11.1 arguably presents the single most important results of this whole evaluation. It shows the genetic trends, for both females and their sires, in the Profitable Lifetime Index (£PLI).

The Index attempts to represent the additional profit a high £PLI bull (or cow) is expected to transmit through each of its milking daughters over her lifetime compared with an average bull (or cow). It has been developed by AHDB-Dairy in consultation with UK producers, and reflects the latest (2017 revision) UK market and farming conditions, which are of course somewhat different from those on Jersey.

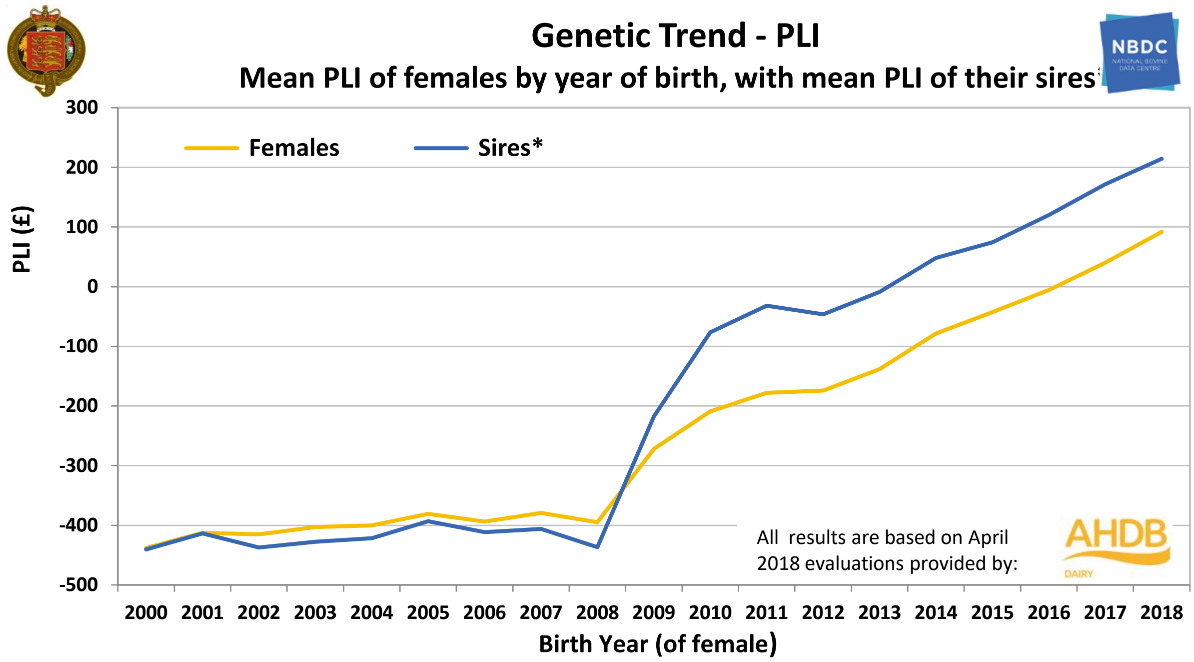
Evaluation and selecting bulls on £PLI should:

- promote yield while protecting milk quality
- increase emphasis on fertility
- improve functional type – feet and legs and udders
- increase emphasis on longevity
- reduce costs associated with maintenance
- improve udder health
- improve calving performance.

More detailed consideration will be given to the future use of £PLI as a main selection criterion within the Island herd in Report 2.

The picture shown in Figure 11.1 is dramatic. After showing almost no improvement over the eight-year period when support for the Jersey Bull Proving Scheme was gradually declining, there has been an immediate and sustained lift in the merit of each successive annual crop of heifers since importations began. The average gain over the nine years is estimated at close to £45/year. Each heifer has the potential to increase the farm profit by this amount, over its lifetime, compared with one born a year earlier. Not just by producing more milk, but by breeding more regularly, costing less to maintain, and remaining healthy in the herd for longer.

Figure 11.1



(*Sire averages are weighted according to the number of daughters)

12. Jersey Dairy Milk Supply and Utilisation

By 2008 the total milking herd had been brought down to around 3000 cows (from some 4500 in 2000) and remained fairly steady (Figure 12.1) until decreasing by a further 10% to 2700 in the 2016 recording year (April to March). Total milk deliveries were at an all time low (11.8m litres in 2008) but rose gradually by around 18% to reach 13.9m in 2016. Not all of the increase in yield per cow can be attributed to improved genetics as its penetration has been shown to be quite a gradual process. No doubt the reduction from 29 to 20 larger supply herds has meant that there is now a more professional dairy sector utilising modern feeding and management practices – with resulting higher yields.

Jersey Dairy has helped with this restructuring process and continues to do so. As a result, the total volume of milk which it has purchased has kept in pace with its successful development of old and new export markets. The prospects for matching future supply and demand will be an important consideration in the genetic plan for the next 10 years (to be developed in Report 2).

Figure 12.1 Dairy industry historical statistics
(supplied by Jersey Dairy from JMMB accounts)

Year (1 April to 3 March)	**Total milk delivery** (million litres)	**No. cows**	**No. herds**	**Average herd size**
2008	11.8	3050	29	103
2009	12.6	2979	27	106
2010	12.9	2970	27	106
2011	12.7	2890	26	107
2012	12.6	2931	24	117
2013	13.4	2917	23	122
2014	14.0	2946	23	123
2015	13.9	2807	20	134
2016	13.9	2731	20	130

Appendix

Table 1.

UK Breed Lactation Production Trends

Island Jersey

Annual Production Trends for registered animals (all ages)

Year ended Sep	No. of Lactations (RJA)	Milk Yield (kg)	Fat %	Protein %	Fat Yield (kg)	Protein Yield (kg)	Somatic Cell Count ('000 cells/ml)	Calving Interval (days)
2000	3767	4619	5.21	3.73	241	172	219	
2001	3748	4663	5.10	3.73	238	174	227	388
2002	3685	4550	5.22	3.75	237	171	229	389
2003	3062	4581	5.08	3.85	233	176	231	390
2004	2923	4662	5.00	3.88	233	181	203	392
2005	2958	4649	5.06	3.80	235	176	199	393
2006	2805	4702	5.14	3.76	242	177	190	394
2007	2975	4636	5.22	3.78	242	175	202	399
2008	2650	4506	5.20	3.79	234	171	208	405
2009	2695	4632	5.21	3.81	241	176	206	411
2010	2577	4815	5.19	3.80	250	183	205	412
2011	2606	5003	5.13	3.75	257	188	193	404
2012	2655	5043	5.17	3.71	261	187	192	402
2013	2765	4943	5.25	3.71	259	183	185	405
2014	2715	5190	5.28	3.70	274	192	170	405
2015	2746	5314	5.24	3.72	279	198	178	401
2016	2655	5443	5.34	3.71	290	202	174	399
2017	2495	5543	5.28	3.73	293	207	155	406

Produced by the National Bovine Data Centre in partnership with the RJA&HS

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Table 2.

UK Breed Lactation Production Trends

Jersey UK

Annual Production Trends for registered animals (all ages)

Year ended Sep	No. of Lactations (JUK)	Milk Yield (kg)	Fat %	Protein %	Fat Yield (kg)	Protein Yield (kg)	Somatic Cell Count ('000 cells/ml)	Calving Interval (days)
2000	15341	5048	5.45	3.90	275	197	184	392
2001	15920	5072	5.48	3.89	278	197	189	391
2002	15898	5257	5.45	3.91	286	205	198	395
2003	15979	5401	5.39	3.88	291	210	189	399
2004	15906	5454	5.39	3.84	294	209	191	401
2005	15185	5531	5.43	3.83	300	212	204	403
2006	15490	5562	5.44	3.82	302	212	217	404
2007	18587	5618	5.38	3.84	302	216	210	406
2008	17987	5673	5.39	3.87	306	220	207	407
2009	17890	5638	5.40	3.89	305	219	201	408
2010	17925	5721	5.40	3.84	309	220	187	407
2011	17473	5862	5.36	3.84	314	225	183	405
2012	18336	5909	5.39	3.82	318	226	193	402
2013	18169	5710	5.47	3.80	312	217	192	405
2014	18504	6024	5.46	3.83	329	230	186	404
2015	18346	6021	5.43	3.85	327	232	185	399
2016	17737	6043	5.49	3.85	332	233	178	399
2017	16792	5967	5.46	3.86	326	230	168	399

Produced by the National Bovine Data Centre in partnership with the Jersey Cattle Society

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